Reforming Social Security with Progressive Personal Accounts

by

John Geanakoplos
Yale University

and

Stephen P. Zeldes
Graduate School of Business, Columbia University; and NBER

Latest revision: February 2006

We thank Theodore Papageorgiou, Allison Schrager, and Carolina Silva for research assistance, and Andrew Biggs, Jeffrey Brown, Jeffrey Liebman, and Deborah Lucas, for helpful comments and suggestions. An earlier version of this paper was presented at the 7th Annual Joint Conference of the Retirement Research Consortium "Creating a Secure Retirement System," August 11-12, 2005, Washington, D.C.

This research was supported by the U.S. Social Security Administration through grant #10-P-98363-1 to the National Bureau of Economic Research as part of the SSA Retirement Research Consortium. The findings and conclusions expressed are solely those of the authors and do not represent the views of SSA, any agency of the Federal Government, or the NBER.
I. Introduction and related literature

During most of 2005, the United States was engaged in a heated debate about whether to replace part of the current, defined benefit Social Security system with a system of defined contribution personal accounts. President Bush gave speeches in numerous cities and towns advocating a reform that included these individual accounts. Both proponents and opponents of individual accounts have emphasize the stark differences between the current defined benefit system and one with individual accounts. The mechanics and outcomes of the two systems would seem to be quite different, and their goals are usually presented as diametrically opposed.

Democrats who advocate retaining the current system will not budge from two implications of regarding social security as social insurance: (1) social security should redistribute wealth from those who have earned more over their whole working lives to those who have earned less, and (2) different generations should share the risks of aggregate shocks.

Republicans, on the other hand, will not give up on what they regard as real social security, and that means (1) ownership by individuals of tangible assets that cannot be revoked by a future government and (2) market valuations of those assets as they are accrued so that rational planning for retirement can take place outside of social security.

Our purpose is to find a common ground between these two approaches which preserves the core goals of each. We show that in fact it is perfectly possible to convert social security into a system of personal accounts, with irrevocable ownership of market priced assets, while at the same time redistributing benefits based on lifetime income and sharing risks across generations. We call these progressive personal accounts.$^1$

Redistribution based on lifetime income is accomplished via a variable matching of contributions; high earners receive lower matches than low earners. The Clinton administration already proposed supplemental social security accounts with matching based on current income. Such a simple plan, however, loses the efficiencies (in our current system) from basing redistribution on lifetime rather than annual income. Thus

---

$^1$ Portfolio choice is another dimension along which Democrats and Republicans disagree. Republicans see choice as beneficial, while Democrats see it as dangerous. Here, a compromise is conceptually easy to work out; one simply restricts the degree of choice available within personal accounts.
one conceptual hurdle we must overcome is how to design a system of personal accounts which irrevocably redistributes retirement benefits each year of work according to lifetime earnings that are not yet known. We show how to solve the problem by taxing or subsidizing new contributions (with a government match) at a rate that depends on the total of past contributions. This variable match approach could be used to modify the standard personal accounts holding traditional financial assets proposed by the Bush administration and others, or the notional accounts that have recently been adopted in a number of other countries.

Variable matching can be used to achieve intra-generational insurance, transferring benefits from those lucky enough to have high lifetime earnings to those unlucky households in the same generation who have had low lifetime earnings. But it does not address the problem of sharing risks across generations. Indeed this is impossible with conventional personal accounts holding traditional securities like stocks and bonds. We are therefore led to propose the creation of a new kind of derivative security whose payoffs depend on the average labor earnings of those working at a specific point in time. We call this security a Personal Annuitized Average Wage security, or PAAW.

A PAAW pays its owner one inflation corrected dollar for every year of his life after a fixed date t (near his retirement age), multiplied by the economy wide average wage at t. Because the security is partly an annuity, it provides insurance for long life, paying every year until death. Furthermore, because the payment depends on the average wage at retirement, it creates risk sharing across generations. If young workers are doing well and receiving high wages, the old will get higher payoffs from their PAAWs, and conversely. Initially the progressive personal accounts could be required to hold all their wealth in PAAWs, without any opportunity to trade them in financial markets.

We show that by choosing a particular variable match, and restricting accounts to hold PAAWs, it is possible to create a system of progressive personal accounts that exactly mimics the promised taxes and payouts of the current system. Such a system would preserve the core goals of the current system, but would also improve upon it due to the increased transparency, enhanced property rights, and lower political risk (of legislation removing benefits) that naturally come with individual accounts. Replicating
the current system may not be the best way to implement individual accounts, but it serves as a starting point that allows one to compare and contrast the current system (translated into the language of DC) with the more standard DC systems typically proposed. This should facilitate improved communication between the two sides of the current social security debate. A natural next step would be to strive for further improvements. We are currently working on modifying our proposed market-based system in order to provide for automatic balancing – reducing or avoiding the need for politicians to alter the tax and benefit rules affecting participants. One way to implement this is to alter the policy rule that transforms contributions into PAAWs. We are also considering ways to improve on the risk-sharing arrangements in progressive personal accounts.

PAAWs are of course a new and unfamiliar security, but they are not different in kind from a host of other derivative securities introduced by Wall Street in recent years. If our progressive personal accounts are prohibited from selling them, then the accounts become similar in some respects to the notional defined contribution (NDC) accounts that have been implemented in Sweden, Italy, and a number of other European countries. In these notional accounts, balances earn a prescribed rate of return (the “notional interest rate”) that is typically tied to the growth rate of wages. By the age of retirement, they, like PAAWs, have value proportional to contemporaneous wages. The fact that other countries, under budgetary pressures similar to the U.S., have moved in the direction of unconventional accounts suggests that they might be worth investigating here. But PAAWs seem to us a distinct advance over notional accounts. In our view, a balance should always correspond to value. By transforming a notional balance into a potentially tradable security, we can create the same payoffs at the end, while attaching a true (not notional) value along the way. If PAAWs were traded, then their market price in every year would certainly not grow at the rate of growth of wages. Market price, not notional balance, gives a reliable indicator of value that would help agents plan for their retirement outside of social security.

PAAWs are individual specific securities, paying as long as the individual lives. They are thus analogous to individual mortgages, whose payments depend on the individual’s decision to prepay or default (in which case the payoff also depends on the individual’s home resale value). To be marketed efficiently, PAAWs should be pooled,
just like mortgages. Investors in the pool would not buy a single PAAW, but a pro rata share of all PAAWs with the same date t.

If workers were allowed to sell all their PAAWs, they might well do so, buying conventional securities, and destroying the risk sharing across generations implied by the PAAWs. We would therefore propose that only a small proportion of their PAAWs, say 10%, could be sold off. In fact, we would oblige the personal accounts to sell precisely this fraction. This would maintain the basic form of the personal accounts, while willy nilly creating a market for PAAWs.

The market price for PAAWs would provide important information to households, governments, and other market participants. First, a market price for pooled PAAWs would give people information about the market value of their own PAAWs, helping them with their financial planning decisions regarding saving and asset allocation. Second, the price of PAAWs would give economists a reliable guide to the present value of the liabilities accrued in the Social Security system, a number which currently is quite controversial. Third, as the pools of PAAWs mature, they turn into pools of individual annuities. As such, they become a form of survivor or longevity bond that provide a market guide to aggregate mortality probabilities.

But there are other advantages to such new markets. The PAAWs could be used as collateral for issuing further annuities. We believe this would have a salutary effect on the annuities markets and the reverse mortgage markets, which at the moment are hobbled by inefficiencies and adverse selection. The social security system embodies a gigantic contingent obligation from the government. The economic system would be improved if a fraction of these obligations could be securitized, and therefore priced and available as collateral for other obligations. Until recently, financial markets may not have been able to process these new securities. But Wall Street is ready for them now, and it would be a great missed opportunity not to avail ourselves of them.

Since the market for PAAWs is most likely some years away, we attempt to estimate the price of a PAAW, under risk neutrality. Using this approximate price for PAAWs, we compute the variable match rate (i.e. the difference in value between contributions and PAAWs awarded) that is implied in the current system. Modifications to the current system might begin by adjusting this match rate.
Our work is related to and builds on a number of other papers in the literature. Feldstein and Samwick (1992) and Cushing (2005) compute the implicit marginal tax rate under the current system. Geanakoplos, Mitchell, and Zeldes (1999) discuss alternative ways to compute accrued Social Security benefits, and Jackson (2004) describes a system of accrual accounting that he argues would more clearly describe Social Security’s financial situation. Feldstein and Liebman (2002) analyze the redistributive features of an individual account plan with a two-tier contribution structure in which part of the inflows are proportional to earnings and part are lump-sum contributions. Vickrey (1947) and Liebman (2003) discuss the advantages of basing taxation on lifetime rather than annual income. Valdes-Prieto (2000, 2005), and Borsch-Supan (2005) analyze notional DC systems, such as those adopted in Sweden and Germany, and the self-adjustment mechanisms built into them.

A number of papers have proposed the creation of related new financial securities. For example, Shiller (1993) proposes GDP-linked securities, Blake and Burrows (2001) proposes longevity or survivor bonds, and Bohn (2002) and Goetzmann (2005) propose aggregate wage-related securities.

II. Progressive personal accounts

Personal social security accounts would seem necessarily to eliminate the progressivity built into the current social security system. In the current system the benefits received by social security contributors is a concave function of lifetime earnings, providing smaller increments in benefits with each additional dollar of lifetime earnings. In this section we show that personal accounts can be made progressive simply by taxing or subsidizing new contributions at a rate depending on the size of accumulated previous contributions.

Personal accounts, by virtue of being personal, would also seem to violate the sharing of risks across generations that is built into the current system. In the current system, retiree benefits depend on the wages of the next generations of workers. As the young do better, so will the old, and vice versa. If the personal accounts hold stocks and bonds it is quite possible that retiree benefits will move in the opposite direction from wages, at least for some cohorts. But there is no reason the personal accounts should be confined to traditional investment securities. We propose the creation of new
In Section V, we discuss briefly how the analysis could be extended to include spouses and children (and their associated program benefits), as well as early or delayed retirement.

We use the terms "labor income", "labor earnings", "earnings", and "wages" interchangeably in this paper to mean annual wage income. The term "average economy-wide earnings" is simply the average of annual wage income across workers.

In fact, we shall show in this section that by creating personal accounts that hold PAAWs, it is possible to create a system of individual accounts that exactly replicates the current system. Progressivity and intergenerational risk sharing are compatible with personal accounts.

A. The current system

We begin by describing the current contribution and benefit rules for the U.S. Social Security system; we ignore adjustments that would have to occur in the event that Social Security is unable to meet its obligations. For simplicity, we focus on an individual who will be single and childless throughout life, who will not become disabled, and who will retire at the “normal retirement age” specified by Social Security.2

Program rules mandate that individuals and their employers together contribute 12.4 percent of all earnings below the earnings cap (the cap equals $90,000 in 2005). Of this, 1.8 percentage points are earmarked for disability coverage. In the analysis that follows, we ignore DI coverage, and therefore use a Social Security contribution rate of 10.6 percent.

For expositional clarity, we define a set of “relative” variables that are equal to the dollar amounts divided by average economy-wide earnings for the year.3 Relative earnings for any year t thus equals current taxable earnings for that year divided by average economy-wide earnings. Average relative earnings equals the average of the highest 35 values of relative earnings,4 and initial relative benefits are defined equal to dollar benefits in the first year of retirement divided by average economy-wide earnings.

We can use these variables to describe the promised benefit structure of the current U.S. Social Security system. Initial relative benefits are equal to a concave function of average relative earnings. This function is given in figure 1. Initial relative

---

2 In Section V, we discuss briefly how the analysis could be extended to include spouses and children (and their associated program benefits), as well as early or delayed retirement.

3 We use the terms “labor income”, “labor earnings”, “earnings”, and “wages” interchangeably in this paper to mean annual wage income. The term “average economy-wide earnings” is simply the average of annual wage income across workers.

4 We ignore for simplicity the program rule that average earnings are based on relative earnings until ages close to retirement, but nominal earnings afterwards.
benefits are equal to 90% of average relative earnings that are less than .24, plus 32% of average relative earnings between .24 and 1.35, plus 15% of average relative earnings greater than 1.35.

Dollar benefits in the first year of retirement (also referred to as the Primary Insurance Amount or PIA) are equal to initial relative benefits multiplied by average earnings in the retirement year. Benefits in subsequent years are indexed to the CPI, so that individuals receive a constant stream of real benefits for as long as they live.

**B. Defining new securities -- PAAWs**

We begin by defining three securities, which for the current purposes need not be traded. First, we define a PANT(I, tR) (personal annuity unit) as a person-I-specific "year tR annuity unit" to equal a security that pays one dollar in year tR and one inflation-adjusted dollar in every subsequent year that the individual I is alive.

Second, we define an Average Wage(t) Security as a security with a single payout in year t equal to the average economy-wide earnings in that year.

Third, we define a PAAW(i,tR): Personal Annuitized Average Wage Security for individual I and year tR. This is a composite security that pays off one PANT(i,tR) for every dollar paid in year tR by the average wage(tR) security.

PANTs, Wage Securities, and PAAWs are derivative securities, similar to countless others that have been created in recent years by Wall Street. In order to replicate the current system, workers would receive PAAWs in exchange for their social security contributions, which they would hold in their personal accounts; workers would be prohibited from selling them. Later we consider both the advantages and disadvantages of allowing trade in PAAWs, and also the advantages of a public market price for PAAWs.

**C. Translating the current system into an equivalent DC system**

We are now in a position to translate the current system into an equivalent defined contribution system, i.e. to show that the contributions and benefits of the current system can be replicated by an appropriately structured individual account system. Under such a system, workers and employers would (as in the current system) together contribute 10.6 percent of earnings up to the earnings cap. The government would credit each individual’s account with a number of PAAWs; the exact number
credited would depend (in a way to be specified) on current and past contributions. At retirement age, each PAAW would pay off a number of PANTs equal to the average wage in the economy in that year. In each subsequent year of life, an individual would receive the proceeds of the PANTs: a constant real (inflation-indexed) payment.

The current system redistributes from rich to poor on the basis of lifetime income, through the computation of benefits at the age of retirement. We wish to replicate this redistribution in personal accounts, where the benefits are irrevocably owned by the account as they are earned, long before one’s lifetime earnings can be measured. At first glance this seems impossible. But by making new accruals depend on accumulated balances, as well as new contributions, we can indeed achieve the lifetime redistribution in the current system.

1. Computing accrued balances (total and incremental)

We define PBAL$_{it}$ to be the number of units of PAAWs(i,t,R) accrued by worker I as of year t. There are actually many rules for the accumulation of balances PBAL$_{it}$ that can replicate the current system of redistribution. We think that the simplest and most logical is to define PBAL$_{it}$ as the benefits worker I would be entitled to under the current system given his earnings history up through year t, and assuming all his future earnings were = 0. Clearly with such a definition PBAL$_{it}$ can rise, but can never fall.

This definition of PBAL accrual makes it clear that we can award irrevocable benefits to young workers and yet still make total benefits accrued at retirement depend on lifetime earnings. There are other methods of accrual that also end with the same amount at retirement and never fall, but our definition accumulates balances most rapidly.

It would seem that our definition of PBAL$_{it}$ is a function of all of i’s relative wages before year t. But a moment’s reflection reveals that PBAL$_{it}$ can be thought of as a function of just (PBAL$_{it-1}$,Contribution(t)), provided that for a contribution coming after the first 35 years, only the excess of that contribution over the 35th highest relative contribution to date counts toward PAAW accrual.

PAAW accrual replicates the redistribution in the current system, and PAAW accrual is a function of 1) new contributions and 2) accumulated balances (PBAL). It turns out that additional PAAWs per additional contribution (measured in relative wages
units) is a decreasing function of PBAL. We illustrate how the accrual works in four examples, based on different assumed age-relative earnings profiles.

For worker 1, we assume that relative earnings equal 1 (i.e. earnings equal average economy-wide earnings in every year). For worker 2, we assume relative earnings equal average relative earnings for the cohort born in 1938. For worker 3, we suppose that relative earnings equal one-half the relative earning of Worker 2. For Worker 4, we assume that relative earnings = 1.5 relative earnings of Worker 2. Our results are shown in Figures 2-5.\(^5\)

Figure 2 plots the additional PAAWs per additional contribution (assuming a tax rate of 10.6 percent) as a function of PBAL. This graph is independent of the earnings history. We see that the pattern in the graph is similar to the slope in Figure 1 for the current system. As PBAL increases, the ratio of additional PAAWs the worker accumulates for every (marginal) contribution into the system, falls from .24 to .09 and eventually to .04 as his accrued balances increase from less than .2 to more than .54. Figure 3 plots the same series against time, effectively showing how fast the workers move along the schedule in Figure 2. The average cohort worker and the 1.5 average worker work their way down to the .04 ratio, but the 1.5 worker gets there sooner. Some of the workers never earn enough to move all the way to the .04 ratio. The economy average worker starts at .24 ratio, and ends in the .09 ratio. The .5*Average cohort worker does the same, but takes longer to get to the .09 ratio. Notice that there is no drop after 35 years, because earnings late in life are always greater than or equal to the 35th highest. Hence, on the margin, an additional contribution would yield the full additional benefit.

In Figure 4, we illustrate the change in PAAW balances over time for the four workers. The graphs are similar to those in Figure 3, but take into account the varying contributions due to the age profile of relative earnings. After year 35, a large fraction of each contribution does not count toward accrual – all that counts toward accrual is the difference between relative earnings and the 35th highest relative earnings.

Finally, in Figure 5, we look at the level of accrued PAAW balances (PBAL) versus age. The cohort average worker (worker 2) accumulates enough securities to

\(^5\) Although we have not done so, our approach could also be used to examine realizations of a stochastic earnings process.
receive almost 60 percent of the average wage in his first year of retirement. The fact that this is less than twice the accumulation of worker 3 (.5 cohort average worker) illustrates again the redistribution in the system.

2. Incorporating other social security benefits into personal accounts
   
   In the analysis above, we focused on single individuals with no children who retired at the normal retirement age with no chance of disability. This could be extended to incorporate spousal benefits, survivor benefits, early or delayed retirement, and disability. For example, spousal benefits could be implemented through the creation of a separate spousal account. The accrual of PAAWs in this account would depend on the current contributions of both the individual and the spouse, as well as the accumulated balances of each individual. The accounts would be vested after 10 years of marriage.

C. PAAWs vs Notional Accounts:

A growing number of countries have recast their social security systems in terms of notional accounts. Typically the money in these notional accounts is legislated to grow at the rate of the growth of wages. By the year of retirement the money in the account is proportional to the wages of the next generation’s workers.

PAAWs achieve the same end, but much more flexibly. Since they are bona fide securities, they can be traded. And their market prices will convey useful information to their owners, and to the stewards of the social security system, as we shall see.

III. Trading PAAWs

So far we have not allowed PAAWs to be traded or priced, and we have replicated the current DB system, including its intra and inter-generational risk sharing, with a system of progressive personal accounts. This has the great advantage over the current system of bestowing property rights over the benefits that workers have already accrued, meeting one of the goals of the Republican push to reform Social Security. The PAAWs themselves also make the future benefits very transparent, in contrast to the opaqueness of the current system.

The trading of PAAWs from individual accounts is a step that need not be taken. But if implemented in a measured way, it could provide further advantages. Pricing PAAWs in the market would enable individuals to observe the market value of their
account and to use this information to help plan their financial future outside social security. In addition, each household would be able to see clearly the difference between the value of the additional PAAWs accrued and the value of its contribution (i.e. the government match). PAAW prices would also be useful for valuing the aggregate accrued liabilities of the Social Security system. This in turn would help in designing policies that make the system self-balancing.

One way to implement the pricing of PAAWs would be to require owners of the personal accounts to sell a fixed percentage of their new PAAWs each year and purchase other securities with the proceeds. One could either require that a specific basket of securities be purchased (for example a broad-based equity index fund) or allow individuals to choose the securities or baskets of securities that they wish to hold in their accounts. Of course, allowing portfolio choice has both advantages and disadvantages, that we will not discuss here. But by keeping the percentage of PAAWs sold each year to be rather low (say at 10%), personal account holders would not be able to put the bulk of their social security benefits at risk.

A. Implementing the trade of PAAWs and PANTs via Pools

PAAWs and PANTs are individual specific securities, so trading them presents many liquidity and adverse selection problems. This is entirely analogous to the difficulties in trading home mortgages. In the mortgage market these problems have been overcome by the pooling of securities, and that is what we propose for PAAWs and PANTs.

We imagine that the personal account owners would actually be required to sell the small percentage of their PAAWs we spoke of above. These would be gathered into great pools, and then shares would be sold off to investors, exactly as in the mortgage market. In the mortgage market different homeowners, with different propensities to prepay or to default, sell their individual specific promises into pools. Shares in these pools are sold to the public. Investors are enabled to hold liquid shares, and they need only predict the average default rates or prepayment rates for the pools, not individual specific rates. The same would be true of pools of PAAWs.

Once PAAWs were pooled and securitized, they could be used as collateral for pools of PANTs. These pooled PANTs would be a form of survivor bond. For more on survivor or longevity bonds, see Blake and Burrows (2001).
annuities market is so hobbled by adverse selection and thin markets that it is hard to obtain a market forecast about longevity. The gigantic savings plan forced upon people by social security provides a remarkable opportunity to improve this situation. The price of the pools of PAAWs and PANTs would be an invaluable guide to private companies wishing to issue their own annuities, or reverse mortgages, making those markets more efficient. Annuity providers could hedge their position by holding shares of pooled PANTs.

IV. Pricing PAAWs

To determine what the market price of a PAAW would be if it were traded, we will need to introduce a model.\textsuperscript{7} We first examine the simplest model: one that assumes risk neutrality. We then sketch out the beginnings of how one might construct a model to compute pricing under risk aversion, leaving the implementation of this for ongoing work.

A. Pricing PAAWs assuming risk neutrality

Under risk neutrality, the value of an individual PAAW depends on assessments of 1) the growth in average wages, 2) the future path of interest rates, 3) individual survival probabilities. For our calculations below, we follow the 2005 Social Security Trustees Report by assuming a long-run growth in real wages of 1.1% and a long-run real interest rate of 3%. We use the cohort life tables from Social Security Actuarial Study 116 and assume for now that all individuals of the same age face the same conditional survival probabilities\textsuperscript{8}, i.e. that there is no heterogeneity or private information about these probabilities. Finally we make the assumption that the individuals are fully rational and have the correct expectations on the average wage growth rate.

Based on these assumptions, we compute an estimate of the market price of one PAAW\(_{(i,t_R)}\), measured in average wage units. The result is shown in Figure 6. The market price of the PAAW, in date \(t\) average wage units, rises steadily as \(t\) approaches \(t_R\), because a) the probability of reaching retirement increases as the individual survives.

\textsuperscript{7} Of course, once the market is thriving, one could simply observe market prices. But this still begs the question of how market participants would price PAAWs.

\textsuperscript{8} For the calculations presented, we used the survival probabilities for males born in 1980.
an additional year and b) \( r > g \), so that one year’s less discounting has a bigger effect than the increasing value of a wage unit.

Next, we compute (see Figure 7) the total projected market value of accrued PAAWs (measured in contemporaneous average wage units); i.e., the product of PAAW balances at any date \( t \) and the price at date \( t \) of a PAAW(\( i, t_R \)). This rises over time, to a value of 6.7 for the cohort average worker, meaning that the value of accrued balances at retirement is expected to be 6.7 times average economy-wide wages.

B. Allowing for risk aversion

Pricing PAAWs by assuming risk neutrality could easily be misleading. In ongoing work, we are examining model-based pricing allowing for risk aversion. We begin by first constructing the best replicating portfolios for the two underlying securities – Average Wage Securities and PANTs.

Consider first Average Wage Securities. If the Average Wage Security were a redundant security (i.e. the payoffs could be perfectly replicated by holding a basket of other traded securities), this would be a relatively straightforward task. For example, if the cash flows were always equal to the cash flows stemming from a certain number of shares of the S&P 500, plus a certain number of TIPS (Treasury Inflation Protected Securities), then one could simply price the Average Wage Security by looking at the market price of the shares of the S&P 500 and the investment needed to acquire the TIPS. Of course it is not possible to perfectly replicate an Average Wage Security with securities that are currently marketed. Alternatively, one could decompose a PAAW into a part that was indeed replicated by currently traded securities and a part that was not, and simply assume that the second part has price equal to zero. If the best replicating portfolio of currently traded securities leaves a residual that cannot be assumed to have price zero, then one has to use an alternative asset pricing model to assess the value of the residual. There are several models available for this purpose, and one would need to check that the price of the residual is robust, or at least that upper and lower bounds can be sensibly computed. We do not pursue this here, but plan to in future work.

Constructing a replicating portfolio is complicated by serial correlation in wage growth. The return on the Average Wage Security will be a function of the innovation in wage growth, not actual wage growth. Goetzmann (2005) ignored this distinction and looked for a replicating portfolio based on growth in average wages. He concluded that
wages and stock returns are not correlated, or even slightly negatively correlated, over the long run. We conjecture that once we allow for a different specification of the wage process, our results may well differ from his.

In addition to pricing the Average Wage Security, we must also price PANTs. The current market for annuities is a good place to start, but this market is beset by illiquidity and adverse selection. The market price for annuities is probably much too high. So we will take the same approach to replicating PANTs as we did to replicating average wage bonds. That will involve finding the correlations between longevity and productivity and stock value and so on.

Once we find reliable prices of average wage bonds and PANTs, we still need to price the composite PAAWs. There is a literature in financial theory indicating how, under certain conditions, it is possible to dynamically trade the replicating portfolios of two securities to replicate the product of the securities. We plan to show how this literature can be applied to obtain the price of PAAWs as a function of the prices of average wage bonds and PANTs.

V. The government match rate (under risk neutrality)

Once PAAWs are priced, in any of the ways indicated above, we can compute the government “match” (which can be positive or negative, i.e. a subsidy or a tax) as the difference between the market value of PAAWs received and the value of the contribution. The average match rate is defined as $[P_{PAAW} \times (\Delta PBAL) / \text{annual contribution}]^{-1}$. The marginal match rate is defined as $[P_{PAAW} \times \text{increment to PBAL per additional dollar of contribution}]^{-1}$.

Unlike most simple DC plans, the match rate is not constant across people or time. It depends on PBAL, the price of a PAAW, and the fraction of a contribution that "counts". The match rate can be positive or negative, but it can never be $<-100\%$ (i.e. balances cannot be taken away). Note that all of the redistribution related to these accounts occurs on the way in (i.e. as contributions are made); none of it occurs while funds are earning returns or when they are withdrawn.

---

For example, Amin and Bodurtha (1995) show how to price certain types of "quantos": contingent claims with a "quantity" or nominal cash flow determined by equity values in one currency but paid in another currency at a fixed rate. For example, the value of a first security, such as the Nikkei stock index, might determine the number of units of a second security, such as the U.S. dollar, that must be paid.
Figures 8 and 9 show the average match rate and the marginal match rate for our sample workers, assuming the price of PAAWs derived earlier from our risk neutral assumptions. Typically, the match rate is positive for young workers and negative for old workers. The match is lower for the old for two reasons. First, progressivity means that a given relative wage contribution generates more PAAWs when young (when PBAL is low). Second, the 35-year averaging formula means that earnings in the 36th year and beyond only increase PBAL by the amount they exceed the 35th highest relative wage to date. These factors are only partially offset by the fact that the price of a PAAW rises with age (and holding PBAL constant, the increment to PBAL due to an additional contribution (measured in average wage units) is constant with age).

This declining match rate (or rising tax rate) seems at first glance to be at odds with the results of Feldstein and Samwick (1992) who estimated the implicit tax rate on labor income (or the extent of the work disincentive) and found that it is much higher for the young than for the old. However, their concept and ours are different. While our measure is the appropriate measure of the current match, it excludes the dynamic effects that belong in the calculation of labor incentive effects: earning more now increases PBAL, and therefore lowers future match rates.

VI. Conclusions and Future Research

We showed that it is possible to preserve the redistribution and risk sharing of the current system in a system of progressive personal accounts, clarifying the link between contributions and benefits, and at the same time enhancing the property rights of the system. Translating the current DB system into the language of DC should facilitate the debate over individual accounts.

We argued that it would be possible to create and trade pools of PAAWs, providing an estimate of the market value of each individual's account, providing an estimate of market value of system liabilities, and opening up the possibility of allowing (limited) trade in accounts. These new markets would have an enormously beneficial impact on the current annuities and reverse mortgage markets.

---

10 Cushing (2005) showed that the decline largely disappears once one takes into account disability and survivor benefits.
In ongoing research, we are working on ways of further improving the risk-sharing and redistribution features of our progressive personal accounts. It is not enough to replicate the current system; we hope to do better. We plan to show that our proposed system can be modified to incorporate a market-based aggregate self-correction mechanism. We will consider tax and benefit rules that are self-balancing, i.e., state-contingent and balanced in each state of the world. This avoids the need (as in the current system) for politicians to legislate rule changes ex-post in order to balance the system. One way to implement this would be to create additional tradeable securities (such as Social Security revenue bonds), and revise benefit rules so that the required benefit adjustments are tied to changes in the market value of these securities, rather than to changes in official government forecasts of future cash inflows and outflows. An alternative approach would be to make the system self-balancing in present value terms. If the system is adjusted such that it is initially in balance, and if the quantity of newly-issued PAAWs is set such that their market value equals the aggregate value of new contributions, then the government should be able to optimally manage its portfolio and maintain NPV balance.

Finally, we plan to work on the model pricing of PAAWs, PANTs, and Wage Bonds under risk aversion. This will not be easy to do, but it could have many important implications, not just for Social Security, but for pension funds in general. For example, once an appropriate replicating portfolio is identified, it may well turn out that the implicit discount rate for the wage bond is greater than the risk-free rate. If so, it would imply that the Social Security unfunded liability (termination value), which is equal to the present value of accrued benefits minus the current trust fund, is less than typical estimates. A higher discount rate may also affect the calculation of the actuarial imbalance, equal to the present value of future contributions minus the present value of future benefits over a set horizon (typically 75 years) – each of these terms is tied directly to aggregate wages.
References


Figure 1
Mechanics of Current OASDI System
Calculation of Primary Insurance Amount (PIA)

Concavity generates redistribution and individual risk sharing. Tying benefits to average wages generates intergenerational risk sharing.
Figure 2

Additional PAAWs Per Additional Contribution
(measured in average wage units)

High when PBAL is low

Using this schedule for every contribution mimics the lifetime redistribution of the current system

And low when PBAL is high
**Figure 3**  
Additional PAAWs Per Additional Contribution
(measured in average wage units)
Figure 4
Change in PAAW Balances

Worker 1: Economy Average

Worker 2: Cohort Average

Worker 3: 0.5 Cohort Average

Worker 4: 1.5 Cohort Average
Figure 5
PAAW Balances (PBAL)
Projected market price of one PAAW (under risk neutrality, measured in average wage units)

Price rises with age because:
- $r >$ growth of average wages
- probability of survival to retirement rises with age
Figure 7
Projected Market Value of Accrued PAAWs
(measured in average wage units)

Worker 1: Economy Average

Worker 2: Cohort Average

Worker 3: 0.5 Cohort Average

Worker 4: 1.5 Cohort Average
Figure 8
Average Match Rate

Worker 1: Economy Average

Worker 2: Cohort Average

Worker 3: 0.5 Cohort Average

Worker 4: 1.5 Cohort Average
Figure 9
Marginal Match Rate

Worker 1: Economy Average

Worker 2: Cohort Average

Worker 3: 0.5 Cohort Average

Worker 4: 1.5 Cohort Average