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Social Security Privatization and Financial Market Risk: Lessons from U.S. Financial History

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LESSONS FROM U.S. FINANCIAL HISTORY

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Abstract

A popular proposal for reforming social security is to supplement or replace traditional publicly financed benefits with a new system of mandatory defined-contribution private pensions. Proponents claim that private plans offer better returns than traditional social security. To achieve higher returns, however, contributors are exposed to extra risks associated with financial market fluctuations. This paper offers evidence on the extent of these risks by considering the hypothetical pensions U.S. workers would have obtained between 1911 and 1999 if they had accumulated retirement savings in individual accounts. The 89 hypothetical contributors are assumed to have identical careers and to contribute a fixed percentage of their wages to private investment accounts. Contributors differ only with respect to the stock market returns, bond interest rates, and price inflation they face over their careers. These differences occur because of the differing start and end dates of workers' careers. The analysis demonstrates that returns under private plans would usually have been good, but that financial market risks in a private account system are empirically quite large. Some of these risks are also present in certain types of public retirement system, but a public system has one important advantage over private pensions. Because public social security is backed by the taxing and borrowing authority of the state, it can spread risks over a much larger population of potential contributors and beneficiaries, including contributors and beneficiaries in several generations.

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ALL MAJOR INDUSTRIAL COUNTRIES face problems connected with population aging. Depressed birth rates and rising longevity have increased the aged dependency ratio throughout the industrialized world. Demographic projections of the United Nations suggest that the percentage of people past age 65 in developed countries will double over the next five decades, and the ratio of aged dependents to working-age people will climb steeply.

As populations in the rich countries grow older, the cost of paying for pension and health benefits must rise, boosting tax burdens and threatening the government's ability to finance other obligations. Only one G-7 country, the United Kingdom, has overhauled its public pensions in a way that is likely to hold down future spending to a level that is comparable to today's. The favorable outlook for British public pensions is the result of policies that tightly restrain growth in basic public benefits and strongly encourage active workers to abandon the second-tier, earnings-related public program in favor of private pensions. Future retirees are expected to derive much more of their retirement income from privately managed and invested pension accounts rather than the public pay-as-you-go system. Other leading industrial countries still face major challenges in paying for or fundamentally reforming their main public pension programs (Bosworth and Burtless, 1998).

Policymakers in a few rich countries show interest in following the British example and replacing part or all of their public systems with private pensions organized around individual retirement accounts. Champions of this reform point to the experience of Chile, where a costly and failing public system was replaced by a less expensive private system in the early 1980s. So far, Chile's private pension system has received high marks for sound administration, good returns, and broad political acceptance. Some may wonder whether the experience of a country that scrapped its public pension system while under the sway of a military dictatorship is relevant to democratic states. Nonetheless, the expected surge in public retirement costs has made many voters and policymakers receptive to the idea of a private alternative to the existing public system.

This paper surveys the relative advantages of public and private systems. More important, it assesses the financial market risks facing contributors in a private system based on individual retirement accounts. The first part of the paper describes the differences between public and private systems and considers the main economic and political arguments for privatization. A principal claim is that private plans can provide better returns to contributors. If this were true, it seems appropriate to weigh possible risks associated with the improved returns. Some of the most important risks are those associated with financial market fluctuations.

The second part of the paper provides evidence on these risks by considering the hypothetical pensions U.S. workers would have obtained between 1911 and 1999 if they had accumulated retirement savings in individual accounts. The 89 hypothetical contributors are assumed to have identical careers and to contribute a fixed percentage of their wages to private investment accounts. When contributors reach retirement age, they convert their retirement savings into level annuities. To make the calculations comparable across time, all contributors are assumed to have an identical career path of earnings and to face the same mortality risks after retirement. Contributors differ only with respect to the stock market returns, bond interest rates, and price inflation they face over their careers. These differences occur because of the differing start and end dates of the workers' careers.

The analysis demonstrates that the financial market risks in a private retirement system are empirically quite large. Although some of these risks are also present in a public retirement system, a public system has one important advantage over private pensions. Because a public system is backed by the taxing and borrowing authority of the state, it can spread risks over a much larger population of potential contributors and beneficiaries. This makes the risks more manageable for active and retired workers, many of whom have little ability to insure themselves privately against financial market risk.

Public and private pensions

The main goal of a pension program is to provide replacement for labor earnings lost as a result of old age, premature death, or invalidity. The usual way rich countries have achieved this goal has been with mandatory, publicly financed pensions. The typical system offers a pension starting at a specified age that is calculated on the basis of the worker's years of coverage under the system and her average covered wages while contributing to the system (World Bank, 1994, esp. pp. 102-09). Benefit payments are usually financed with current tax contributions from employers and workers, with contributions scaled according to each worker's wages (often up to a maximum taxable limit). Only a few public systems have built up large enough reserves to pay for a high percentage of future pension obligations. Almost all public defined-benefit systems

are financed under the pay-as-you-go principle, that is, out of current contributions from workers, employers, and, in some cases, the state budget.

Because pay-as-you-go systems can provide generous benefits to early contributors at modest cost, they were both politically popular and hugely effective in reducing old-age poverty within a few decades of their introduction. Unfortunately, the pay-as-you-go financing method is encountering serious problems in most rich countries. These nations face a steep drop in labor force growth that limits the size of the workforce available to pay for public pensions. Declining mortality rates have boosted the relative size of aged populations. The increase in life expectancy in rich countries has been reflected almost exclusively in longer periods of retirement rather than longer active work careers. In fact, several Western European countries effectively reduced the early entitlement age for benefits in the 1970s and 1980s as a policy response to increases in structural unemployment (Gruber and Wise, 1999). The slowdown in growth of labor productivity and real wages has also slowed the expansion of the tax base used to finance the system. In combination these factors have boosted the public cost of supporting an aging population.

The private alternative. Privatization is based on a simple idea. Instead of contributing to a collective, pay-as-you-go retirement program, workers would be required to build up retirement savings in individually owned and directed private accounts. Workers could withdraw their funds from the accounts when they became disabled or reached the retirement age, and their heirs could inherit any funds accumulated in the account if the worker died before becoming disabled or reaching the retirement age. At the time a worker chooses to start receiving a pension, some or all of the funds in the worker's account would be converted into an annuity that would last until the worker dies. In most privatization plans, workers would be free to decide how their contributions were invested, at least within broad limits.

Private defined-contribution pension plans differ from public systems in two important ways. First, the worker's ultimate retirement benefit depends solely on the worker's contributions and the success of the worker's investment plan. Workers who make larger contributions receive bigger pensions, other things equal. Workers whose investments earn high returns enjoy more comfortable retirements than workers who invest poorly. Second, in a private system workers' pensions are paid out of accumulations of their own previous savings. In contrast, public pensions are financed mainly by the payroll taxes of active workers and their employers. This difference between the two kinds of system implies that the savings accumulation in a private plan would be many times larger than the reserves needed in a pay-as-you-go public system.

Because the connection between individual contributions, investment returns, and pension benefits is very straightforward in a defined-contribution pension program, a private

retirement system offers less scope for redistribution in favor of low-wage workers and other favored groups. Redistribution favoring low-wage and other kinds of workers must take place outside these accounts. Most public pension formulas explicitly favor low-wage workers and workers with short careers in order to minimize poverty among elderly workers who become eligible for public pensions. To duplicate public pension programs' success in keeping down poverty among the elderly, a private system must supplement the pensions from individual retirement accounts with a minimum, tax-financed pension or with public assistance payments.

No rich country can immediately scrap its public retirement system and replace it with a private system. In the United States, for example, more than 44 million people -- about one in six residents -- collects benefits under the public Social Security system. About 1.6 million workers began to collect new retirement benefits during 1998 and another 600,000 were awarded new disability pensions. Even if the United States replaced Social Security with a private system for young workers, Americans who are already retired or who will enter retirement within the next few years would continue to receive public pension checks for several decades. Public funds must be appropriated to pay for these pensions, regardless of the system established for workers who will retire in the distant future.

The need to pay for the pensions of people who are already retired or near retirement age poses a challenge to all plans for privatizing public pensions (except in the handful of countries that never established a large public system). Money must be found for existing pension liabilities at the same time workers will be asked to contribute to a new type of private pension account. Because young workers will be required to finance pensions for retired workers and active workers near retirement, they may resist being forced to pay for their own retirement pensions through contributions to new private accounts.

Claimed advantages of a private system. Privatization potentially offers both economic and political advantages over a pay-as-you-go public system. If workers are permitted to invest their retirement savings as they choose, many will obtain utility gains by investing in portfolios tailored to their individual taste for financial market risk. Workers enrolled in a single public system are obliged to accept the portfolio choices of that system.[1] Even more important, proponents of privatization claim workers will receive larger pensions and the economy will grow faster under a private rather than a public retirement system.

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[1] Of course, workers who wish to save more for retirement than the amount they save in the public system can choose to invest their private funds in a way that offsets the portfolio choices of the system. However, empirical studies of saving behavior suggest that for a large percentage of workers, the overwhelming share of household saving takes the form of a home purchase and contributions to the public pension system. Many worker households have few assets aside from their home and pensions and thus cannot offset the portfolio choices of the public pension program.

Almost all advocates of a private retirement system argue that pension contributions would be more affordable or benefits more generous if countries adopted a private system. Stated crassly, most workers could expect a better deal under a private system than they can obtain under existing public pension systems. This argument is based on a straightforward calculation. If workers invested 10% of their earnings in a private retirement account yielding a moderate rate of return (say, 3% a year after adjusting for inflation), most would collect bigger pensions than they can expect under a fully mature pay-as-you-go public pension system requiring the same level of contributions.

Samuelson (1958) and Aaron (1966) showed that contributors in a fully mature pay-as-you-go pension system can expect to earn an annual rate of return on their contributions equal to the sum of the annual growth rate in the work force plus the annual growth rate of real wages. In the 1950s and 1960s, for example, the U.S. labor force was growing 1½% to 2% a year and wages were rising 2½% to 3% a year. The real rate of return on contributions was expected to be 4% to 5% a year when the U.S. Social Security system became fully mature. That was a better rate of return than most workers then earned on other investments available to them. By the 1990s the expected return on contributions to a pay-as-you-go pension system was sharply lower for young workers in most industrialized countries. The labor force was growing much less rapidly than it did in the 1960s, and in some countries the workforce was actually declining. The productivity slowdown has meant that real wages are increasing much more slowly than they did in the early post-war period. The expected real rate of return for workers who will retire in the next century may be 1% or less in many industrialized countries. Workers can expect to earn better returns under a funded private pension system. Proponents of privatization suggest that workers in a funded system could reliably earn 4% or more a year on their contributions if pension savings were invested in a mix of stocks and bonds.

Privatization is not essential if future workers are to obtain a better return, however. Public pension systems could shift from pay-as-you-go financing toward advance funding of pension obligations. Public pension managers could invest the new pension reserves in high-expected-return assets, including equities, real estate, and corporate bonds. If the public system invested in the same mix of assets that workers collectively would have chosen for their own individual accounts, the rate of return on public reserves would be the same as on assets in the private account system. In fact, the rate of return on worker contributions would almost certainly be higher in the public system, because the lower administrative costs of a collective system would boost net returns.

In the short run, of course, the shift to more advance funding can only be achieved by reducing some workers' rate of return. Some workers or taxpayers must accept lower pensions or higher taxes and contributions if the public system is to accumulate more reserves that it

would under pay-as-you-go financing. But the same sacrifice is required if a new private pension system is established to replace or supplement traditional public pensions. Some workers must contribute more to the public and private systems, or some retirees must accept smaller pensions, if reserves are to be accumulated in the newly established private system while pensions continue to be paid under the old public program. The higher rate of return promised by private systems depends on adopting a new retirement saving strategy and a more aggressive approach to investing pension reserves. Both of these changes can be accomplished by reforming the existing public pension system as well as by establishing a new system of private retirement accounts.

Many advocates of privatization believe that full or partial privatization will boost saving rates. If national saving could be increased, income growth might accelerate, making it easier for the nation to afford the extra burden of supporting a large retired population in the future. Unlike most public retirement systems, which are financed on a pay-as-you-go basis, a private retirement system requires huge accumulations of assets in individual retirement accounts. Because workers would be setting aside a percentage of their pay in private accounts for their own retirement instead of sending in contributions that are immediately spent on pension payments, the introduction of a privatized system could lead to a jump in saving.

Privatization is not really needed to achieve higher national saving, however. The same increase in saving would occur if the public retirement system moved away from pay-as-you-go financing toward advance funding. This could occur if the government increased the contribution rate to the public system or reduced benefits, increasing the annual surplus of the program. The public program would accumulate larger reserves than are anticipated under current law. Instead of accumulating assets in millions of individual retirement accounts, as in a private system, the saving would take place in a single public fund. The crucial policy change needed to boost national saving is the move to advance funding rather than a shift to private management or to individual retirement accounts.

Political feasibility. Even if long-run rates of return and national saving could be increased within existing public pension systems, critics of public retirement systems are skeptical that the funds accumulated within a public fund would actually be saved. They fear that governments would use the funds to finance deficits in other government accounts or to increase non-pension public spending. Privatization advocates therefore believe it is more realistic to think pension saving will actually take place in millions of privately owned accounts, outside the reach of a revenue-hungry government.

Privatization can also offer a politically acceptable method of managing the accumulation of huge reserves and company stocks. In a system where the accumulation takes place in a single public system, public officials are ultimately responsible for allocating the funds among

investment alternatives and purchasing the stocks or bonds of individual companies. Opponents of a funded public system fear that politicians' investment decisions would be guided by political rather than economic considerations, reducing the yield of the investments, diverting investments into unproductive uses, and intruding on the business decisions of company managers. In a private system of individual accounts, decision making authority over the accumulation would rest with millions of workers. Through their choices among investment alternatives and specific investment funds, workers and private fund managers rather than public officials would exercise ultimate authority over the allocation of investments.

A private retirement system, with its broad dispersion of asset ownership, has another advantage over a public retirement fund when it comes to accumulating corporate stocks. If retirement asset accumulation took place within a single public fund and if the public fund owned shares in thousands of companies, national legislatures or public officials would have to decide how these shares should be voted. Voting decisions might be determined by political rather than economic criteria, possibly reducing the efficiency and profitability of the nation's business sector.

Many advocates of a private retirement system also believe that workers would be more willing to accept an increase in their contribution to the retirement system if their extra contribution took the form of deposits into individually owned and managed investment accounts. While workers would resist a hike in the payroll tax, they will tolerate -- and may actually welcome -- compulsory saving in individually owned accounts. This argument for privatization is essentially pragmatic. Voters or public officials are more likely to take needed steps to increase national saving and prepare for an older population if workers have direct ownership of their extra contributions to the retirement system.

Economic versus political advantages of privatization. This brief survey of the claimed advantages of privatization makes clear that private, individual account systems have only one inherent economic advantage over public systems. Private systems permit individual workers to fashion an investment strategy for their retirement saving that reflects their risk aversion. A single collective system forces at least some workers -- those with no other savings to invest -- to accept the portfolio allocation of the public pension system. This gain from privatization may be offset, in whole or in part, by the higher management cost of administering a system with millions of individual accounts, a feature of private pensions that reduces net rates of return.

As noted by Diamond (1997), the main issues dividing supporters and opponents of privatization hinge on political rather than economic considerations, since all but one of the claimed economic advantages of privatization can be achieved within a redesigned public system that is partially funded and that pursues a sound investment strategy. The crucial political questions are these: Will a nation's political institutions permit the accumulation of enormous

reserves within a public retirement system? If reserve accumulation is actually achieved, will it be offset by lower taxes or increased non-pension spending elsewhere in the government sector, eliminating the effect of reserve accumulation on national saving? Even if the reserve accumulation is accomplished and is not offset by larger deficits in other parts of the government budget, will pension reserves be prudently invested? Or will political influence divert investments into uneconomic projects, producing sub-par returns? Assuming that the public pension reserves can be prudently invested, will public officials exercise their privileges as corporate shareholders to meddle in the internal affairs of private companies, reducing corporate efficiency and profitability? Observers who distrust the motives, discipline, and capacity of public officials believe that a funded pension system will be better managed and produce better results if it is under private rather than government control (see Diamond, 1999, esp. pp. 67-110).

Riskiness of Pensions

A public pension system enjoys one important advantage over a private system with individual accounts. Because its benefit promises are ultimately backed by the government's power to tax, the public system can spread risks across a broader population, including workers who have not yet entered the labor force. In a private individual account system, each worker's pension depends on the level and pattern of his contributions and the success of his investment strategy. Workers who claim pensions after a long period of low returns will receive small pensions; workers who retire after periods of exceptional returns will collect large pensions. Workers who make well-informed or lucky investment choices will obtain big pensions; workers who invest imprudently or unluckily will receive small benefits. The wide variation in outcomes is reduced under a common public system, where all contributors who make similar contributions can be assured of similar benefits.

A defined-contribution system allocates risks in a very different way than a collective, defined-benefit system. Under most public pension systems, workers born in the same year who have similar earnings records receive similar retirement benefits. Because of political constraints on democratically elected governments, the public pension formula changes very slowly and only after protracted political debate. Since this debate involves both contributors and beneficiaries, changes in contribution and benefit formulas tend to reflect a compromise between the interests of the two groups. The effects of unanticipated demographic, labor market, and financial market developments are rarely if ever borne by a single cohort. They are spread across a number of cohorts through gradual changes in contribution rates and benefit levels. In contrast, workers participating in a defined-contribution system bear many more of the risks associated with financial market fluctuations.

Workers enrolled in a defined-contribution pension plan face three kinds of financial market risk. They are exposed to the risk that the real return on their contributions may fall below the historical norm over the course of their working careers. If workers obtain unexpectedly low returns on their retirement savings, they may enter old age with too little savings to finance a comfortable retirement.

Second, at the point they retire workers may find it expensive to purchase annuities. Workers who want to ensure they will not outlive their assets will seek to convert their retirement savings into an annuity around the time they retire. The market price they pay for annuities depends on four factors: their expected life span when they purchase annuities, the amount of adverse selection among the population buying annuities, the profit requirements needed to induce insurance companies to offer annuities, and the market rate of interest at which insurance companies can invest their reserves. Even assuming that mortality risk among workers at the same age is identical, adverse selection among potential annuity buyers is negligible, and insurance companies would sell annuities at zero profit, workers will still pay wildly varying prices for annuities over time because of fluctuations in market interest rates.

Finally, workers who buy level nominal annuities are subject to inflation risk. The amount of inflation that occurs after a worker retires has a dramatic impact on the purchasing power of the worker's pension. If inflation turns out to be unexpectedly low, the worker's retirement consumption can be much higher than initially anticipated. If it turns out to be unexpectedly high, the worker may reach advanced old age with very little spendable income and face destitution. The risks just mentioned are substantial, even in an economy like that of the United States, which has efficient and well regulated capital markets, a long tradition of respect for property rights, and has enjoyed more that two centuries of relat__e prosperity. The risks are so daunting, in fact, that they challenge the ability of a pension system based solely on individual accounts to deliver reliable income replacement in old age.

Indexed defined-benefit pensions in a pay-as-you-go program such as U.S. Social Security are not directly affected by these risks. Benefits are mainly financed by the current contributions of active workers rather than the market returns earned on workers' past contributions. Benefits are legally prescribed in terms of each worker's past covered earnings and do not depend on the worker's investment skills. Inflation risks in this system are manageable. The contribution base is likely to rise in line with price inflation. In addition, benefit promises are ultimately backed by the government's power to borrow and tax, not by the assets held in an individual retirement account.

Public retirement systems are subject to political, economic, and demographic risks, of course. Slow wage growth and lengthy economic slumps deprive the system of needed taxes. A sharp decline in fertility or immigration slows the growth of contributions without changing the

need for funds to pay for benefits in the short run. Future voters might resist paying higher taxes, and benefits would then have to be cut or the budget deficit would soar. This does not mean public pension benefits must cut to zero, as some workers may fear. But it does mean taxes will have to be increased or benefits trimmed if the system is to be kept solvent in the long run.

Future tax rates and benefit payments will be determined by legislators who have not yet been elected (and may not even have been born). This fact introduces substantial political uncertainty around future benefit levels and tax burdens. Future voters and elected officials might decide to fundamentally change the structure of the existing pay-as-you-go, defined-benefit system. Legislators might decide to scale back the system's benefit promises, including its promises to people who are already retired or on the threshold of retirement.

These political risks are easy to overstate, however. Elected officials are keenly aware of public opinion. Mature public pension systems are among the most popular programs run by democratic governments. Most voters recognize that the elderly and disabled rely on public pensions for a sizable portion of their income. Millions of people collect public pension benefits, and many of these recipients vote faithfully. Most contributors to public pension programs have relatives and friends who collect pensions, so even among contributors there would be resistance to big benefit cuts.

It should also be noted that political risk can affect pension contributions and benefits in a private, individual account system as well as in a public system. Legislatures can change the terms under which contributions to individual accounts are calculated, accumulated, redeemed, or taxed, affecting the net value of individual retirement annuities. The idea that private retirement pensions are somehow immune to political risk is a serious misconception.

Effects of Financial Market Fluctuations

The remainder of the paper focuses on financial market risks affecting the value of pensions under a private, defined-contribution plan. The size of these risks is relevant to considering whether an individual account pension system can deliver dependable income replacement in old age. To assess these risks I calculate the value of savings accumulation available to workers at retirement, the initial annuities that they can purchase given their accumulations and interest rates at the time they retire, and the real value of annuity flows after retirement given the actual pattern of inflation over the twentieth century. The calculations are based on historical stock market prices and dividends, bond market returns, and price inflation in the United States for the period since 1871.[2]

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[2] Stock market data are based on the Standard and Poor Composite Stock Price Index dating back to 1871. These stock data and some of the price and interest rate data are taken from Chapter 26 ("Data Appendix") of Shiller (1989), with most series updated through 1999. See http://www.econ.yale.edu/

To calculate real stock and bond returns during a worker's career and the purchasing power of an annuity during the worker's retirement, it is necessary to convert nominal returns and nominal pension flows into dollars that have constant purchasing power. I use Bureau of Labor Statistics (BLS) estimates of the January producer price index for finished goods for the period from 1871 to 1912. Starting in 1913, the BLS began estimating a consumer price index for urban workers. I have spliced these two series together to form a price level series for the entire 1871-1999 period. Calculations that require a projection of the price level after 1999 are performed under the assumption that annual price inflation will be 2.5% starting in 1999.

Figures 1 and 2 show real U.S. stock and bond returns over the past century. Because stock market prices fluctuate so much from year to year, the first figure shows the annual rate of return on a dollar invested in the stock market 15 years before the indicated year. This method of calculation smooths out much of the annual variability in real returns, but it still reveals the wide variability of returns over different 15-year periods. The 15-year trailing return was negative in 1920 and 1980, but it exceeded 12% in the mid-1930s, 1960s, and late 1990s. The heavy line in Figure 2 shows the nominal rate of return on government and other low-risk bonds. For years after 1923 it is based on the average market yield on U.S. government bonds with a maturity of at least 10 years. To convert this nominal yield into a real interest rate, I subtract the average annual inflation rate during the next five years. This seems an appropriate way to measure the real return on bonds, because their ultimate return depends on the value of the real income flows they generate for investors. This depends on actual inflation in years after the bond is issued rather than in the year of issue or in years before the issue.

U.S. stocks have produced substantially higher average returns than bonds over the past century. In the period since 1910 the geometric mean annual rate of return on stocks has been 6.9%. The mean real return on bonds was only 1.6% in the same period. In exchange for higher expected returns, owners of stocks have had to accept considerably greater short-term risk. The standard deviation of the annual returns was 18.8% for stocks but just 3.8% for bonds between 1910 and 1999.

In order to calculate the effects of stock and bond yields on workers' pensions, it is necessary to define a standard career path of earnings and pension contributions. All the

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~shiller/chapt26.html. Estimates of the long-term government bond rate are published by the Federal Reserve Bank of St. Louis for years back through 1924. For the period from 1906 through 1923 I formed an estimate of the riskless long-term bond rate using Macaulay's estimates of the yield on high quality railroad bonds. Since even high quality private bonds are subject to default risk, I predicted the riskless (Treasury-equivalent) yield for 1906-1923 by estimating the yield premium of railroad bonds over government bonds for the period 1924-1936, when observations of both railroad bond rates and long-term Treasury bond rates are available. See http://www.stls.frb.org/fred/data/irates.html.

calculations that follow are based on male earners who have a full, 40-year career. In the absence of economy-wide wage growth, these workers are assumed to have a lifetime path of real earnings that matches the age-earnings profile of employed U.S. men in 1995.[3] In addition, wage growth in the economy at large is assumed to average 2% a year after adjusting for inflation. This is similar to the rate of wage growth in the past few years, but it is higher than average wage growth since 1973 and is somewhat slower than typical wage growth over the 20th century.[4] Each worker is assumed to enter the work force on his 22nd birthday and to work for 40 years until the day before his 62nd birthday, which is assumed to occur on January 1st. Thus, a worker who begins to work at the beginning of 1871 is assumed to begin receiving his pension on the first day of 1911.

The worker saves 6% of his earnings and invests his retirement savings in some combination of bonds and common stocks. All stock dividends are reinvested in stocks, and all bond interest payments are reinvested in newly issued long- or short-term bonds.[5] The income flows from both kinds of assets are assumed to be free of individual income taxes at the time they are reinvested. Unlike ordinary investors, who must pay trading fees and commissions when buying and selling stocks and bonds, the worker is assumed to face no transaction costs in making his investments.

On his 62nd birthday the worker converts his accumulation into a single-life annuity that is fixed in nominal terms. The insurance company selling the annuity bases its charge on the expected mortality experience of American males who reached age 65 in 1995, using mortality projections of the Social Security Actuary.[6] The Actuary's projections take account of gradual

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[3] Estimates of annual earnings by age and gender can be found in U.S. Census Bureau (1996).

[4] The assumed rate of economy-wide wage growth has important effects on some of the calculations. With a slower assumed rate of growth, pension contributions and investment returns early in a worker's career become relatively more important in determining his pension, because earnings when the worker is young represent a larger percentage of the worker's lifetime wages. At the same time, with slower wage growth it is easier to attain a high pension replacement rate, where the replacement rate is defined as the real value of the pension divided by the worker's real average wages near the age of his retirement.

[5] When a bond-investing worker reaches age 53 and is less than 10 years from retirement, he is assumed to invest in short-maturity rather than long-maturity bonds to avoid the risk of accepting capital losses when he converts his bonds to an annuity at retirement. From age 53 through 61 his new retirement contributions as well as the interest earnings on the long-maturity bonds already in his portfolio are used to buy bonds which have a yield equal to the one-year U.S. Treasury bond rate. Under this investment strategy, all bond holdings are redeemed at par when the worker retires.

[6] The Social Security Actuary's mortality projections are reported in Mitchell, Poterba, and Warshawsky (1997). These were supplemented with estimates of actual mortality rates in U.S. Census Bureau (1998), Table 130.

improvements in mortality experience that older males are expected to enjoy over the next several decades. Unlike annuities actually available in the U.S. market, the insurance company does not charge a load factor to cover its profit requirements and possible adverse selection among people who wish to buy annuities. (Thus, the worker is assumed to purchase a "fair" annuity.) In determining the sales price of the annuity, the insurance company assumes it will be able to invest the worker's funds at the long-term riskless bond rate prevailing when the annuity is purchased (the nominal yield in Figure 2). The annual annuity payment is fixed in nominal terms. That is, unlike Social Security pensions the annuity is not adjusted from year to year to reflect changes in the price level.

Fluctuations in the value of defined-contribution pensions can be computed in a variety of ways. I emphasize two principal measures of pension value, the replacement rate and the real internal rate of return on workers' contributions. For a given worker, both the replacement rate and the internal rate of return may differ depending on the age at which they are measured. I estimate them at the age workers enter retirement (age 62) and also at the end of their life.

Alternative investment strategies. In light of the wide differences between stock and bond returns, workers' decisions about how to invest their pension savings can have large effects on their pension accumulations by the time they retire. To investigate the impact of portfolio choice, I calculate pensions under three contribution allocation strategies: 100% stocks, 50% stocks / 50% bonds, and 100% bonds. Workers are assumed to steadily invest their new contributions in stocks or bonds following these investment proportions. Because stock returns are always higher than bond returns for investment periods of about 15 years or more, the worker who invests half of his contributions in stocks and half in bonds will reach retirement with a much larger portfolio of stocks than of bonds.

One way to measure the size of the worker's pension accumulation is to calculate the worker's stock accumulation on the day of his retirement and then divide this amount by his average annual earnings when he was between 54 and 58 years old. This "nest egg / pay" ratio is roughly equivalent to the worker's wealth / income ratio around the time of his retirement. When economy-wide real wages are growing 2% a year, as assumed in this exercise, a worker's annual earnings are likely to reach a peak sometime around age 55. Both the numerator (the worker's retirement nest egg) and the denominator (his peak career earnings) are measured in constant dollars. The ratio thus measures the worker's lifetime retirement savings as a multiple of his peak career earnings. Since each worker is assumed to have the same pattern of career earnings, the variability of the nest egg / pay ratio is due solely to variations in average investment returns during the forty-year accumulation phase when the worker is contributing to his retirement saving plan.

Workers who invest exclusively in U.S. stocks accumulate more pension assets than workers who invest in bonds or in a combination of stocks and bonds. Workers retiring after 40-year careers in 1964 through 1999, for example, would have accumulated more than three times as much assets if they had invested their pension savings exclusively in stocks as they would have obtained if they invested exclusively in bonds. Stock market investments delivered widely varying accumulations over time, however. The worker retiring in 1921, after a period of exceptionally poor stock market returns, managed to accumulate a retirement next egg of only a little more than two years' peak earnings. In contrast, the worker retiring in 1966 accumulated more than 12 times his peak career earnings. The first column in Table 1 shows distributional statistics on the nest egg / pay ratio for workers retiring between 1911 and 1999, assuming all pension contributions were invested in stocks. The average nest egg ratio for the 89 forty-year careers is 6.1 with a median ratio of 5.1 and a standard deviation of 2.6.

Initial replacement rate. A common measure of the adequacy of pension income is the replacement rate, which measures pensions as a percentage of the worker's earnings before retirement. Figure 3 shows workers' initial replacement rate, where that rate is defined as the ratio of a worker's initial real annuity divided by his peak real earnings. The three lines in the figure correspond to replacement rates under the three alternative investment strategies described above. The top line in the figure shows replacement rates obtained by workers who invest all their pension contributions in U.S. stocks. The lowest initial replacement rate under this strategy, about 20%, was obtained by the worker retiring in 1921; the highest replacement rate, slightly over 100%, was obtained by the worker retiring in 1966. Since both workers have identical expected life spans and career earnings patterns, the astonishing difference in their replacement rates is due solely to differences in stock market returns and in the interest rate used by the insurance company to determine annuity charges. The time series pattern of replacement rates is generally similar to the time series pattern of nest egg ratios. This suggests that stock market variability has historically been more important than interest rate variability in causing ups and downs in the real value of initial pensions for workers who invest their pension savings in equities.

The second column in Table 1 shows statistics describing the distribution of initial replacement rates for workers who invest their pension contributions in stocks. The mean and median initial replacement rates are 52% and 47%, respectively; the standard deviation is 22%. Similar calculations can be performed to determine the replacement rate available to a husband-wife couple purchasing a level, joint survivor annuity. The couple is assumed to accumulate the same retirement nest egg as the single male worker who retires in the same year. A married couple purchasing a joint survivor annuity would obtain a lower annual pension payment, however. Because a joint survivor annuity continues until the death of the longer-lived spouse,

the insurance company can anticipate making annuity payments for substantially longer than it would if the annuity ended with the death of the male pensioner.[7] The median joint survivor annuity is thus about one-quarter lower than the median single life annuity (36% versus 47% of the male worker's career high earnings).

The lower lines in Figure 3 reflect replacement rates for single male workers who invest some or all of their pension contributions in bonds. The middle line shows replacement rates for men who invest half their contributions in U.S. Treasury bonds; the lower line shows rates for men who invest all their contributions in bonds. Replacement rates under these investment strategies cannot be calculated for the full span of years from 1911 to 1999. Data on U.S. Treasury yields are only available starting in 1924, so the first retirement we can examine is one that occurs in 1964. The replacement rate of workers who invest some or all of their contributions in bonds is always below the rate received by workers investing exclusively in equities. Workers who invest 50% in stocks and 50% in bonds, for example, receive an initial replacement rate that is typically about half that of workers who invest solely in equities. Workers who invest exclusively in bonds receive about one-third the replacement rate obtained by workers who invest solely in stocks, although the relative success of workers who invest in bonds has varied over time. In comparison with stock investors, the best relative performance of bond investors occurred for workers retiring in the early 1980s, when U.S. stock market prices were very depressed. Even in that year, however, the pension based on bond investments was only about half the pension that was produced by investments in U.S. equities.

The estimates in the figure overstate the typical pensions workers would obtain under the economic conditions prevailing between 1871 and 1999. As noted earlier, the calculations assume that stocks and bonds can be bought, sold, and held without any transactions costs. The typical U.S. mutual fund charges customers a little more than 1% of assets under management to handle customers' funds. Even efficient and exceptionally well-managed funds charge 0.20% a year for management and selling costs. Over a 40-year career, this charge would seriously erode the real value of the pension accumulation in comparison with the estimates shown in the figure. Also as noted earlier, the calculations also assume that 62-year-old retirees can purchase fair annuities, whereas in practice insurance companies, banks, and mutual fund companies impose a load charge amounting to about 10% - 15% of the capital converted when the person buys an annuity.

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[7] To calculate the fair annuity premium, I assume that both spouses are the same age. The wife's mortality experience is assumed to follow the Social Security Actuary's projections for a woman who attains age 65 in 1995. I assume the mortality experiences of husbands and wives are independent.

Some of the variation in replacement rates in Figure 3 arises because of fluctuations in the long-term interest rate, which determines the sale price of annuities when workers convert their pension savings into an annuity. The nominal interest rate has varied widely over the twentieth century. Figure 2 shows the nominal rate on long-term riskless bonds between 1910 and 1999. From 1910 through the mid-1960s, the nominal long-term rate ranged between 2% and 4%, and it moved sluggishly. After 1965 the rate soared, permitting insurance companies to sell annuities at a substantially lower price. With the same retirement nest egg, a worker retiring after 1965 could purchase a larger annual annuity than a worker retiring before that year. The nest egg / pay ratio accumulated by a stock-investing worker who retired in 1982 was about the same as that accumulated by workers during the worst years of the Great Depression. Yet the replacement rate of the 1982 retiree was about two-thirds larger (45% versus 27%). The reason for the difference is straightforward. The nominal interest rate was almost 13% in the early 1980s but just 3½ % in the early 1930s. An insurance company selling annuities in 1982 could expect to receive far more interest income on its investments than a company selling annuities in 1932. The difference in the company's expected interest earnings is reflected in the sales price of annuities. Annuities are cheaper to buy when interest rates are high.

Internal rate of return. Another way to summarize a worker's success in saving for retirement is to calculate the real internal rate of return on his contributions. Figure 4 shows the time series pattern of internal rates of return for workers retiring between 1911 and 1999 under the three investment strategies. The average real return on contributions in a plan that is exclusively invested in U.S. equities is 6.3%, measured at the point a worker's retirement nest egg is converted into an annuity (see column 1 in Table 2). Real stock market returns have been somewhat higher in recent years. If we exclude careers that began before 1924 (in other words, if we ignore retirements that occurred before 1964), the average real return on contributions is 6.7%.

Table 2 displays statistics on the distribution of internal rates of return when pension contributions are invested solely in equities. The first column in the table shows the distribution of returns when the internal rate of return is calculated at age 62, in the month the worker's pension accumulation is converted to an annuity. The mean and median returns are 6.3% and 6.0% respectively, but the range of returns is surprisingly wide. The lowest return, attained by a worker retiring after the stock market collapse following World War I, was just 1.5%, more than 4½ points below the long-term historical average. The highest return, almost 10%, was achieved by workers retiring in the mid-1960s. These workers had the happy experience of accumulating stocks during lengthy periods when stock market prices were depressed and converting their nest eggs into annuities when stock prices were exceptionally high. Workers retiring in the late 1990s enjoyed similar good fortune.

The fluctuations in realized returns, even over short periods, are often startling. Between 1921 and 1929 the internal rate of return on contributions rose from 1.5% to 8.4%, and the real return then plunged to 4.1% in 1933. The return fell from 8.5% in 1973 to 5.0% in 1975 and to 3.6% in 1982 before recovering to 9.3% in 1999. While it is certainly true that common stocks offer exceptionally good returns compared with alternative investments, it is also the case that no worker can be confident of achieving the historical average return over an investment career spanning 40 years. Figure 4 shows realized returns for 89 workers who invested their pension contributions exclusively in stocks. Among these workers, 57% achieved a real return that was below the historical average return, and more 10% achieved a return that was less than two-thirds of the historical average. Workers with the worst investment experiences obtained returns no better than those obtainable in mature pay-as-you-go pension systems.

The two lower lines in Figure 4 show that workers who include U.S. government bonds in their portfolios manage to reduce the variability of their returns, but they obtain returns significantly below those of workers who place all their contributions in U.S. equities.   For workers retiring between 1964 and 1999, those who invested exclusively in bonds achieved a real return of just 0.9% compared with the 6.4% average return obtained by workers who invested solely in stocks.

Figure 5 shows the tradeoff between expected real return and investment risk as workers vary the percentage of their pension contributions placed in stocks. The estimates are based on potential rates of return enjoyed by workers retiring between 1964 and 1999, which in turn are determined by stock and bond returns between 1924 and 1999. The expected real internal rate of return is measured on the vertical axis, and the standard deviation of returns is measured on the horizontal axis. Workers who invest exclusively in stocks can anticipate higher returns, but they must accept considerably more variability in outcomes. Workers who invest exclusively in bonds achieve very low average returns, but see comparatively little variability around those returns. The estimates imply that a portfolio consisting only of bonds throughout a worker's career can never be optimal. By investing a small fraction of his annual contributions in equities, the worker can increase his expected annual return by up to 0.5% without accepting any additional risk. A lifetime portfolio consisting exclusively of bonds has somewhat greater risk than a portfolio that also includes a small share of equities.

Inflation after retirement. The discussion so far has emphasized risks associated with stock and bond market fluctuations over the period workers contribute to a pension fund and at the point they convert pension accumulations to annuities. After workers retire they face another risk -- price inflation. Public pensioners in most of the rich countries have been spared this risk as a result of indexing. For example, from 1950 through 1972 the U.S. Congress informally adjusted Social Security benefits every two or three years to keep pensions current with prices.

Since 1972, Social Security benefits have been annually adjusted to reflect changes in the consumer price index. Workers who purchase private annuities are rarely protected against inflation.[8] In some countries, the government issues bonds indexed to inflation. The U.S. Treasury recently began issuing inflation-indexed bonds, for example, so it should eventually be possible for private companies to sell indexed annuities. Such annuities are not available in most industrialized countries today, however.

In a world where private markets fail to provide indexed annuities, retired workers face substantial risk from inflation. Figure 6 shows the real replacement rate of retired workers as they age. The figure shows replacement rates from age 62 through age 110 for U.S. workers retiring in four selected years -- 1921, 1929, 1933, and 1966.[9] As noted earlier, the worker retiring at the beginning of 1921 received the smallest initial pension of any worker considered here; the worker retiring at the beginning of 1966 received the largest initial pension (see Figure 3). The experiences of these two workers also differed after they retired. Prices were stable or falling during most of the 1920s and early 1930s. A worker retiring in 1921 therefore saw the purchasing power of his annuity increase over much of his retirement. In contrast, American workers who retired in 1966 saw prices climb without interruption after their retirement. (In years after 1999, I assume inflation is 2.5% a year.) The worker retiring in 1966 saw his real replacement rate fall steeply and continuously, shrinking from almost 100% at age 62, to 65% at age 70, and to 31% at age 80. In contrast, the worker retiring in 1921 saw his replacement rate increase from 19% to 26% between ages 62 and 75.

The experience of the worker retiring in 1966 has been more typical of U.S. experience since World War II. In fact, all workers retiring after the mid-1930s suffered significant losses in purchasing power during retirement. Figure 7 displays the time series pattern of real replacement rates at two different ages -- 70 and 80. (These calculations are based on the experiences of workers who invest all their pension contributions in equities.) The solid line shows replacement rates at age 70 for workers retiring between 1911 and 1999; the lightly dotted

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[8] Some American insurance companies offer "graded annuities" that increase over time. This kind of pension does not offer retired workers complete protection against inflation, however, because the annual percentage increase in the annuity is not directly linked to changes in the price level. If a worker buys a graded pension that rises 3% a year, the real value of the pension would still decline in each year that annual inflation exceeds 3%.

[9] The replacement rates are calculated for workers who invest all their pension contributions in equities. The initial replacement rates shown in Figure 6 differ slightly from those in Figure 3. The latter are calculated using the price level in the January when the worker attains age 62. The replacement rates in Figure 6 take account of changes in the price level that occur over the full calendar year when the worker is first retired. This change in price level is relevant unless the worker receives and spends all his annuity income in January.

line shows replacement rates at age 80 for workers who retire in the same years. On average, replacement rates fell somewhat more than a fifth (or 11 percentage points) between age 62 and age 70. They shrank by almost half (or 27 percentage points) between ages 62 and 80. The drop in the real purchasing power of pensions has been particularly severe for workers retiring after 1960. For recent retirees, replacement rates fell about 30% between ages 62 and 70 and by almost 60% between ages 62 and 80. If retired workers depended solely on their pensions to pay for consumption in old age, these losses in purchasing power would cause painful reductions in real spending as pensioners reach advanced old age.

Consumer price increases after retirement, if they are large enough, can substantially erode the real return that workers obtain on their pension contributions. I have calculated the real internal rate of return on worker contributions at age 110, the oldest age at which any pensioners are assumed to survive. This return is calculated for the 89 workers who retire in successive years from 1911 through 1999 and who invest all their pension contributions in stocks. The annual real value of contributions to the pension fund is 6% of each worker's projected real earnings at every age between 22 and 61. The expected real value of the pension in any year after retirement is simply the worker's initial pension adjusted to reflect price changes that occurred after age 62, multiplied times the probability that the worker will survive to that year. (The probability of survival to age 111 is zero.) The internal real rate of return on the worker's tax contributions is the interest rate that is required so that the discounted value of real contributions before age 62 is exactly equal to the discounted value of real pension payments after age 61.

The second column in Table 2 provides a statistical description of the internal rate of return on contributions when that rate is measured at the end of workers' lives. Note that the peak rate of return is two percentage points lower when returns are measured at the end of life rather than at age 62. The average return is about one percentage point lower (compare the first and second columns in Table 2). The lower average value of returns when returns are measured at the end of life should not be surprising. When workers convert their pension savings into an annuity, they are essentially trading stock market investments for a long-term bond investment. Their lifetime return represents a weighted average of the return earned when their funds are invested in stocks and when they are invested in bonds. Since bonds have historically offered a lower real return than stocks, the weighted average of stock and bond returns is likely to fall short of the return earned when all funds are invested in common stocks.

This theory is confirmed in the data. In only 15 of the 89 retirement years between 1911 and 1999 did the lifetime return on contributions exceed the return earned by age 62. In the other 74 years the lifetime return was less than the return measured at age 62. The gap was greatest for workers retiring between 1932 and 1979, when a combination of low nominal

interest rates and comparatively high (and often unanticipated) inflation produced poor bond returns. In contrast, workers retiring in the early 1980s enjoyed higher lifetime returns on their pension contributions than the returns they had obtained up through age 62. The high nominal interest rate on long-term bonds combined with a steep decline in inflation after 1981 meant that these workers were able to purchase annuities on terms that turned out to be very favorable. For these workers, real bond returns after age 61 were higher than the stock market returns they had enjoyed up through age 62.[10]

Protections against risk. As this exercise demonstrates, replacement rates can vary enormously over relatively short periods of time when workers invest all their pension savings in equities. The replacement rate was almost 100% for workers retiring in 1969, but just 42% for workers retiring just six years later in 1975. Pensions depend crucially on when workers buy stocks and when they convert their investment portfolios into annuities. The real value of a pension also depends critically on the course of inflation between the date an annuity is purchased and the time of death of the annuitant.

Workers can follow a couple strategies to reduce the uncertainty of private pensions. First, they can invest a portion of their retirement savings in bonds rather than stocks, diversifying their investment portfolio. This strategy reduces the volatility of the worker's replacement rate, but it significantly reduces the expected value of the annuity. Over nearly all 10-year periods in this century the real return on U.S. bond investments has been lower than the real return on U.S. equities. If workers invest all their pension savings in government bonds, the calculations in the this paper imply they will obtain lower returns than those available under a pay-as-you-go pension system, at least in the United States. Evidence on the investment behavior of American workers suggests that low-wage workers and workers with limited education tend to allocate their retirement savings to low-risk investment alternatives, including money market funds, bonds, and guaranteed income contracts (EBRI, 1996, and Ameriks and Zeldes, 1998). Thus, low-wage workers might see less fluctuation in the value of their retirement savings, but they would also tend to obtain below-average returns on their contributions and receive below-average retirement pensions. The investment behavior of low-wage and low-education workers would thus tend to produce even more inequality in individual-account pensions than is observed in career earnings levels.

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[10] The estimates of internal rates of return at the end of a worker's life depend for some workers on my predictions of inflation in 1999 and later years. If inflation turns out to be higher or lower than 2½% a year, which seems quite likely, the estimated internal rate of return will be incorrect. The inflation prediction error obviously has little effect on estimates pertaining to retirements that occur before 1980, but it could have a big impact on estimates for retirements in the 1990s. The possibility of this kind of error does not affect any of my estimates of rates of return or replacement rates measured at age 62.

Workers can follow another strategy to reduce the riskiness of their individual account pensions. They could convert their retirement nest eggs into annuities over several years rather than at a single point in time, as assumed in the calculations. For example, workers could convert their nest eggs into annuities in more or less equal annual installments beginning several years before they retire. Under one plan, each worker would purchase five annuities rather than only one. The annuities would differ in size depending on stock market prices and interest rates at the moment of conversion. Since the conversion occurs in five successive years rather than only once, workers would not convert all their retirement savings into an annuity at a time when stock market prices and interest rates make it particularly disadvantageous to do so.

Figure 8 shows replacement rates at age 62 under this annuitization strategy. For purposes of comparison, I also show the replacement rates workers obtain when they convert their retirement savings to an annuity on their 62nd birthdays. (Both sets of computations assume that 100% of pension contributions are invested in stocks.) The strategy of phased annuitization yields a distribution of replacement rates that has less variability, but the strategy also yields a lower average replacement rate. The standard deviation of replacement rates is 22% if the entire annuity conversion takes place at age 62, but it falls to 18% when annuitization is phased over five years. The average replacement rate also drops 5 percentage points, however, falling from 52% to 47% when workers adopt the phased annuitization strategy. This decline in average replacement rates is hard to avoid. As noted earlier, when workers purchase an annuity they are exchanging stock market investments for a bond market return. By converting his pension accumulation to an annuity approximately two years earlier than would be the case if a single annuity were purchased at retirement, the worker who follows a phased annuity strategy is exchanging two years of stock returns for two years of bond returns. This reduces both the variance and the expected return of his retirement savings.

To protect themselves against price inflation that occurs after they retire, workers can retain some of their retirement savings as a nest egg that continues to be invested in the stock market. Alternatively, they could purchase variable annuities based on a combined portfolio of stocks and bonds. Common stocks represent an ownership claim on real assets whose nominal value may eventually increase with the general price level. Under the assumption that price inflation will eventually be reflected in the nominal value of the common stocks that the retiree continues to hold, stock ownership may protect retirees against some of the adverse effects of price inflation. Holding retirement savings in the form of stocks during part of retirement also increases the expected return on the worker's savings. As we have seen, however, it substantially increases the investment risk to which the worker is exposed. In light of the historical variability of equity prices, retired workers will be uncertain how much consumption their stock holdings will buy five or ten years after they retire. If the ultimate goal of a

mandatory pension system is to assure workers of at least a minimum real income during old age, a variable annuity backed by stock market assets is unlikely to provide any guarantee that the goal will be achieved.

Conclusions

The argument usually advanced for moving away from pay-as-you-go retirement pensions to a private individual account system is that workers could make smaller contributions and obtain higher benefits under the private system. Most workers would get a better deal under the private system than they can obtain under public retirement systems.

The argument has two problems. First, the contribution rates to existing public systems and to a new individual account are not comparable. Contributions to public programs include a large implicit tax to pay for the unfunded liabilities that were accumulated in the past. Virtually all of this tax will have to be paid, regardless of whether the present public system is maintained or is replaced with a new system of private accounts. To make a meaningful comparison between the contribution rates to public and individual-account systems, it is necessary to either subtract this implicit tax from the social security contribution rate or add it to the rate needed to fund the new private accounts.[11]

Second, a defined-contribution system allocates risks in a very different way than a collective, defined-benefit system. Under most public systems, workers born in the same year who have similar earnings records are provided similar retirement benefits. Pensions are financed with taxes imposed on current workers and their employers, and they are ultimately backed by voters' willingness to tax themselves in order to keep benefits flowing. They are usually indexed to price changes. In the rich democracies, real benefit cuts typically occur gradually and only after intense political debate.

In contrast, pensions under a private, individual account system are paid out of financial market assets held in individual retirement accounts. The real value of the payment flows is limited by the current market value of assets held in the accounts. Although proponents of individual accounts are confident that workers can purchase safe assets that will yield high rates of return, U.S. experience over the past century suggests that neither the value of financial assets nor their real return is assured. Workers who follow an identical investment strategy but who retire a few years apart can receive pensions that are startlingly unequal. The investment strategy

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[11] In the United States, approximately 90 percent of current Social Security contributions are used immediately to pay for benefits to retired pensioners and their dependents. The contributions needed to finance these benefits must be collected whether the public retirement system is maintained or is replaced by a new system of individual accounts. It is thus incorrect to treat as equivalent the contribution rate to Social Security and to an individual retirement account. See Geanokoplos, Mitchell, and Zeldes (1998).

that produces the highest expected return and biggest pension is also the one that yields the widest swings in pension entitlement. The investment strategy that offers the most predictable pension yields an expected rate of return that in the United States is lower than the return available in a pay-as-you-go retirement system. In addition, the real value of private pensions is subject to sizable inflation risk after workers retire.

Even though American workers on average can obtain good pensions under an individual account system, such a system generates wide variability in outcomes, even for workers who follow an identical investment strategy. Assuming workers deposit 6 percent of their annual pay into a retirement account that is invested in common stocks, historical experience suggests their initial pensions can range from less than 20 percent of their peak career earnings to more than 100 percent of peak earnings. Averaged over their full retirements and taking account of the effects of inflation, workers' real pensions ranged between 15 percent and 70 percent of peak career earnings. The variability in outcomes could be even larger than this in practice, because risk-averse workers will choose much safer investment portfolios. Low risk portfolios can produce real pensions that over retirement average even less than 15 percent of the worker's peak career earnings.

While all workers would welcome the opportunity to earn better returns on their contributions to the retirement system, defined-contribution accounts would expose workers to a substantial hazard that their pensions would be too small to finance a comfortable retirement. The most often cited benefit of private retirement systems is that they can provide better returns to covered workers. If public systems were reformed to include advance funding and prudent investment of reserves, they could provide the same expected return to workers with far less financial market risk. An interesting question is whether such a reform is feasible or politically sustainable.

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TABLE 1.
Stock Accumulation and Initial Replacement Rates of Male Workers
Retiring after Forty-Year Careers, 1911 - 1999

		Initial replacement rate (% of career high earnings)	
	Nest egg / Pay ratio	Single life annuity	Joint survivor annuity
Average	6.08	52.2	40.6
Minimum	2.18	18.2	14.0
1st Quartile	4.19	35.1	26.2
Median	5.09	47.4	35.9
3rd Quartile	7.58	63.8	49.8
Maximum	12.17	100.2	78.1
Standard Deviation	2.63	22.2	17.5

Note: Pension contributions are invested entirely in U.S. stocks.

TABLE 2.
Internal Rates of Return on Pension Contributions of Male Workers
**Retiring after Forty-Year Careers, 1911 - 1999**

	Real internal rate of return on contributions (%)	
	Measured at age 62	Measured at end of life a/
Average	6.30	5.10
Minimum	1.54	2.20
1st Quartile	5.02	3.78
Median	5.96	5.19
3rd Quartile	7.76	6.27
Maximum	9.87	7.89
Standard deviation	1.95	1.46

a/ The assumed inflation rate after 1998 is 2½ % a year.

Note: Pension contributions are invested entirely in U.S. stocks.

Figure 1.
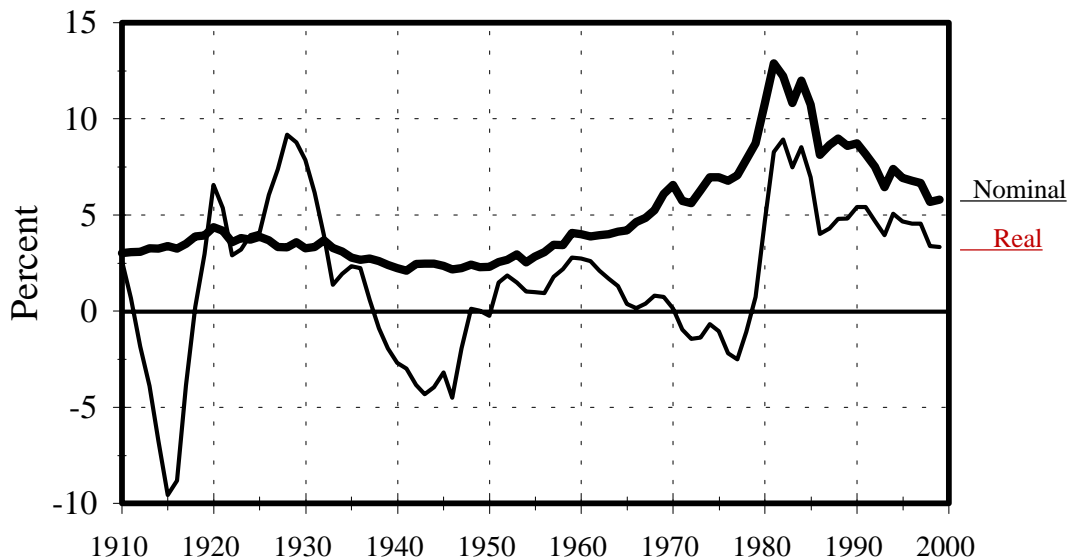
Real Stock Market Returns, 1871-1998
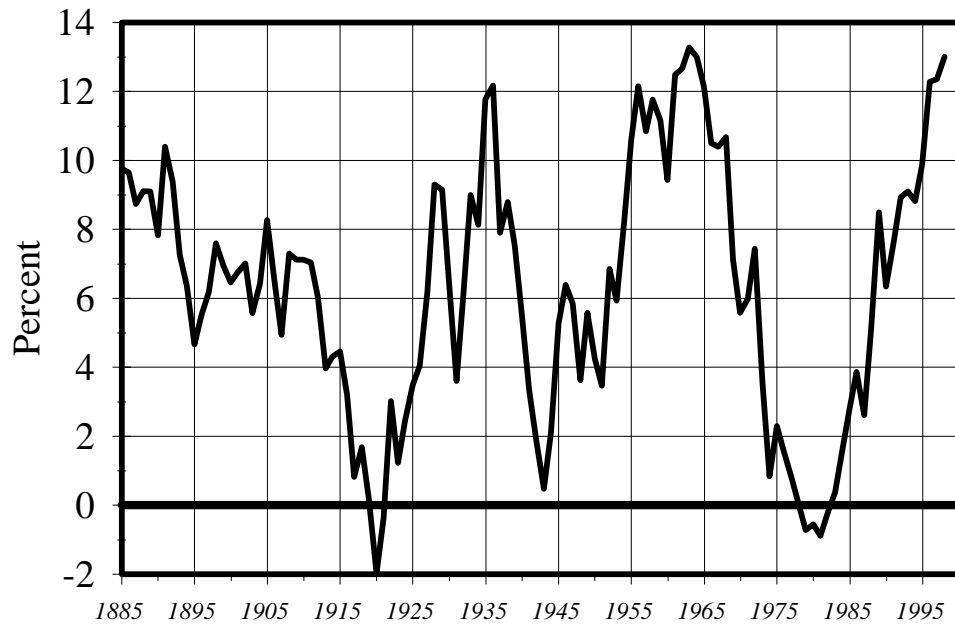
Note: Annual real rate of return on investment in U.S. stocks for fifteen-year period ending in the indicated year.

Source: Standard and Poor's composite U.S. stock market data cited in Shiller (1989), updated through 1999, and U.S. Bureau of Labor Statistics.
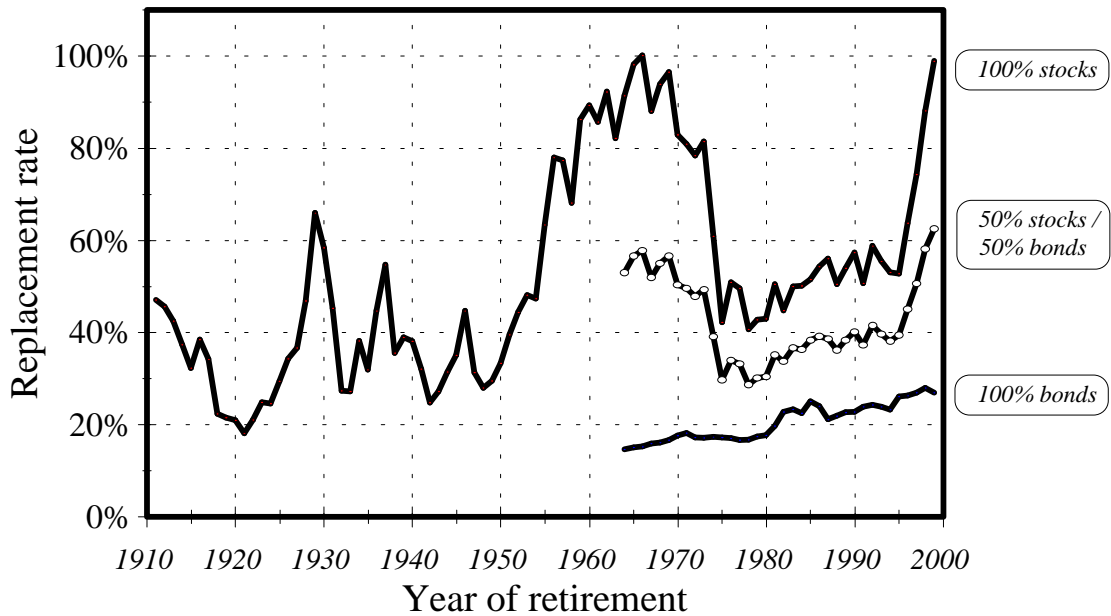
Figure 2.

"Riskless" Long-term Interest Rate, 1910 - 1999

Note: "Riskless" rate is assumed equal to nominal U.S. Treasury long-bond rate from 1924-1998 and equal to adjusted high-quality railroad bond rate 1910-1923 (see text). Real rate is obtained by subtracting the annual inflation rate over the next five years from the nominal interest rate.

Source: Federal Reserve Bank of St. Louis and U.S. Bureau of Labor Statistics.

Figure 3.
Male Single-life Annuity as a Percent of Career High Annual Earnings (Measured at Age 62)

100% stocks

50% stocks / 50% bonds

100% bonds

Note: "Replacement rate" is the worker's intial annuity divided by his average real annual earnings when he was 54 - 58 years old.

Figure 4.
Real Internal Rate of Return Measured at Age 62, 1911 - 1999

100% stocks
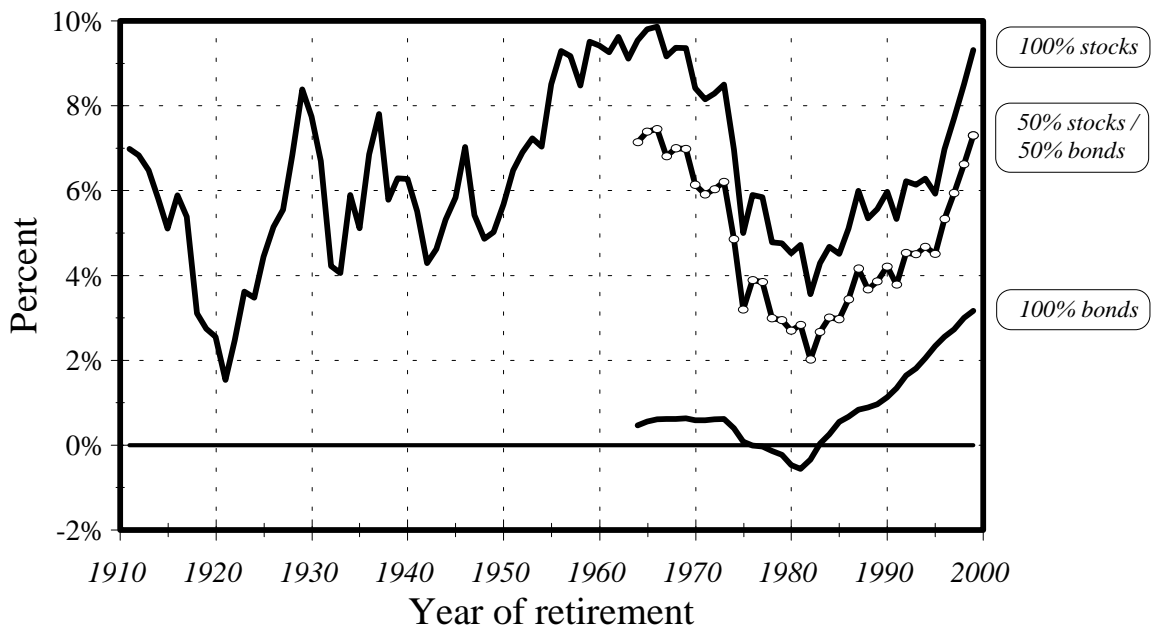
50% stocks / 50% bonds

100% bonds

Figure 5.
Risk - Expected Return Tradeoff for
Stock and Bond Pension Investments

Expected internal rate of return
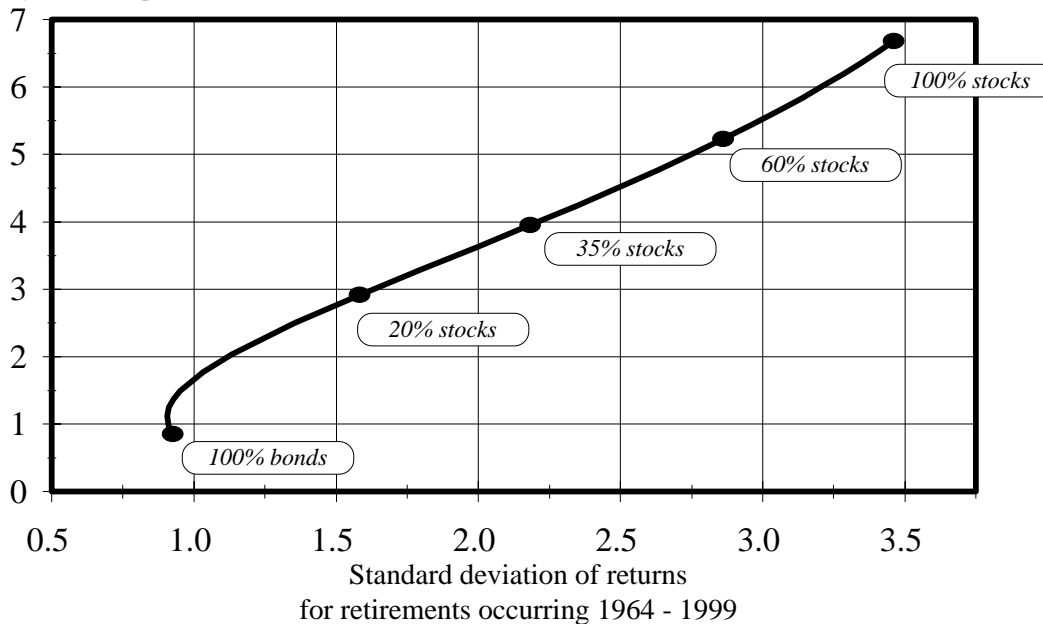after 40-year career (percent)

100% stocks

60% stocks

35% stocks

20% stocks

100% bonds

Standard deviation of returns
for retirements occurring 1964 - 1999

Figure 6.
Real Annuity as Percent of Career
High Annual Earnings at Selected Ages

Replacement rate

Year of retirement = 1966

1929

1933

1921

Age of pensioner
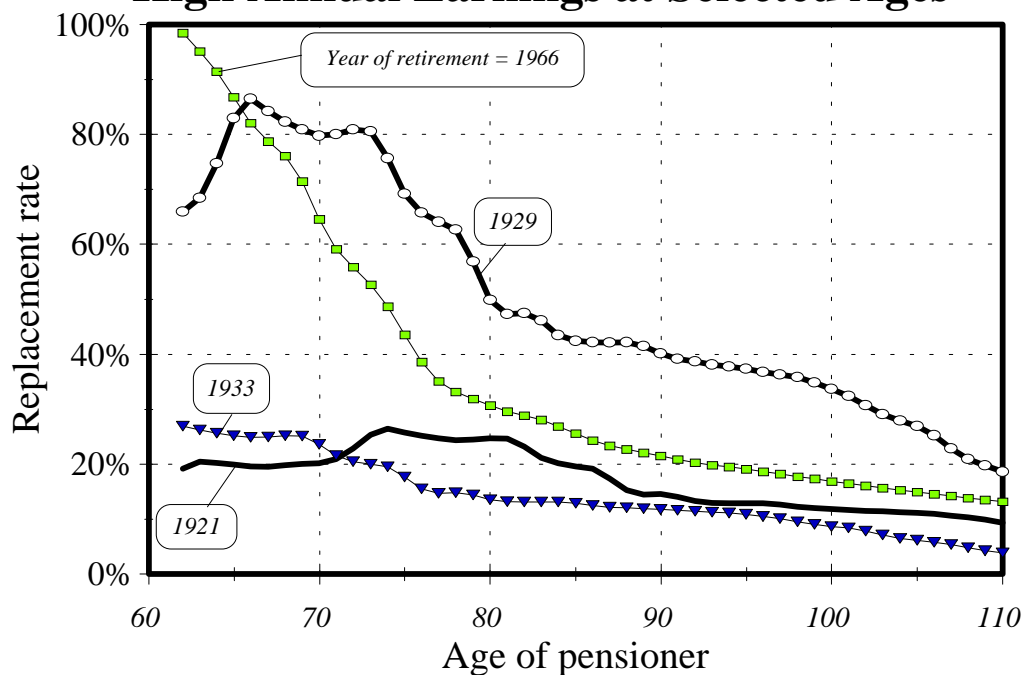
Figure 7.
Real Annuity as Percent of Career
High Annual Earnings at Selected Ages

Replacement rate at --

Age 70

Age 80

Replacement rate

Year of retirement
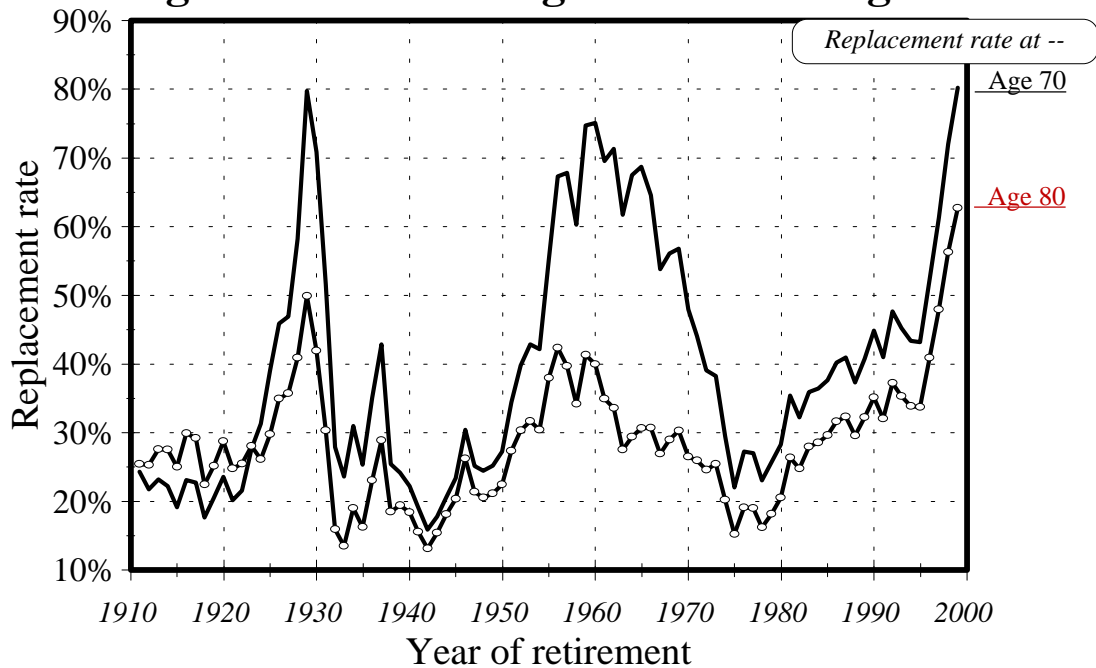
Figure 8.
Replacement Rates under One-Time
and Phased Annuitization, 1911-1999

Single annuity purchased at age 62

Phased annutization between ages 58 and 62

Percent

Year of retirement
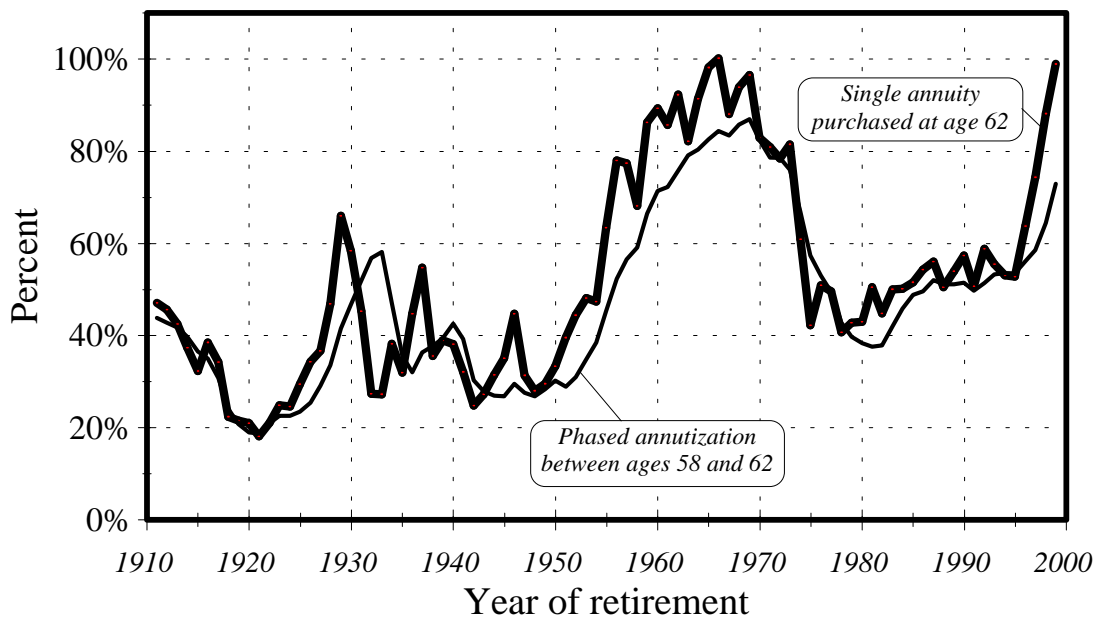
Note: "Replacement rate" is the worker's real annuity at age 62 divided by his average real earnings when he was 54 - 58 years old.