Autopilot:
Self-Adjusting Mechanisms for Sustainable Retirement Systems

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Foreword

The Society of Actuaries' Retirement 20/20 *project kicked off in 2006 with a conference titled "Building the Foundations for New Retirement Systems." The conference focused on needs, risks and roles for the stakeholders in today's retirement system, and discussed how to make social insurance, private pensions, private savings, annuities and other retirement plans work better in the 21st century. One key theme that emerged was that wherever possible, systems should be designed to self-adjust, specifically to correct for changes in economic and demographic conditions.*

The Pension Section Council of the SOA commissioned this paper to explore where self-adjusting systems are in place today – what they do and don't do. Most self-adjusting mechanisms that exist today are in social insurance systems, and they often focus on ways to adjust for changes in longevity. The Pension Section Council hopes that this paper will spur researchers to develop more ways that self-adjusting mechanisms might work to shape of social insurance and private retirement plans into the 21st century.

Introduction

Defined benefit retirement systems are often designed with mechanisms to self-adjust for many factors. For example, plans have adjusted for inflation and real wage growth over the working lifetime with a myriad of design factors. Final average defined benefit plans "adjust" by basing the final benefit on final pay; cash balance defined benefit plans accrue over time with interest (often short-term Treasury rates); and the US Social Security system adjusts individual wages (used in benefit calculations) as well as its contribution structure (wage base) and bend points with the growth in average wages.

However, most systems do not have factors to take into account other risks. One key risk, improvement in average longevity, will be discussed at length as it has been the focus of many self-adjusting mechanisms put into place in recent years. But other factors will be discussed as well, including mechanisms to adjust for solvency in social insurance systems in ways other than raising or lowering taxes.

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Within defined benefit retirement income systems—both employer-provided systems and social security systems—much work has been done recently to put self-adjusting mechanisms in place to deal with improvements in life expectancy. Improvements in life expectancy raise the lifetime generosity of these retirement income systems, raising their costs, and placing strains on their financing. As many of these systems have wrestled with significant improvements in life expectancy in the second half of the 20th century, we have seen several models emerge for how to deal with this systematic risk.

The failure to adjust social security systems for improvements in life expectancy is one of the causes of the financing problems they are facing (Palmer 2000). Traditional social security systems generally are not self-sustaining in the face of increasing life expectancy at older ages because retirees receive benefits for more years. By contrast, in defined contribution systems, life-expectancy indexing of benefits occurs automatically when benefits are annuitized using current mortality tables because increases in life expectancy reduce benefit levels. Eventually, traditional social security systems require adjustments to deal with the increased benefit cost caused by rising life expectancy. With a pay-as-you-go system, solvency can be maintained three ways: cutting benefits, raising taxes, or raising the early retirement age. Raising the early retirement age will help Social Security finances if benefits are not raised to adjust for the increase in age of eligibility.

Increased life expectancy raises the cost to employers of providing defined benefit pension plans. While in the short run, changes in interest rates normally dominate changes in life expectancy in their effect on pension liabilities, over a period of decades, the effect on pension costs of the increase in longevity can be considerable, while changes in interest rates generally have much less effect. The short run and long run importance of the effects on pension cost of changes in life expectancy are thus quite different.

A New Trend

This paper focuses on automatic adjustment mechanisms for social security and employer-provided pension systems, examining the experience around the world. Since the late 1990s, starting with an innovative reform in Sweden, a growing number of countries have reformed their social security systems to include automatic adjustment mechanisms. At least twelve countries have adopted life-expectancy indexing of benefits or automatic adjustments tied to social security insolvency. Both types of reforms provide automatic adjustment mechanisms for sustaining the solvency of social security systems.

This survey has found few examples of employer-provided pension systems with similar automatic adjustment mechanisms. Nonetheless, the types of arrangements surveyed here may provide useful models for the reform of the U.S. Social Security system and provide new options for employer-provided defined benefit plans.

Life expectancy indexing of social security benefits goes a long way toward resolving future financial problems, but it does not completely solve them. The Congressional Budget Office has estimated the effect of a U.S. reform that only involved life expectancy indexing of initial Social Security benefits. This one change, put into effect in 2012, would eliminate 43 percent of the 75-year deficit, and would extend the date of insolvency by seven years, resulting in a date of insolvency more than 50 years into the future (Congressional Budget Office 2005).

This report surveys countries that have adopted automatic adjustment mechanisms for social security and employer-provided pensions. Most of the countries surveyed with such mechanisms in their social security systems have made the adjustments through benefit cuts. This strategy represents a change from the past, where adjustments generally involved an ad hoc increase in contribution rates. Some countries now have decided that it is not feasible to raise contribution rates further, so that adjustments must come either through benefit cuts or through raising the early retirement age.

Many countries index social security benefits in retirement for increases in the price level or wages. The United States indexes initial benefits at retirement for changes in average wages and indexes benefits in payment for changes in prices. This report is limited to indexing tied to changes in life expectancy or indexing tied to measures of the social security system's solvency. These forms of indexing traditionally have not been part of social security systems.

The report first considers countries that have indexed social security benefits for life expectancy but have not also adopted other automatic adjustments related to social security solvency. It then considers the smaller number of countries that have automatic adjustments that are tied to the solvency of the social security system. Lastly, it considers the few countries that have automatic adjustment mechanisms as part of their employer-provided pension systems. The effect of life expectancy increases on benefit liabilities is considerably greater in pension systems that are price indexed than in systems that have nominal benefits that do not adjust for inflation because the value of future benefits is much greater in systems that are price indexed.

Ad Hoc versus Automatic Adjustments

Countries can adjust social security either ad hoc or through an automatic adjustment mechanism. Ad hoc adjustments tend to be large, infrequent and unpredictable. They tend to be made due to a crisis, and often there is little lead time between the enactment of the adjustment and the date that it becomes effective (Turner 2007). The short lead time gives workers little time to adjust their savings and labor supply.

By contrast, automatic adjustments are generally small, frequent, and predictable-- all desirable features. Automatic adjustments are transparent. It is clear how adjustments will be made and who will bear what costs when an adjustment occurs. Automatic adjustment processes solve the problem of political risk, which is the problem

that workers and retirees do not know in advance how the political system will resolve problems of social security insolvency.

With increases in life expectancy, one automatic adjustment mechanism involves indexing social security benefits. This indexing generally is done so as to maintain the expected present value of lifetime benefits for the typical retiree. The reduction in annual benefits offsets the effect on lifetime benefits of an increased life expectancy and thus the increased number of years that benefits are received. In that case, life expectancy indexing does not cut benefits when measured over a lifetime. The reduction in benefits can be offset by working longer and provides an incentive for doing so.

Indexing Social Security with Automatic Adjustment Mechanisms

The basic mathematics of pay-as-you-go systems clarifies the role of indexing in social security with respect to both economic and demographic changes. With a pay-as-you-go social security system, the total benefits paid out in a year equal the total payroll tax payments received. That relationship can be expressed as a budget constraint, where B equal average benefits in real terms, N equal the total number of beneficiaries, t is the payroll tax rate (or contribution rate), w is the average real wage, and L is the number of workers.

$$BN = twL \qquad (1)$$

That budget constraint can be rewritten in terms of percentage changes over time, where E is the percentage change operator (technically, the derivative of the natural logarithm).

$$E(BN) = E(twL) \qquad (2)$$

For social security to continue to maintain financial balance, the growth rate in total real benefit payments must equal the growth rate in total real payroll tax payments. For countries where the payroll tax rate t is fixed, having reached the maximum level considered politically acceptable, the constraint becomes

$$E(BN) = E(wL) \qquad (3)$$

Thus, the growth rate in total real benefit payments must equal the growth rate in total real wages. This constraint can be disaggregated into the growth in its component parts and expressed in terms of the economic and demographic changes that limit the sustainable growth in real benefits.

$$E(B) + E(N) = E(w) + E(L) \qquad (4)$$

$$E(B) = E(w) + E(L) - E(N) \qquad (5)$$

To maintain solvency, the growth rate in average real benefits must equal the growth rate in real wages plus the difference between the growth rate in the labor force and the growth rate in beneficiaries. In most countries, the growth rate in beneficiaries exceeds the growth rate of the labor force. This may be one place where self-adjusting mechanisms can be focused to improve the stability of these systems. In particular, while the labor force is continuing to grow in the United States, in some countries its growth rate is close to zero. In a few countries, such as Japan, the growth rate of the labor force is negative, with the size of the labor force declining.

Some countries use the ratio of retirees to workers as an aspect of their automatic adjustment mechanism. The pay-as-you-go constraint can be rewritten to illustrate the logic behind that choice.

$$E(B) = E(w) - E(N/L) \qquad (6)$$

This formulation indicates that a sustainable program could have benefits growing at the rate of real wage growth less an adjustment for the rate of growth in the dependency ratio—the ratio of beneficiaries to workers.

The current demographics and a fixed payroll tax rate dictate that the social security replacement rate must fall. It is not possible to maintain the current generosity of social security in this situation. This conclusion derives from the pay-as-you-go budget. With the labor force growing slower than the number of beneficiaries and the payroll tax rate fixed, the growth rate in real benefits must be less than the growth rate in real wages for a pay-as-you-go system to maintain its financial balance. This implies that the replacement rate (B/w) must fall over time.

$$E(B/w) = E(L) - (EN) \qquad (7)$$

The social security budget constraint limits countries' social security options. If countries have decided that they will not raise the social security payroll tax rate, their choices are further limited. Because of falling birth rates and increasing life expectancy at older ages, the number of beneficiaries is growing faster than the number of workers. In this situation, the social security budget constraint indicates that countries have no choice—they must reduce the generosity of social security benefits relative to wages. With a fixed early retirement age, this means that the replacement rate—the ratio of benefits to wages—must fall. This cut in benefits can be achieved by life-expectancy indexing of benefits.

Although the expected lifetime payout to each retiree is the same, these changes can not only improve the funding of systems by paying out benefits for shorter periods, but also can encourage workers who are still able to work, e.g. knowledge workers, to remain at work longer, which brings added benefits not only to the social insurance system (more taxes paid in) but may also improve economic conditions if there is a shortage of workers. However, these changes can also penalize workers who are no

longer able to work – often those at the lower end of the income scale whose jobs are low skilled or have involved physical labor.

Indexing Social Security Benefits for Life Expectancy Increases

Starting in the late 1990s, a number of countries have reformed their social security systems to incorporate life expectancy indexing or some other automatic adjustment of social security benefits. Thus, the reforms discussed here are all relatively recent. These reforms all establish in a way that was clearer than in the past who will bear the costs of needed adjustments to social security financing.

Life expectancy indexing of benefits shifts aggregate (systemic) life expectancy risk to workers. However, retirees are still protected from their individual life expectancy risk by being provided an annuitized benefit that is unaffected by how long they live. Life expectancy indexing for successive cohorts gradually reduces benefits below what they would otherwise be, with the effect being cumulative over successive birth cohorts, so that the percentage decline increases gradually over time. In all cases, unisex life expectancy has been used, rather than having different indexing for men and women or for other identifiable groups (such as race) with differential mortality rates. Note that defined contribution plans, including notional defined contribution designs, shift aggregate life expectancy risk to workers and may, depending on their design, shift individual (idiosyncratic) risk to individuals as well.

This section provides an overview of life expectancy indexing of benefits in different countries (table 1). The countries are divided into those with traditional social security programs and those with Notional Defined Contribution (NDC) programs (explained below). Generally, the indexing in these programs is designed to maintain the lifetime expected present value of benefits with an increase in life expectancy.

Traditional Social Security Programs

At least three countries have adopted life expectancy indexing within traditional social security programs. In this respect, Brazil is a major innovator, being the first country to life expectancy index benefits in a traditional social security program.

Brazil. In 1998, the Brazilian social security program for private sector workers underwent a major reform. Brazil adopted a benefit formula that incorporates life expectancy indexing based on indexing of Swedish notional accounts. At retirement age, the calculation of social security benefits takes into account unisex life expectancy at that age, with an annual updating of life expectancy at retirement age. Life expectancy is officially estimated by the annual household survey of the Brazilian Institute of Geography and Statistics. The addition of this automatic adjustment mechanism is credited with going a long way toward ensuring the long-term sustainability of the system (Bonturi 2002).

Finland. In 2003, Finland passed a law to incorporate increases in life expectancy in the calculation of social security benefits, starting in 2010. It will use unisex mortality tables based on past mortality data averaged over a five-year period to adjust initial pension benefits at age 62. Irrespective of the age the person actually retires, that person's benefits at retirement will be adjusted by the longevity coefficient established for unisex life expectancy at age 62. Disability pensions are also adjusted by the longevity coefficient (Alho, Lassila, and Valkoner 2006, Lindell 2003). By 2040, after 30 years of life-expectancy indexing, the level of benefits is expected to be reduced to 88.6 percent of their level without that indexing (Whitehouse 2007).

Portugal. In 2006, Portugal passed legislation that indexes its social security benefits for improvements in life expectancy. The legislation takes effect in 2008.

NDC Programs

Notional Defined Contribution (NDC) plans, also called Non-Financial Defined Contribution plans, are a new type of social security plan. These plans have the objectives of addressing the fiscal instability of traditional defined benefit plans and mimicking the characteristics of funded DC plans while retaining pay-as-you-go finance (Auerbach and Lee 2006). NDC plans establish an individual account for each worker. The worker's contributions are credited to the account, as are interest earnings on the account. However, the system as a whole is financed on a pay-as-you-go basis, with a small, collectively managed trust fund maintained only for the purpose of covering periods when payroll tax payments are temporarily low. These plans were conceived in Sweden, which implemented its plan in 1999. NDC plans have also been adopted by Italy, Poland, and Latvia (Holzmann and Palmer 2006), and more recently, Norway.

NDC plans typically index benefits at retirement for changes that have occurred n life expectancy at the benefit entitlement age. Life-expectancy indexing in NDC plans appears to be a natural outcome of the structure of these plans because they accrue benefits in the form of an individual account balance, just as do defined contribution plans.

Sweden. Sweden has adopted life-expectancy indexing of benefits in a pathbreaking system that involves several other aspects of indexing. This system is discussed later.

Italy. Italy has established an NDC system that calculates benefits taking into account unisex life expectancy at the Normal Retirement Age, including the probability of paying benefits to survivors (Franco and Sartor 2006). Every ten years, the factor used to calculate benefits will be adjusted for increases in life expectancy. This adjustment is not fully automatic, however, but will require legislative approval. This system has a long phase-in period, since only new entrants to the labor force are required to participate in it.

Latvia. Latvia uses unisex life expectancy at retirement age to convert the NDC account balance to an annuity. It bases life expectancy on projected cohort life tables,

which are adjusted annually (Palmer et al. 2006). Projected life tables for a birth cohort arguably are superior for this purpose than ones based on the contemporaneous cross section of mortality rates because the projected ones anticipate continued improvement in life expectancy.

Norway. In 2006, the Norwegian government passed a reform that will institute an NDC system. This system will have unisex life-expectancy indexing of benefits at retirement, following Sweden and Finland. The system is proposed to begin in 2010.

Poland. Poland uses unisex life expectancy at age 62 to convert the NDC account balance to an annuity. Age 62 was picked because it is between the entitlement ages of 60 for women and 65 for men (Chłoń-Domińczak and Góra 2006).

Indexing Social Security Adjustment Factors for Life Expectancy Increases

Typically, social security systems raise annual benefits for an individual worker if that worker postpones the initial receipt of benefits. Often this adjustment is designed so that the increase in annual benefits is just sufficient to offset the loss of benefits due to the postponement of initial receipt, so that the worker's expected lifetime benefits are unaffected. With fixed adjustment parameters, as life expectancy increases over time, the increase in annual benefits becomes too large to maintain lifetime neutrality because the number of expected years over which that benefit increase will be received grows. Thus, over time the lifetime benefits increase due to postponing retirement will be larger.

Italy. Italy has established indexing of its actuarial adjustment factors in its NDC system. Every ten years it will examine those factors and adjust them as needed (Brugiavini and Peracchi undated). While the other adjustments discussed in this report are designed to maintain or restore solvency, this adjustment has only a slight effect on solvency, and is designed more to affect the incentives for early or postponed retirement.

Indexing the Pensionable Age

As of 2006, no country had indexed its pensionable age (benefit entitlement age) for changes in life expectancy.

United Kingdom. In 2005, a national pensions commission proposed life-expectancy indexing of its pensionable age, the earliest age at which workers can receive social security benefits (Pensions Commission 2005). The British proposal would index the entitlement age so that the ratio of working years to retirement years would be constant. Such a policy would implicitly take into account increases in life expectancy from the start of work life. It would announce any increase in the entitlement age 15 years in advance, so that for the current entitlement age of 65 for men, no one would be affected who was age 50 or older. It is expected, based on the projection of life expectancy improvements, that such indexing would result in a benefits entitlement age of 68 in 2050. The Pensions Commission (2005) argues that this type of indexing is fair

across generations, with every generation spending the same percentage of adult life in retirement.

With this type of indexing, the pensionable age does not increase one-to-one with increases in life expectancy. Rather, if the ratio of retirement years to working years is one to two, then for every 3 years increase in life expectancy, the pensionable age would be increased by two years in order to maintain the ratio of one retirement year for every two working years.

This proposal was transformed, however, when it was presented as a bill in Parliament. The proposed bill would raise the pensionable age in three steps, with a phase in between April 2024 and April 2026 of the increase from 65 to 66, followed by a phase in from April 2034 to 2036 of the increase from 66 to 67, and a phase in from April 2044 to 2046 of the increase from 67 to 68 (Watson Wyatt Worldwide 2007).

Indexing Years of Contributions Required for a Full Benefit

France Starting in 2009, the number of years of contributions for full benefits in the French social security system, which currently is 40, will increase by one calendar quarter per year until it reaches 41 years in 2012. Thereafter, through 2020, the contribution period for full benefits will increase as needed to keep the ratio of the contribution period to the average retirement period equal to its ratio in 2003, which is approximately two to one.

This adjustment mechanism effectively results in a reduction in benefits that is tied to increases in life expectancy. The French government retains the right to not make these adjustments if labor market conditions, such as high unemployment, do not support the extra years of work.

Countries with Automatic Adjustment Mechanisms Tied to Solvency

While life expectancy indexing of benefits is designed to reduce the likelihood of system insolvency, some countries have adopted other automatic adjustment mechanisms that deal directly with insolvency when it arises. Countries with automatic adjustment mechanisms differ considerably as to how these mechanisms are structured and in the likelihood that these mechanisms will come into play. In some countries, the mechanisms will be rarely, if ever, used, while in other countries they will be used annually.

Sweden is the intellectual leader in the movement toward life expectancy indexing and automatic adjustments. Sweden has a system of interlinking adjustment mechanisms, focusing on life expectancy indexing, adjustments for actual inflation and growth and real per capita wages, and fiscal balance that adjusts current and future benefits that are designed to reduce the need for its other automatic adjustment mechanism devised to prevent insolvency. The other countries have an automatic adjustment mechanism that operates without there being separate life expectancy indexing of benefits.

Sweden—An Automatic Adjustment Rarely Needed. In 1994 the Swedish parliament passed legislation, with a phased implementation that began in 1995, that established an NDC plan. Each year the initial benefits received by new beneficiaries are adjusted slightly downwards as each new birth cohort reaches the benefit entitlement age of 61. Workers can offset the benefit reduction by postponing retirement by about three weeks for each year since the start of the indexing. Thus, the difference for adjacent birth cohorts is quite small. After 15 years, workers would need to postpone retirement by 11 months to avoid receiving lower benefits, which could be done by working longer or by postponing the date at which benefits are claimed (Table 2).

The life expectancy indexing is done by use of an annuity divisor that reflects improvements in life expectancy at age 65. No further adjustments for improvements in mortality occur after age 65. Thus, the life expectancy adjustment does not take into account life expectancy improvements that occur for a particular cohort after age 65. It is expected that the failure to adjust for life expectancy improvements after retirement will be expensive, costing about one percent of payroll in contributions (Palmer 2000). The initial generation in the system will benefit from this feature, but subsequent generations will pay for it through the automatic adjustment process required to maintain solvency.

Mortality experience is averaged over the previous five years to avoid year-to-year fluctuations that do not reflect longer-term trends. The Swedish system uses period mortality tables, which are mortality tables based on the experience of the cross section of older persons. For each cohort, the annuity divisor adjustment is established at age 65, with a provisional adjustment made for retirements starting at age 61, which is the benefit entitlement age.

In addition, annuities in payment in the NDC system are adjusted annually for changes in the growth rate of real per capita wage income. If the growth rate of real per capita wage income is constant at 1.6 percent per year, the annuity is adjusted solely by changes in the Consumer Price Index. If the annual growth rate of real per capita wage income falls below 1.6 percent, the annuity grows less fast than the CPI, and if the growth rate of real per capita wage income exceeds 1.6 percent, the annuity grows faster than the CPI. Real per capita wage growth in Sweden has averaged about 2 percent over long periods (Palmer 2000), so it is expected that over time this indexing will be more generous than price indexing. Thus, Swedish pensioners share with workers in the fluctuations in the Swedish economy, rather than being guaranteed a full adjustment of their benefits for inflation, as in the United States. If there is an economic recession, such as proceeded the passage of the reform legislation, Swedish pensioners will have the indexing of their benefits reduced.

Sweden has built into its system an additional automatic adjustment mechanism. This mechanism, added in 2001, is called the automatic balancing mechanism. The automatic balancing mechanism has two goals: to fix the contribution rate so that it does not need to be raised in the future, and to automatically restore financial balance to the social security system without the intervention of politicians. Life expectancy indexing

and the adjustment of benefits in payment for changes in productivity may not be adequate to assure solvency. Solvency is also affected by fertility rates and labor force participation rates. When those adjustments are not adequate to maintain the solvency of the social security system, the system adjusts the rate at which workers accrue benefits. The automatic balance mechanism only is used when the system reaches a certain point with respect to future solvency. Thus far, it has not been used, and it is expected that it will be used infrequently.

In the Swedish notional account system, each worker has an account with an account balance. That account balance. A_t at time t, equals the contributions C credited to the account, which equals the payroll tax rate t multiplied by the workers wage earnings w, plus the account balance in the previous year A_{t-1} multiplied by the accrual rate r.

$$A_t = C + (1+r)A_{t-1} \qquad (8)$$

The accrual rate r equals the growth rate of per capita wages w.

$$r = E(w) \qquad (9)$$

With the automatic balancing mechanism, each year the Swedish government measures the assets and liabilities of the system. If the liabilities exceed the assets, and the system is thus out of balance, it reduces the interest rate r used to calculate accruals in the notional balances and it reduces by the same amount the indexing rate for annuities. Thus, the future benefits of workers are cut through the cut in their accrual of benefits. The current benefits of retirees are also cut through the reduction in indexing of their benefits. All of the adjustment occurs on benefits and the accrual of benefits, the level of contributions is not affected. This mechanism shares the burden of the adjustment across generations, with both workers and beneficiaries bearing the burden.

The NDC system has few actual assets because it is funded basically on a pay-as-you-go basis, with a reserve fund that is small relative to liabilities. To calculate assets for the purposes of the automatic balancing mechanism, the annual contributions received by the system are multiplied by what is called the expected turnover duration. The expected turnover duration is the average length of time, measured in years, until the system must pay out benefits to liquidate the liability created in the current year. It can be shown that if the population structure of the system is stationary, the present value of benefits accrued during a year equals the contributions during the year times the turnover duration. Japan has evaluated this method of determining the future liabilities of its system and decided that it would not work for their country because it has a declining work force, rather than a stable population structure (Sakamoto 2005).

The turnover duration is calculated as the difference between the earnings-weighted average age of persons contributing to the system and the pension-weighted average age of beneficiaries receiving annuities from the system. Currently, Sweden's

expected turnover duration is 32.3 years, indicating the pay-as-you-go system can finance liabilities equal to approximately 32.3 times the annual contributions it receives.

Thus, for purposes of determining solvency, total assets in the Swedish system are calculated as follows:

Assets= ((annual contributions) times (turnover rate)) plus (reserve fund) (10)

This value of assets is compared to the present value at the end of the fiscal year of the liabilities for future benefit payments. If assets exceed or equal liabilities, no adjustment is made. If assets are less than liabilities, the rate of return credited to the notional account balances is reduced and the indexing of current benefits is reduced. To smooth out temporary variations, the calculation is done on the basis of a three-year moving average of the ratio of assets to liabilities (Kőnberg, Palmer, and Sundén 2005).

The rate of return credited to the individual accounts in the Swedish NDC system is the rate of growth of real per capita wage income. This rate of return links benefits to the standard of living of workers. However, the system would have greater ability to function on autopilot if the rate of return chosen had been the rate of growth of the total wage bill in the economy. Using the rate of per capita wage growth rather than the rate of total wage growth raises the possibility that benefits will grow faster than the wage base that finances them. This would happen if the labor force declined. If Sweden were to get into a situation like Japan with a declining labor force, it might be forced to change its system of accruing benefits.

The adjustment in the Swedish system occurs entirely on benefits in payment and benefits being accrued. The logic of the system dictates that the adjustment occur through benefit reductions. If the payroll tax rate were increased, that would increase the contributions credited to the individual accounts, which would increase future benefit liabilities.

If, rather than insolvency being the problem, assets grow to become unexpectedly large, a different adjustment would be made. If the ratio of assets to liabilities reaches a point, as yet undetermined, where it is viewed that future insufficiency is unlikely, the excess reserves will be distributed to the participants. A government commission has proposed that a ratio of assets to liabilities of 1.1 should trigger that adjustment.

An automatic adjustment mechanism is not an inherent aspect of an NDC system. Italy and the other countries with NDC systems have not incorporated such a mechanism.

Germany: An Automatic Adjustment that is Ongoing. Unlike Sweden, Germany does not index benefits for life expectancy. Germany, however, has changed its calculation of initial benefits in a way that incorporates life expectancy as one aspect of a more complex mechanism. The adjustment factor in Germany is called the sustainability factor. The sustainability factor, introduced in the reform of 2004, attempts to achieve sustainability by limiting the indexing of initial benefits.

The sustainability factor takes into account the ratio of contributors to pensioners (Bőrsch-Supan and Wilke 2006). More precisely, to adjust for contributors with very low contributions and beneficiaries with very low benefits, the sustainability factor is tied to an "equivalized" measure of contributors to pensioners, where, for example, two low-wage contributors might equal one equivalized contributor. The dependency ratio includes unemployed persons in the denominator.

The sustainability factor includes more demographic factors than just life expectancy. It includes the effects of migration, and changes in birth rates, in labor force participation rates, in retirement rates, and in life expectancy. The sustainability factor is used to index initial benefits, but part of the adjustment to solvency also occurs by raising the social security payroll tax rate.

Initial benefits for a retiree are determined by multiplying the benefits received under the benefit formula of the previous year by the sustainability factor. With the sustainability factor, the benefit formula is multiplied by the following adjustment factor A

$$A = 1 + \alpha(1- R) \qquad (11)$$

where R is the ratio of the dependency rate in year t-2 to the dependency rate in year t-3, and is thus a number greater than 1 because of the increasing dependency ratio over time. The parameter α has been set in the German reform at 0.25. Thus, the term $\alpha(1- R)$ is negative, making the adjustment factor A have a value that is positive but less than 1.

Using the framework developed earlier in this paper, the German adjustment factor is based on the percentage change in the dependency ratio E(N/L)

$$E(B) = E(w) – E(N/L) \qquad (7)$$

The sustainability factor has reduced the projected payroll tax necessary to finance the system in 2040 from 28 percent to 24 percent (Capretta 2006). However, unlike for Sweden, the sustainability factor does not fully correct for causes of insolvency. The sustainability factor is weighted so that it offsets just one-quarter of the percentage increase in the system's dependency ratio, rather than the full increase.

Japan: An Automatic Adjustment that Combines Features from Germany and Sweden. Japan has studied the reforms in Sweden and Germany and developed its own system of automatic adjustments that incorporates aspects of the systems in both countries.

Japan's social security program has had to deal with both increasing life expectancy at older ages and a continuing decline in the birth rate to levels considerably below the replacement rate. Because of the low fertility rate, the population in Japan is declining. Even though major reform legislation was passed in 2000, improvements in

life expectancy since then that were greater than expected, plus declines in birth rates that were greater than expected in the official projections, caused the need for reform in 2004. Because of the political cost of the continuing process of reform, Japanese politicians wanted an automatic mechanism that would cause the system to return to solvency without the intervention of politicians (Sakamoto 2005).

In reform legislation passed in 2004, Japan incorporated a demographic factor into the calculation of social security benefits (Takayama 2006). This factor, as in Germany, takes into account the growth or decline in the workforce. In Sweden, Germany, and Japan, the desire to not raise the payroll tax rate above a set level motivated the change. This decision was made in Japan in part because of concerns of younger workers as to the possibility of very high contribution rates, which some viewed as being unfair to their generation. The adjustment occurs by reducing the indexing of initial benefits.

Under the automatic adjustment mechanism, the indexing of initial benefits at retirement is reduced by a modifier until financial solvency is restored, at which time indexing reverts to the formula used before the reform. The modifier takes into account that the Japanese workforce is declining, and it also takes into account the increases in life expectancy in Japan. It s calculated as follows:

Modifier = rate of decline in the Japanese workforce participating in social security programs + rate of increase in life expectancy at age 65. (12)

In Japanese policy discussions, it was noted that the rate of growth of the beneficiary population was also a factor affecting solvency, but that the rate of growth of the beneficiary population would eventually reflect the rate of growth of the workforce (Sakamoto 2005).

For purposes of benefit calculation, the rate of increase in life expectancy at age 65 is fixed in the law at 0.3 percent per year, based on the 2002 projection over the period 2000 to 2025. It was fixed in order to avoid year-to-year fluctuations in the benefit adjustment. The modifier differs from the modifier used in Germany in that it does not take into account the growth in new beneficiaries. However, adjusting by the rate of growth of life expectancy overcorrects for the effect of life expectancy on the present value of benefits.

The modifier is subtracted from the regular indexation rate. It is expected that the modifier will reduce the indexation rate by 0.9 percentage points per year on average. The expected effect of this change is to reduce the average replacement rate from 59 percent in 2004 to 50 percent by 2023 The modifier, however, is not applied if it would result in a decline in nominal benefits, and it applies only to benefits, not to the payroll tax rate. If the CPI declines in a year (as has happened in Japan) or if per capita disposable income declines, benefits are maintained at their nominal value, rather than reflecting the effects of indexing. If the replacement rate were to fall much more rapidly than expected, and fell to 50 percent or lower by 2009, the adjustment mechanism would

be stopped, and the policy would be reviewed. Thus, the law contains a provision to override the automatic stabilizer.

The Japanese government is gradually increasing the payroll tax rate to 18.3 percent in 2017, at which point the payroll tax is considered to be fixed. In the absence of the 2004 reforms, the payroll tax rate was projected to increase to 25.9 percent. It was 13.58 percent in 2004, and is scheduled to rise by 0.354 percent annually until 2017. With these increases in the payroll tax rate, it is estimated under the best case scenario that the modified indexation will continue until 2023, when indexation will return to that used in 2004.

Japan decided not to follow the Swedish approach that involves calculating the turnover ratio because in the context of the Japanese social security system it is difficult to calculate that measure. This difficulty arises because of the variety of types of benefits, including disability benefits, provided by the Japanese system. Also, the demographic situation in Japan differs considerably from that in Sweden. In Japan, the workforce is declining, which implies a declining population paying into social security, which is not the case in Sweden.

Canada: An Automatic Adjustment if Politicians Cannot Agree. Canada uses an approach to automatic adjustments that differs considerably from that in Sweden, Germany, and Japan. The Canada Pension Plan (CPP) is Canada's social security program for all of Canada, except the province of Quebec, which maintains a similar but separate plan. CPP is partially funded, and financed with a combined employee-employer tax rate of 9.9 percent. Its fund is invested in part in the stock market. The system is designed so that a fund will be built up that will be adequate to cover the retirement of the Canadian baby boom and the aging of the population, so that there never will need to be further contribution rate increases or benefit cuts. However, if there is a prolonged period of adverse financial markets or if life expectancy increases considerably more rapidly than anticipated, or if another economic or demographic variable affecting funding turns out to be much more adverse to funding than expected, it is possible an automatic adjustment will be needed.

Every three years, the system's Chief Actuary evaluates the financial sustainability of the system. If the Chief Actuary determines that the system is not financially sustainable in the long run, legislation passed in 1997 requires that there be an automatic adjustment (American Academy of Actuaries 2002, Canada Pension Plan 2007). The automatic adjustment occurs only if the Canadian parliament cannot first decide on an adjustment, which is considered to be unlikely. The automatic adjustment freezes benefits for three years and increases the contribution rate over that three-year period, until the next triennial evaluation of the fund. If the changes in long run assumptions raise the projected steady state contribution rate required to maintain a constant ratio of assets to expenditures, then the contribution rate will be increased permanently. The need for an automatic adjustment has not arisen, and it is fairly unlikely that it will arise.

Employer-Provided Plans with Automatic Adjustment Mechanisms

As noted in the introduction, most self-adjusting mechanisms are found in social insurance systems. Employer provided plans have not tended to include these, partly because in many countries statutes have focused on "preserving" benefits for participants.

Many countries have minimum funding requirements for defined benefit plans that require plan sponsors to contribute when the funding ratio falls below a fixed level. The use of other automatic adjustment mechanisms by employer-provided plans is rare.

Iceland. Iceland has mandatory employer-provided hybrid pension plans that cover nearly all workers. Benefits are calculated based on a formula, but the level of benefits is reduced if the plans become underfunded. These plans have been funded by a contribution of 4 percent of wages by employees and 6 percent of wages by employers. In January 2007, the employer contribution was increased to 8 percent. In the past, these plans fixed the contribution rate and occasionally would adjust the generosity of benefits depending on their funding level. Pension plans that were adequately funded could choose to put part of the contributions into a defined contribution plan. A law passed in January 2007 has made the reduction of benefits automatic when a plan is underfunded . If a plan is underfunded by 10 percent or more in a year or by 5 percent for five years in a row, it must reduce the generosity of its benefits (Social Security 2007).

Netherlands. The ABP plan, which is the Dutch Civil Servants' Pension Plan, is one of the largest pension plans in the world in terms of assets. It is a privatized plan for civil servants (de Jong and Turner 2001). This plan bases benefits on a benefit formula, as is done in defined benefit plans, but it is a hybrid plan. The plan is financed by contributions by employees and employers. Automatic adjustment occurs through changes in the contribution rate of workers and the indexation rate of benefits in payment for pensioners.

The Board of Governors running the system changes contribution and indexation rates annually based on the investment performance of the pension fund, using a formula called the contribution/indexation matrix. The calculation of the contribution rates and indexation uses a procedure that smoothes the fluctuations in the rates so that the annual variation is generally small. The formula determines by how much benefit indexation must decline and contribution rates must increase during periods of weak financial performance, and conversely, by how much indexation can increase and contribution rates can decrease during good times. The ABP's Board of Governors is able to take other factors into account besides the matrix, such as general economic conditions and forecast pay trends, so the adjustment is not fully automatic.

In July 2003, the funding ratio of the ABP plan was 104 percent. According to the contribution/indexation matrix, the indexation rate was 66.7 percent of the average pay increase for workers in the plan in 2003, rather than 100 percent. Thus, the indexation rate for benefits for 2004 was 1.77 percent, rather than 2.65 percent, which would have been the full indexation. According to the contribution/indexation matrix, full indexation

could be resumed at a funding ratio of 114 percent, assuming a 36-month rolling average interest rate of 3.25 percent. However, the actual rolling average interest rate was 3.18 percent, which raised the required funding rate to 115 percent. In 2004, the contribution rate for workers would have risen from 15.6 percent to 22.4 percent, based on the contribution/indexation matrix, but a decision to reduce the generosity of the benefit formula (explained below) allowed for the increase to be reduced to 19 percent. The contribution rates in 2001 and 2002 were 11.8 percent and 13.6 percent.

The funding ratio of the plan had been 141 percent in 1999, but in early 2003, following the decline in world financial markets, the funding ratio fell below 100 percent. At that point, the generosity of the plan was reduced in order to reduce the required contribution rates. The plan is required to maintain a funding ratio of 114 percent (ABP 2004).

United States. Variable annuity plans in the United States are defined benefit plans that provide for an automatic adjustment of benefits that is tied to the investment performance of the underlying assets. These plans are fairly uncommon and have been adopted by few employers. In these plans, workers accrue benefits in the form of points. The value of the benefit received varies depending on the value of the points, which is determined with respect to a target rate of return on the assets in the plan. This type of self-adjusting mechanism adjusts the liability for benefit payments to changes in the rate of return received on the pension fund. Historically, many plans used participating group annuity contracts, which was a form of self-adjusting system where the customer paid enough to include a margin. They were replaced because people wanted to pay less up front.

United Kingdom. The United Kingdom has a type of plan similar in some respects to a variable annuity plan, which is called a With Profits Pension Annuity. With this type of annuity, the individual participant chooses an anticipated bonus rate (ABR). If the participant chooses an ABR of zero percent, the participant is guaranteed that each year's benefit in retirement will be no lower in nominal terms than the starting benefit--the guaranteed minimum benefit. If the underlying investments perform sufficiently well, the participant will receive higher benefits. If the participant chooses an ABR higher than zero percent, the starting benefit will be higher, but the participant risks that future benefits will be reduced at some point, but to no lower than the initial benefit had an ABR of zero percent been chosen. Rather than the plan's payments varying with the rate of return received each year, however, the plan smoothes the benefit payments over time.

The main factor affecting bonuses is the rates of return earned on the fund's assets. The bonuses paid also depend on the longevity experience of the plan's participants relative to assumed longevity experience. The bonuses received are divided into regular bonuses, which change once a year, and additional bonuses, which change more frequently and may change by greater amounts than the regular bonuses. However, both the regular and additional bonuses are affected by the policy of smoothing payments over time. Insurance companies that provide these annuities take an annual charge related specifically to providing the guarantee. One company takes a yearly charge of 75 basis

points for the guarantee, with the charge being reviewed annually. Participants are permitted at any time to convert to a fixed income annuity (Norwich Union undated).

A different form of self-adjustment plans has been developed recently. In the United Kingdom, employee contributions to DB plans are tax deductible, The new arrangement adopted by some plans ties the level of employee contributions to the improvement in life expectancy at retirement age for participants in the plan (Pension Protection Fund and Pensions Regulator 2006).

Reform Options. The Taxonomy of Parametric Reform Mechanisms

Understanding the taxonomy of reform types helps clarify the reform options. The major division is between parametric reforms—ones that involve changing the parameters of an existing system, and systemic reforms—ones that end an existing system and start a fundamentally new system. This discussion focuses on the taxonomy of parametric reforms. This survey has shown that the simple bifurcated taxonomy of ad hoc versus automatic indexing does not capture the range of reform options. This section presents an expanded and clarified taxonomy.

Ad Hoc Reforms. Ad hoc reforms are legislated reforms in which changes are legislated for a particular date. For example, the benefit formula is cut on a particular date or the cut is phased in over a short period. These reforms tend to have a high degree of political risk because the timing and magnitude of the reform, and its distributional consequences are unknown in advance.

Automatic Indexing. With automatic indexing, the government legislates a contingent change. For example, if life expectancy increases, the generosity of the benefit formula, in terms of annual benefits, will be cut. With automatic indexing, the problem of political risk is largely solved. It is not completely solved, because there is always the possibility that legislators will intercede and override the automatic mechanism. Nonetheless, political risk is greatly reduced. However, workers still face economic and demographic risk. They do not know in advance what the generosity of their benefits will be because that depends on future improvements in mortality for their birth cohort.

Automatic indexing can be further categorized in terms of characteristics of its frequency. It can occur annually, as in Sweden for life expectancy indexing, it can occur at a different regular frequency, as in Italy with its ten-year cycle for life expectancy indexing, or it can incur infrequently, as in the automatic adjustment mechanism for insolvency in Sweden.

Automatic Quasi-Indexing. Automatic quasi-indexing solves both the problem of political risk and demographic risk, at least for the period of its operation. With automatic quasi-indexing, as in Japan for life expectancy indexing, the annual rate of decline in the generosity of the benefit formula is fixed at a rate equal to that viewed as the most likely path that indexing would take. In the United Kingdom, a recent commission proposed automatic indexing of the pensionable age, but the bill introduced into parliament used

automatic quasi-indexing, which provides future retirees with a lower degree of uncertainty as to the situation they will face in the future.

Discussion

The discussion first discusses the implications of auto-adjustment mechanisms for social security systems. Then it discusses the implications for employer-provided pensions.

Social Security. The risk of a social security system becoming insolvent, and thus requiring an automatic adjustment mechanism as a feature, varies by the type of system (table 3). Without adjustments, traditional pay-as-you-go defined benefit social security systems will eventually become insolvent with continuing increases in life expectancy. The risk of insolvency is greatly reduced if these systems adopt life expectancy indexing of benefits. The risk is eliminated if in addition to life expectancy indexing, the systems adopt automatic adjustment mechanisms, as has been pioneered by Sweden.

The use of life expectancy indexing and automatic adjustment mechanisms is less than a decade old. Thus, early patterns across countries may change. However, at this point there is a major difference between traditional defined benefit social security programs and NDC programs in terms of the adoption of life expectancy indexing. Life expectancy indexing in some form is used by all countries that have recently adopted NDC programs, but it is rarely used to date by traditional defined benefit social security programs. This difference presumably is because life expectancy indexing is standard practice when an account balance is converted to an annuity, but it has not been used as an aspect of calculating benefits in defined benefit programs. This pattern may change over time as possibly more countries with traditional defined benefit social security programs adopt life expectancy indexing.

With the self-adjusting mechanisms used by Sweden, Germany, and Japan, all of them incorporate an adjustment for life expectancy. In Sweden and Japan, the adjustment is explicit. In Germany, the adjustment occurs through the effect of life expectancy on the dependency ratio.

This survey of self-adjusting mechanisms indicates several major differences in the ways they are used (table 4). Social security financing can be established with life expectancy indexing of benefits and adjustment of benefits indexing for changes in per capita wages, as is done in Sweden, so that the self-adjustment mechanism that is tied to solvency would rarely or infrequently be needed. Alternatively, the self-adjustment mechanism can be designed so that it is the primary way that system balance is maintained, and that it is used annually, as in Japan and Germany.

Some countries have explicitly built into the system the possibility that the self-adjustment mechanisms can be over-ridden by political decisions, as in France. In Canada, the self-adjustment mechanism is viewed as the final fall-back if political negotiations fail. In Sweden and other countries the self-adjustment mechanism is viewed

as a policy tool to reduce the need for policy decisions and the uncertainty as to outcomes that those decision-making processes entail. In the Dutch ABP plan, the trigger for the self-adjustment mechanism is not full funding but a minimum level of over-funding. In the social security systems, the trigger is less than full funding.

Germany and Japan have automatic adjustment mechanisms that in effect incorporate life expectancy indexing. In all three countries (Sweden, Germany and Japan), the adjustment is annual, with the two countries not having separate life expectancy indexing having to apply the automatic adjustment mechanism annually. Thus, the differences between life expectancy indexing and automatic adjustment mechanisms are not as great as they might appear.

In some countries, the automatic adjustment mechanism, while viewed as a parametric reform of an existing system, fundamentally changes the system. In the past, many social security systems could be thought of as defined benefit systems, where the benefit level was fixed by a benefit formula and contribution rates were raised as needed to finance the promised level of benefits. Some countries have moved towards a mixed system, where both contribution rates and benefit levels are adjusted. Now, in Sweden the system has been transformed, at least in this one respect, into a defined contribution system. The contribution rate is fixed, and benefit levels adjust to maintain solvency.

Employer-Provided Pensions. Legal restrictions may explain the types of adjustments made in employer-provided plans, and why some types of adjustments have not been observed. In the United States, the Employee Retirement Income Security Act (ERISA) prohibits a cutback in benefits that have already accrued. The definition of accrued benefits over time has grown to include the subsidies that might be provided on early retirement (whether benefits are actuarially reduced for early retirement). It measures accrued benefits in terms of annual benefits, rather than lifetime benefits. Thus, life expectancy indexing of benefits would presumably not be allowed under current law because it would reduce annual benefits, even though it could be structured so that it did not affect expected lifetime benefits (Muir and Turner 2007). This restriction limits automatic adjustments through benefit reductions.

While not many employer-provided pension systems have adopted automatic adjustment mechanisms, such mechanisms would provide new options for maintaining pension system funding. For example, if pension laws were changed to permit this, employers could adopt life-expectancy indexing of defined benefit pension benefits, as is done in Sweden and elsewhere for social security. With this option, at the point of retirement, benefits would be adjusted for improvements in life expectancy relative to a base year. Thus, for each new birth cohort reaching retirement, there would be a slight adjustment downward in the generosity of benefits, relative to the benefits received by the cohort born a year earlier. No further adjustment during the period of receipt of benefits would be made. This change would shift cohort life expectancy risk and cost—the risk and associated cost that life expectancy will increase over time—from employers to workers. Employers would still insure against the idiosyncratic life expectancy risk that a particular person would live longer than his or her colleagues. That insurance

would be provided, as now, through the option of life annuities. Life expectancy indexing of benefits could be made available to plan sponsors as an incentive to offer defined benefit plans that provide life annuities.

Few private sector plans in the United States offer post-retirement cost-of-living adjustments (COLAs), which takes away the possibility of making automatic adjustments through adjusting the COLA. Pension law would have to be amended to permit such an adjustment because a COLA is considered to be an accrued benefit, and it cannot be reduced for benefits accrued in the past.

Conclusion

Increasingly, countries are adopting automatic adjustment mechanisms for social security financing. These mechanisms address both problems of sustainability and of political risk. With the growth rate of beneficiaries exceeding the growth rate of the workforce, countries need to reduce the generosity of benefits relative to wages. This can be done through life expectancy indexing of benefits and through other automatic adjustment mechanisms. A wide range of mechanisms are being used, with large differences in the probability that the mechanisms will actually come into play.

Restoring financial solvency by cutting social security benefits, raising taxes, or raising the entitlement age are politically difficult policies for politicians to enact. However, with increasing life expectancy, some combination of those changes is required to maintain solvency in traditional pay-as-you-go systems. A small but increasing number of countries have dealt with this political problem by indexing their social security benefits for changes in life expectancy. This policy innovation has occurred both for traditional social security programs and for Notional Defined Contribution systems.

So far, no country has indexed its age of entitlement for benefits (early retirement age). The United Kingdom briefly considered such a proposal. In addition, a few countries have adopted automatic adjustment mechanisms that are triggered by the insufficient financing for their social security systems. While many countries have minimum funding rules for employer-provided defined benefit plans, a couple have adopted automatic adjustment mechanisms to maintain solvency.

Automatic adjustment mechanisms have the advantage over ad hoc approaches that they reduce the political risk workers face concerning the types and timing of adjustments. Also, because politicians tend to postpone difficult decisions, the adjustments under automatic approaches tend to be smaller and more timely than the adjustments that occur under ad hoc approaches. Automatic quasi indexing solves both political risk and demographic risk. However, countries with automatic adjustment methods often have built into the law the possibility for the automatic mechanism to be over-ridden by government action, which raises the likelihood that such override would occur.

Countries have relatively little experience with life expectancy indexing of benefits, so it is not possible yet to assess their long run effects. Countries may eventually decide that life expectancy indexing of benefits results in too large a drop in the replacement rate. That drop can be offset voluntarily by workers if they choose to work longer. However, countries may eventually they may want to raise the early retirement age as a way of raising benefit levels and the replacement ratio.

References

ABP. Annual Report 2003. 2004. http://www.abp.nl/abp/abp/overabp_en/images/engelsjaarverslag2003_tcm11-15733.pdf

Alho, Juha M.; Lassila, Jukka; and Valkoner, Tarmo. 'Demographic Uncertainty and Evaluation of Sustainability of Pension Systems." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp.95-112.

American Academy of Actuaries. "Automatic Adjustments to Maintain Social Security's Long-Range Actuarial Balance." Issue Brief. September 2002.

Auerbach, Alan J. and Lee, Ronald. "Notional Defined Contribution Pension Systems in a Stochastic Context: Design and Stability." NBER Working Paper No. 12805, December 2006.

Barr, Nicholas. "Non-Financial Defined Contribution Plans: Mapping the Terrain." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 57-69.

Boeri, Tito A.; Bőrsch-Supan, Axel and Tabellini, Guido. "Pension Reforms and the Opinions of European Citizens." American Economic Review 2002 (92): 396-401.

Bonturi, Marcos. "The Brazilian Pension System: Recent Reforms and Challenges Ahead." Organisation for Economic Co-operation and Development (OECD).Economics Department Working Papers No. 240. August 23, 2002.

Bőrsch-Supan, Axel and Wilke, Christina B. "The German Public Pension System: How It Will Become an NDC System Look-Alike." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp.573-610. http://siteresources.worldbank.org/INTPENSIONS/Resources/395443-1139338370854/Pension_ch22.pdf

Brooks, Sarah M. and Weaver, R. Kent. "Lashed to the Mast: The Politics of NDC Pension Reform." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform:

Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 345-385.

Brugiavini, Agar and Peracchi, Franco. "Fiscal Implications of Pension Reforms in Italy (undated).

Canada Pension Plan. "Optimal Funding of the Canada Pension Plan." Actuarial Study no. 6, April 2007. http://www.osfi-bsif.gc.ca/app/DocRepository/1/eng/oca/studies/Optimal_Funding_CPP_e.pdf

Capretta, James C. "Building Automatic Solvency into U.S. Social Security: Insights from Sweden and Germany." Brookings Policy Brief #151, March 2006.

Chłoń-Domińczak, Agnieszka and Góra, Marek. "The NDC System in Poland: Assessment after Five Years." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 425-447.

Congressional Budget Office. "Projected Effects of Various Provisions on Social Security's Financial and Distributional Outcomes." May 25, 2005. http://www.cbo.gov/ftpdocs/63xx/doc6377/Social_Security_Menu-CBO_baseline.pdf

de Jong, Philip and Turner, John. "Privatizing Government Pensions: The United States and the Netherlands." *Benefits Quarterly* 17 No. 3 (Third Quarter 2001): 51-56.

Diamond, Peter. "Conceptualization of Non-Financial Defined Contribution Systems." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 76-80.

Diamond, Peter. "Reforming Public Pensions in the US and UK." Presented at the London School of Economics, May 18, 2005.

Diamond, Peter A. and Orszag, Peter R. Saving Social Security: A Balanced Approach. Washington, DC: Brookings Institution, 2004.

Franco, Daniele and Sartor, Nicola. "NDCs in Italy: Unsatisfactory Present, Uncertain Future." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp.467-492.

Goss, Stephen C. "Estimates of Financial Effects for a Proposal to Restore Solvency to the Social Security Program—INFORMATION." Memorandum to Peter Diamond and Peter Orszag, October 8, 2003.

Gustman, Alan L. and Steinmeier, Thomas L. "The Social Security Early Retirement Age in a Structural Model of Retirement and Wealth." NBER Working Paper No. 9183, September 2002.

Holzmann, Robert and Palmer, Edward. "The Status of the NDC Discussion: Introduction and Overview." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 1-15.

Kőnberg, Bo; Palmer, Edward, and Sundén, Annika. "The NDC Reform in Sweden: The 1994 Legislation to Present." World Bank, 2005.

Lindell, Christina. "Longevity is Increasing. What About Retirement Age?" Presented at the 4th International Research Conference on Social Security, ISSA, Antwerp, 5-7 May, 2003.

Norwich Union. "Guide to With Profits Pension Annuity Investment." Undated. http://www.norwichunion.com/library/pdfs/an01010.pdf

Palmer, Edward. "The Swedish Pension Reform Model: Framework and Issues." World Bank Social Protection Discussion Paper No.0012, June 2000. http://siteresources.worldbank.org/SOCIALPROTECTION/Resources/SP-Discussion-papers/Pensions-DP/0012.pdf.

Palmer, Edward. "What is NDC?" In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 17-33.

Palmer, Edward: Stabiņa, Sandra; Svensson, Ingemar; and Vanovska, Inta. "NDC Strategy in Latvia: Implementation and Prospects for the Future." In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 397-424.

Pensions Commission. "A New Pension Settlement for the Twenty-First Century: The Second Report of the Pensions Commission." 2005. www.pensionscommission.org.uk.

The Pension Protection Fund and the Pensions Regulator. "The Purple Book: DB Pensions Universe Risk Profile." December 2006. http://www.thepensionsregulator.gov.uk/pdf/PurpleBook.pdf

Sakamoto, Junichi. "Japan's Pension Reform." The World Bank, Social Protection Discussion Paper No. 0541. December 2005. http://siteresources.worldbank.org/SOCIALPROTECTION/Resources/SP-Discussion-papers/Pensions-DP/0541.pdf

Society of Actuaries. "Longevity Risks: Key Findings and Issues." Autumn 2005.

Swedish Social Insurance Agency. "The Swedish Pension System Annual Report: 2004." http://www.forsakringskassan.se/filer/publikationer/pdf/par04-e.pdf. Downloaded April 6, 2006.

Takayama, Noriyuki. "Reforming Social Security in Japan: Is NDC the Answer?" In Holzmann, Robert and Palmer, Edward (eds.). Pension Reform: Issues and Prospects for Non-Financial Defined Contribution (NDC) Schemes. Washington, DC: The World Bank, 2006, pp. 639-647.

Turner, John. "Social Security Pensionable Age in OECD Countries: 1949-2035." *International Social Security Review,* 2007 (forthcoming).

Turner, John and Muir, Dana. Longevity and Retirement Age in Defined Benefit Pension Plans." In *Work Options for Older Americans*, edited by Teresa Ghilarducci and John Turner, Sloan Foundation, 2007

U.S. Social Security Administration. *Internaitonal Update*. March 2007. http://www.socialsecurity.gov/policy/docs/progdesc/intl_update/2007-03/2007-03.pdf

Watson Wyatt Worldwide. "United Kingdom: Pensions Bill Published. January 2007. http://www.watsonwyatt.com//news/media/UK2.pdf

Whitehouse, Edward. Pensions Panorama: Retirement Income Systems in 53 Countries. Washington, DC: World Bank, 2007.

Table 1. Countries indexing social security for life expectancy

Country	Type of Indexing	Measure of Life Expectancy	Gender-Based or Unisex Life Expectancy	Life Expectancy from What Age?	What Indexing Affects
Traditional social security systems					
Austria					
Brazil	Life expectancy	Current cross section	Unisex	Retirement age	Benefits
Finland	Life expectancy	Current cross section	Unisex	Retirement age	Benefits

Germany	Ratio of beneficiaries to contributors	Current cross section	Gender-based	Start of work life	Benefits and contributions
Japan	Ratio of beneficiaries to contributors	Current cross section	Gender-based	Start of work life	Benefits
NDC social security systems					
Italy	Life expectancy		Unisex	Retirement age	Benefits
Latvia	Life expectancy	Cohort projected life expectancy	Unisex	Retirement age	Benefits
Poland	Life expectancy	Current cross section	Unisex	Retirement age	Benefits
Sweden	Life expectancy	Current cross section	Unisex	Retirement age	Benefits
Sources: See text.					

Table 2. Life Expectancy Indexation of Benefits in Sweden					
Birth cohort	**Reaches age 65 in**	**Annuity factor at 65**	**Change in benefits at age 65 from increased life expectancy**	**Retirement age required to neutralize the effect of increased life expectancy**	**Implying an expected length of retirement**
1940	2005	15.7	-	65	18 years, 6 months
1945	2010	16.1	-2%	65 and 4 months	18 years, 7 months
1950	2015	16.4	-4%	65 and 8 months	18 years, 7 months
1955	2020	16.8	-6%	65 and 11 months	18 years, 10 months
1960	2025	17.0	-8%	66 and 2 months	19 years, 1 month
1965	2030	17.3	-9%	66 and 5 months	19 years, 2 months
1970	2035	17.5	-10%	66 and 7 months	19 years, 4 months
1975	2040	17.7	-12%	66 and 10 months	19 years, 5 months
1980	2045	17.9	-12%	67	19 years, 6 months
1985	2050	18.1	-13%	67 and 1 month	19 years, 8 months
1990	2055	18.1	-14%	67 and 2 months	19 years, 10 months
Source: Swedish Social Insurance Agency (2005)					

Table 3. Type of social security system and risk of becoming insolvent	
Type of social security system	**Risk of becoming insolvent**
Pay-as-you-go defined benefit	High, due to increases in life expectancy
Defined benefit with life expectancy indexing	Moderate, due to changes in fertility, labor force participation rates, and real wage growth
Defined benefit with life expectancy indexing and an automatic adjustment mechanism	None, because the automatic adjustment mechanism prevents shortfalls from occurring
Defined contribution individual account	None, promised benefits are equivalent to the annuitized value of account balances
Source: author's compilation	

Table 4. Auto-adjustment systems for social security				
Country	**NDC system or traditional (T) system**	**Life expectancy indexing of benefits**	**Indexing tied to solvency**	**Indexing of required years of contributions for full benefits**
Brazil	T	x		
Finland	T	x		
Portugal	T	x		
Italy	NDC	x		
Latvia	NDC	x		
Norway	NDC	x		
Poland	NDC	x		
Sweden	NDC	x	x	
Canada	T		x	
Germany	T		x	
Japan	T		x	
France	T			x
Source: Author's compilation				