

## AGEING WORKING PAPERS

### Maintaining Prosperity In An Ageing Society: the OECD study on the policy implications of ageing

#### WORKING PAPER AWP 3.5

### PREDICTABILITY OF INDIVIDUAL PENSIONS

This is one of a series of analytic papers that supported the OECD's ageing study, a "horizontal" project in the sense that it involved a number of OECD directorates. The results of the entire project are summarised in *Maintaining Prosperity in an Ageing Society*, OECD 1998. Chapter V of *Maintaining Prosperity*—on retirement income reforms—drew on this working paper.

This paper focuses on one aspect of the current debate that has not received the attention it deserves, namely how each of these alternative pension approaches operates in an unpredictable environment. Economic and demographic events do not proceed according to predictable patterns and at constant rates of change, and public programs don't always get implemented in the way that their designers had envisioned. In an uncertain world, what happens to retirement incomes when previously unforeseen events occur and things don't work out as planned? Are some approaches immune from the impact of unforeseen events that will cause problems for other approaches? Are the risks that such events pose for individual retirees greater under one approach than another? Who actually ends up assuming the risks associated with this kind of uncertainty in each of the approaches?

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## **PREDICTABILITY OF INDIVIDUAL PENSIONS**

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### **Introduction**

1. The past fifteen years have witnessed an unprecedented level of both debate about and actual change in the scope, structure and role of national pension systems. These activities are driven by a variety of motives, with the precise mixture varying dramatically from one part of the globe to another. The motives include: the need to restructure entire economic systems or reinvigorate failed pension institutions, the wish to improve social protection in concert with improving economic conditions, the hope that alternative pension structures will improve macro-economic performance and help respond to changing demographics, and the desire to reflect changes in social philosophy about the relative importance of individual and collective roles in the provision of retirement income.

2. Several new approaches for organizing national pension systems have emerged out of this debate. Prior to 1980, almost all public pension systems were managed centrally, paid defined-benefit pensions and were financed, more or less, on a pay-as-you-go basis. (The few notable exceptions were centrally-managed provident funds.) A dramatic alternative to the traditional approach was first implemented in Chile in 1981 and has since spread to other Latin American countries, the United Kingdom and at least one country in Eastern Europe. The Chilean model stands in sharp contrast to the traditional model in that it features decentralized management, defined-contribution accounts, and full-reserve financing. A second alternative has emerged in the last few years as a hybrid between the Chilean model and the traditional approach. Known as "notional defined contribution," it combines elements of the defined-contribution approach to calculating benefits with central management and pay-as-you-go financing.

3. Mature national pension systems are large and complex institutions that interact in important ways with the national political, social and economic environment. Each of these interactions is of sufficient importance to justify careful analysis. In recent years, however, some topics seem to have received more attention than others. In particular, a fair amount of attention has been focused on possible links between alternative pension systems and various national economic concerns, such as the operation of labour markets, the status of government finances, the development of capital markets and the rate of growth of the economy. Proportionately less attention has been devoted to examining how well these alternatives function as sources of retirement income. Concerns about retirement income have tended to focus primarily on the relationship between contribution rates and benefit levels in a world of constant and predictable rates of return on investment portfolios and rates of change in economic and demographic parameters.

4. This paper focuses on one aspect of the current debate that has not received the attention it deserves, namely how each of these alternative pension approaches operates in an unpredictable

environment. Economic and demographic events do not proceed according to predictable patterns and at constant rates of change, and public programs don't always get implemented in the way that their designers had envisioned. In an uncertain world, what happens to retirement incomes when previously unforeseen events occur and things don't work out as planned? Are some approaches immune from the impact of unforeseen events that will cause problems for other approaches? Are the risks that such events pose for individual retirees greater under one approach than another? Who actually ends up assuming the risks associated with this kind of uncertainty in each of the approaches?

## **The basic framework**

### ***Predictability as a pension system goal***

5. The analysis in this paper is based on the assumption that the most important goal of any public pension system is to provide a stable, predictable and adequate source of retirement income to each participant. This should not be the only goal that a society has for its public pension system, and this goal should not be pursued without due consideration for other social, political and economic effects a pension plan can have. But, the basic purpose of a public pension system is to provide retirement incomes, and a national pension system that doesn't do an acceptable job of producing retirement incomes must surely be judged to be a failure.

6. Pension systems operate on the basis of promises made to those working under the system. The promise is that in return for making regular contributions during their working years, the system will supply income during their retirement years. The focus in this paper is on the predictability of that retirement income promise.

7. In this context, predictability has two important attributes. First, although the promise is stated in terms of a particular future benefit, it has meaning only in the context of the standard of living that the benefit affords. The reason for supplying retirement incomes to pension system participants is to allow them to maintain a particular living standard after they are no longer able to (or expected to have to) work. To achieve this purpose, the nominal amount of the benefit promise must reflect the cost of maintaining prevailing living standards at the time the participant retires.

8. Second, participants must be able to rely on pension plan promises, even though these promises may have been made two decades or more prior to the participants' planned retirement date. A major reason for making pension promises in advance is to allow people to make intelligent life plans. Such a promise has value, however, only if it can be relied on as people make decisions about how long to plan on working, how much to save, how to finance their children's educations or how much assistance to offer their own parents.

### ***The risks and the approaches***

9. The challenge in delivering predictable retirement income is that the world is inherently unpredictable. Pension systems — and the promises that they make — are subject to a variety of risks. The economy may not behave as expected, demographic trends may alter, political systems may change, and private and public sector institutions important to the pension system may fail to execute the responsibilities they have been assigned. Moreover, at the beginning of an individual's working career, his own fortunes are not entirely predictable. He may experience a prolonged spell of unemployment or find

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that a promising career is disrupted by industrial restructuring. Each of these possibilities introduces a risk that pension promises made previously may no longer be kept.

10. No national pension system that operates in an unpredictable world can be completely successful in providing a predictable source of retirement income. Some threats to a predictable retirement income may have more serious consequences under one approach to pension provision than under another, however, and some approaches may involve less risk in one economic or institutional environment than in another. Our task is to examine each of the major kinds of risks which can affect the pension promise and assess how each might affect that promise under the different approaches to organizing a national pension system. Our concern is with the risk that the promises made to an individual at the beginning of a work career will be broken before this individual reaches retirement age.

11. The analysis here focuses on five categories of risk:

1. demographic risk arising from unexpected changes in overall birth rates or mortality rates occurring between the time the pension promise is made and the date of retirement;
2. economic risk arising from unexpected changes in the rate of growth of wages or prices or from unexpected changes in the rate of return earned in financial markets over the course of the worker's career;
3. political risk arising from a breakdown in governmental decision processes which allow politicians to make benefit promises in excess of what society can afford to pay or which prevent the political system from making timely adjustments to changing economic and demographic trends;
4. institutional risk arising from the possible failure of private financial institutions and/or their government regulators or from the inability to obtain retirement benefits due to inadequate record keeping or other kinds of incompetence on the part of pension administrators; and
5. individual risk arising out of uncertainties about the individual's future work career.

12. The analysis examines how each of these sources of risk is likely to interact with each of three major public pension models now being debated. The three models are:

1. *the defined-benefit model*, a centrally-managed, pay-as-you-go, defined-benefit plan. Unless otherwise specified, it is assumed that pensions are financed entirely from employee and employer contributions, that benefit levels at retirement are set to reflect wage levels prevailing at the time the worker retires, and that benefits are adjusted after retirement to reflect changes in general wage levels in the economy. Under such a plan, earners are given promises about the benefit they can expect to receive in retirement and also about the contribution rate they will have to pay while employed.
2. *the defined contribution model*, a privately-managed, advance-funded, defined-contribution plan. In this model, earners make contributions at a specified rate and these contributions are invested in some mix of financial assets. At retirement, prior contributors receive a benefit based on the current market value of the financial assets in their accounts. The only explicit promise is the rate at which contributions will be made. The implicit promise, of course, is that participants in the plan will be afforded a reasonable standard of living. Pension fund

managers often supply projections of the income that could be expected given certain specific assumptions about future contributions and returns.

3. *the notional accounts model*, a centrally-managed, pay-as-you-go, notional contribution plan. In this model, each worker has an account in the central pension system institution which is credited with the contributions made by or on behalf of the worker. Account balances are also credited with the analogue of interest payments, but typically at a rate tied to the growth of wages—either the rate of increase in the average wage or the rate of increase in total wages. At retirement, the balance in the account is converted into a life annuity based on estimates of the cohort's expected life-span.<sup>1</sup> The promises under notional accounts are similar to those under the defined contribution model.

## The interplay of risks and approaches

### *Demographic risks*

13. A key factor driving pension costs is the aged-dependency ratio, defined as the ratio of the population over a certain age (commonly, age 65) to the population of working age (often set as ages 15 through 64). Aged-dependency ratios have been rising around the world for a half-century or more. Further increases are projected into the next century in most countries.

14. Regardless of the cause, an increase in the aged dependency ratio must lead to one or more of the following changes:

1. an increase in the fraction of a nation's economic activity that is devoted to supporting its retired population,
2. an increase in the age at which people are allowed to retire, or
3. a reduction in the standard of living of the retired population relative to the standard of living of the working-age population.<sup>2</sup>

15. The particular pattern of changes, the mechanisms through which they are achieved and the resulting impact on benefit promises varies, however, depending on which approach is being used to provide pensions and the particular demographic change that caused the aged-dependency ratio to rise.

16. Aged-dependency ratios can rise as a result either of a decline in birth rates or of an increase in life expectancy, particularly life expectancy among the aged. Although both changes affect aged-

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<sup>1</sup> If pension contribution rates are constant, a notional accounts system that indexes account balances to the increase in average wages produces roughly the same pension as a defined benefit system that sets benefits in proportion to lifetime, wage-indexed earnings (such as the current German system). Perhaps the most important difference between the two approaches is the automatic adjustment in the monthly annuity under the notional account approach to reflect cohort life expectancy.

<sup>2</sup> This point is explained more completely in Lawrence H. Thompson, "Principios de financiación de las pensiones de seguridad social," *Revista Internacional de Seguridad Social*, vol 49, no. 3 (1996), pp 53-76.

dependency ratios, they must be considered separately because of differences in their impact on the three pension models considered here.

*Changes in birth rates*

17. Consider first the case in which birth rates fall but mortality rates do not. Although the life expectancy of the average person reaching retirement age will not change, the number of workers available to support each retired person will eventually decline. This occurs because fewer births means that proportionately fewer people are added to the labor force each year. How does this affect the respective pension models? In the traditional pay-as-you-go, *defined-benefit* system, the decline in the number of workers relative to the number of retirees causes the income from worker contributions to fall short of the amount needed to finance retirement benefits. Either the contribution rates have to be increased or the retirement benefits have to be curtailed (breaking either the promise to current contributors or the promise to those about to retire). The adjustment will be decided through the political process and, if the past is any guide, is likely to involve some mixture of benefit reductions and contribution increases.

18. The impact of this change in a mature, privately-managed, *defined-contribution* plan is substantially more complicated and therefore much more difficult to predict. Once a defined-contribution system has reached maturity, the aged support themselves by drawing down their accounts (i.e., selling assets) at the same time as the working-age population saves for retirement by adding to their accounts (i.e., buying assets). Considering only the transactions that occur within the retirement system, if the number of workers who are buying assets falls relative to the number of retirees who are selling assets, there will be more sellers than buyers, and, as with any market, the price of the asset being sold can be expected to decline.

19. The complication is that these retirement system transactions form only one part of a larger set of capital market transactions. Asset prices will be determined not just by what is happening within the retirement income system, but by the aggregate of all sales and purchases in the capital markets. Net sales of assets in the retirement system may well be offset — partially or fully — by a reduction in domestic investment requirements, reflecting the slowing in the growth of the work force. Foreign transactions can provide another source of offsetting flows, at least for a while. In either case, it may be possible for the adjustments in the retirement system to be achieved without upsetting the benefit expectations of working-age participants.<sup>3</sup>

20. Economists and financial analysts are just beginning to analyze the likely effect on the economy of a major draw-down in pension assets.<sup>4</sup> At this time it is simply not possible to make a prediction. Thus,

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<sup>3</sup> If other capital market adjustments of the type hypothesized here offset the net asset sales from the retirement system, the adjustment to a higher aged-dependency ratio has been achieved through an increase in the net value of imported goods and services or through reductions in net investment. Either of these adjustments allows the fraction of the nation's economic resources devoted to supporting its retired population to rise without reducing the consumption of any other national residents. Presumably the same strategy could have been followed in either of the two pay-as-you-go models with the same net impact on both retirement income expectations and the aggregate economy. This would be done by financing the increased costs through government borrowing. However, the parallel between the two approaches' economic impact is unlikely to be recognized in the political process or by financial markets, so that this adjustment strategy is far less likely under either of the pay-as-you-go models.

<sup>4</sup> One of the first papers to look explicitly at this issue is Sylvester J. Schieber and John B. Shoven, "The Consequences of Population Aging for Private Pension Fund Savings and Asset Markets," in Michael D.

it may be best simply to say that we can not now predict the impact of a change in the aged-dependency ratio produced by a decline in the birth rate on the ability of an advance funded, defined-contribution system to pay promised retirement benefits.

21. Under the third model, *notional accounts*, the impact of changes in birth rates will depend on which of the various measures of wage growth is being used to update the balances in workers' accounts. If notional account balances are increased by average earnings per worker, the size of the annual update will not be affected by changes in the number of workers. In this case, the impact will mirror that of the defined-benefit model. Contribution income will fall short of the amount needed to meet benefit payments and the political process must produce an adjustment in one or the other or both.

22. The result is different, however, where notional account balances are increased by the rate of growth of aggregate wages (or aggregate GDP). Under this variant, a slowing in the rate of growth of aggregate employment will have the effect of automatically reducing the size of the adjustment in the value of individual accounts. In turn, this will slow the rate of growth in the amount of the benefit that future retirees can expect to receive. The adjustment to a lower birth rate occurs virtually entirely in the initial benefits of future retirees.<sup>5</sup>

23. What is the risk to individual participants? The risk from a change in birth rates occurring during a person's working years is that retirement benefits will have to be adjusted in order to keep the pension system's finances in balance. Such adjustments may cause actual retirement benefits to deviate from the level that the individual might have expected at the time retirement plans were being made. The risk appears to be greater under either of the pay-as-you-go models than under the defined-contribution model. Of the two pay-as-you-go models, the risk is greater under the notional account model in which account balances are indexed to total earnings since that plan automatically reduces future benefits to offset the full effect of this kind of demographic change. Under the other pay-as-you-go approaches, the adjustment is likely to be through a combination of benefit reductions and contribution increases, moderating the impact on those approaching retirement age.

24. How large is the possible benefit adjustment? A change in the birth rate will have a powerful effect over time on pay-as-you-go pension financing, but the effect phases in fairly slowly. Thus, although this one factor introduces major uncertainty about long-run prospects for pension system finance, the risk that a major change will come as a surprise that upsets a given individual's retirement plans is likely to be fairly modest.

25. The possible magnitude of such a change can be illustrated by focusing on one particularly dramatic historical example. Between the early 1950s and the early 1990s, a time span which represents roughly the working career of someone born in 1930, the fertility rate in Japan dropped by a third and the crude birth rate fell by a half. The decline in the birth rate, taken by itself, would be expected eventually to cause that country's aged-dependency to double.<sup>6</sup> In a pay-as-you-go pension program, this kind of change

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Hurd and Naohiro Yashiro (eds.), *The Economic Effects of Aging in the United States and Japan* (Chicago: University of Chicago Press, 1997).

<sup>5</sup> In this situation, the adjustment to benefits may occur more slowly than the decline in contribution income, causing a temporary imbalance which would have to be financed either through a contribution increase or from some other sources.

<sup>6</sup> This is calculated by comparing the steady-state population structure produced by using the crude birth rate at the beginning and end of the period in combination with the actual 1950 Japanese mortality structure. It does not represent an actual projection since it ignores a host of other factors that will also influence the development of Japan's aged-dependency ratio.

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in the aged-dependency ratio will eventually require either that the average benefit fall to one-half its previous level, the contribution rate double, or some combination of the two.

26. The changes in aged-dependency ratios caused by such movements in fertility occur only gradually, however. The annual number of births declines only gradually over a period of several decades. Moreover, change in the number of births have no effect on pension finances for at least another 15 or 20 years when they begin to influence the size of the labor force. Thus, whereas the birth rate decline after 1950 would eventually cause a doubling in the aged-dependency ratio, it would have caused only about a 25 percent increase in that ratio by 1990, some 40 years later.

27. In summary, changes in birth rates introduce one source of risk that pensions will not actually materialize in the amounts promised. The potential impact on benefit levels and contribution rates under a pay-as-you-go system is large, but the effect phases-in quite slowly. Therefore, the long-range social challenge they pose is probably greater than the risk to any particular individual's retirement plans.

28. It is not possible to predict the impact of this kind of demographic change in an advanced-funded, defined-contribution pension system. Of the other two pension models being analyzed here, the risk of change is potentially larger under a notional account variant that automatically adjusts the initial retirement benefit for changes in total (in contrast to average) earnings in the economy. The impact under the defined-benefit model as well as under a notional account model in which initial benefits are adjusted for change in average earnings is likely to be dampened by the tendency for the political process to adjust to financial imbalances through a combination of benefit reductions and revenue increases.

### *Changes in post-retirement mortality*

29. A second risk involves general mortality trends. Regardless of the pension model employed, an increase in the amount of time that newly retiring workers can expect to live in retirement will raise the cost of providing them with a given monthly income. When this occurs, the choices facing *new entrants* to the labor force are the same under all three models. Either they must make higher contributions during their working years, extend their work lives or accept a lower retirement income. The models differ, however, in their treatment of those who are currently in *mid-career* at the time that life expectancies increase.

30. Life expectancies at age 65 have increased substantially in many parts of the world since the Second World War, causing populations to age and pension costs to rise. Japan again provides a particularly dramatic example. Between 1953 and 1990, life expectancy at age 65 for Japanese men increased by 40 percent, from 11.8 years to 16.7 years. A young Japanese worker initiating his retirement saving program in 1953 could find by 1990 that he had accumulated only 70 to 75 percent of what was needed to finance his target retirement income simply because life expectancies for him and his colleagues had increased so dramatically.<sup>7</sup> Defined-benefit pension plans would face cost pressures of similar magnitude due to the dramatic drop in mortality.

31. Rising post-retirement life-spans increase the total cost of supplying a given retirement income under all models, but the initial impact of these cost increases differs. Under the defined-benefit approach,

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<sup>7</sup> The estimate of 70 to 75 percent represents the difference between the value of an annuity that could be purchased with a specified sum assuming the 1950 Japanese male life table and the annuity that could be purchased with the same sum assuming the 1990 male life table, assuming a real interest rate of 0 percent and 3.5 percent respectively.

the pension promise is of a defined monthly amount and, at least initially, the extra cost associated with an unanticipated increase in life-spans must be borne by the sponsor of the pension plan. Under both the defined-contribution and notional accounts models, the initial promise is limited to the monthly benefit that can be purchased at the time of retirement by the aggregate balance in the account. Under these approaches, the impact of an unanticipated increase in life-spans falls entirely on the worker in the form of a lower than expected monthly benefit.

32. As a first approximation, then, changes in retirement life-expectancy occurring during one's working life do not cause a reduction in monthly benefits under the defined-benefit model, but do cause reductions in either the defined contribution or notional accounts models. The differences are not quite so stark in actual practice, however, since these kind of cost increases will also eventually be offset — at least in part — through benefit reductions in pay-as-you-go pension plans. The reductions may come either through lower monthly benefits or through increases in the program's retirement age. Benefit changes tend to be phased-in over a number of years, however, so that the risk to workers who are in the middle of their work careers should be significantly less than under either of the other two models.

### *Economic risks<sup>8</sup>*

33. The contribution rate needed to finance a given pension under the defined-contribution model is not very sensitive to changes in the fertility rates, but it is sensitive to changes in the rate of growth of wages and the rate of return on investments. In contrast, the contribution rate required under either of the pay-as-you-go models is not particularly sensitive to either of these economic developments.

34. Wage changes and investment returns can not be expected to follow a regular and predictable path over the course of an individual's work career. Every time they change, the contribution rate needed to finance a given retirement pension under the defined-contribution model also changes, leading to changes either in the amount that workers must contribute for a given pension or in the amount of pension associated with a given level of contributions. Since the economic environment cannot be known in advance, the contribution rate must simply be established to reflect the best information then available about future developments and modified as new information becomes available. For individual participants, however, this means that the contribution rate actually prevailing during working years may turn out to be either too high or too low to produce the target pension at the point that retirement age is reached.

35. Mis-estimates of the required contribution rates have serious implications under the defined-contribution model because, under this model, pension benefits are determined solely by the total amount contributed and the investment returns earned on it. Any difference between the contribution rate actually used and the rate that it turns out should have been used (regardless of the reason for the discrepancy) creates a gap between the actual asset accumulation and the amount necessary to produce the target pension benefit. The retiree either overshoots or undershoots the target. Retirees who overshoot the target will have saved too much. They will be able to enjoy higher than anticipated retirement incomes, but at the cost of having made greater sacrifices during their working years than were necessary. Retirees who undershoot will be forced to live in retirement with less than they had anticipated.

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<sup>8</sup> The analysis in this section is based on work originally done as part of the "Stockholm Initiative" of the International Social Security Association. That work will be published in a separate volume early in 1998.

*The general analytical approach*

36. The importance of mid-career changes in the economic environment depends on how unpredictable actual trends turn out to be and how wide the fluctuations are from one year to the next. To gain an appreciation for the possible magnitude of this effect under the defined-contribution model, simulations were performed of the impact of the kind of economic variations that actually occurred in four major economies over the period 1953-1995. The historical evidence employed in the analysis is that from the period 1953 through 1995 in Japan, Germany, the United Kingdom and the United States.

37. To keep the analysis simple, it was based on a simplistic model under which everybody entered the labor force at age 22 and was employed consistently at the economy-wide average wage for the following 43 years. All workers then retired at age 65 and they all died on their 82nd birthday. The target pension for each worker was equal to one-half of the average wage, indexed after retirement to reflect changes in prevailing wage levels. The objective of the exercise was to apply plausible decision rules about how contribution rates would be set and see how close people came to achieving this target pension. For the purpose of these calculations, administrative costs are ignored.

38. Several different decision rules were used to set initial contribution rates and to adjust these rates in response to emerging experience. Simulations of economic variations were run using the wage-rate/ interest-rate relationship as it actually unfolded and in exactly the opposite order of the way it actually unfolded. The assumption is that changes of the magnitude actually observed historically can easily occur again, and that the trend could go in either direction.

39. The economic experience in these countries is summarized in Table 1.<sup>9</sup> That table also shows the contribution rate required to produce the target pension at the average rate of wage growth and the average investment returns for each period. Over the first two decades of the period, wages grew relatively rapidly everywhere except the U.S. and real interest rates were fairly low. (Even in the U.S., the real wage growth rate exceeded the real interest rate over the period 1953-1972.) In the later two decades, wage growth slowed and real interest rates rose in all four countries. Since 1973, the real interest rate has consistently been higher than the rate of growth of real wages in three of the four countries; in Japan, it was higher than the real wage growth rate at least until 1993.

40. It is immediately clear from Table 1 that the contribution rates required to produce the target pension are extraordinarily sensitive to the economic environment. Actual experience at several points in the history of these countries saw wage growth so high relative to real interest rates that the contribution rate required under the simple model exceeds 50 percent (e.g., the 1950s in Japan, Germany and the UK and the 1960s in Japan). At other times, wage growth was so slow relative to the level of interest rates that the target pension could have been produced with a contribution rate of less than ten percent (e.g., the 1970s and 1980s in the U.S. and the 1980s in Germany and Japan).

*Variability when long-term trends are known*

41. The first set of simulations was based on the assumption that the authorities know how real wages and interest rates will behave in the long run, but do not know what kind of year-to-year fluctuations to expect. The results of these simulations employing the actual economic data applicable to these four countries are shown in the first panel of Table 2. (Country identifications in these simulations

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<sup>9</sup> Wage data tend to reflect increases in manufacturing wages and interest rates are for 10 year government bonds.

are intended as a means of identifying the particular wage and interest pattern being simulated, not a prediction of the results that might apply in any particular country.)

42. The simulations start with the calculation of the stock of assets that will be needed at age 65 in order to meet the pension target of 50 percent of average wages (shown at the bottom of Table 2). The required asset stock is itself dependent on long-term economic trends, and is calculated based on the 43-year average of real wage growth and interest rates for each country. For example, in this basic model, financing a wage-indexed pension equal to 50 percent of average wages for 17 years would require at age 65 a stock of assets equal to 9.2 times average earnings in the economic environment that prevailed in Germany, 9.5 times average earnings in the Japanese environment, and so forth.

43. The next step is the calculation of the stock of assets that would be accumulated if someone actually worked each of the 43 years at the average wage, made contributions at the rate implied by the long-term economic trends, and earned interest each year on the accumulated contributions at the prevailing interest rate. This calculation is performed twice for each country, once assuming the year-to-year fluctuations in wage growth and interest rates that actually occurred and once assuming the exact opposite of the actual year-to-year fluctuations.

44. As the results indicate, the timing of the variations has a significant effect on the size of the asset stock accumulated. In these simulations, the contribution rate that is appropriate based on the 43-year average produces a stock of assets that is from 30 percent to 40 percent too high using the actual sequence of events and produces a stock of assets that is from 15 percent to 25 percent too low using the reverse of the actual sequence. These simulations suggest that, even if the long-term average were predicted perfectly, year-to-year variations in the values that produce the annual average would cause actual pensions to differ substantially from the target. Instead of replacing 50 percent of pre-retirement earnings, pensions could run anywhere from 37.5 percent to 75 percent of pre-retirement earnings.

#### *Variability when long term trends are not known*

45. The second set of simulations shown in the middle panel of Table 2 introduces slightly more realism by relaxing the assumption that the authorities could make a perfect forecast of long-term economic developments over a 43-year period. In this second set, the authorities can only predict with certainty how the economy will perform for the first 20 years, and they set contribution rates accordingly. Although they predict the long-term trend correctly for the first 20 years, they do not foresee subsequent developments.

46. As is shown in the middle panel, this decision rule produces large gaps between the actual asset accumulation and the target. When annual fluctuations are introduced in the actual sequence, the contribution rate established in this way proves to be much too high and results in asset accumulations that are two to three times as much as needed for the target pension. In contrast, when annual fluctuations are introduced in the reverse of the actual sequence, the contribution rate established based on perfect foresight of the first 20 years proves to be much too low and results in asset accumulations that are only 30 to 40 percent of the target. In this simulation, variations in the actual course of economic events causes pensions to range from 15 percent to 170 percent of pre-retirement earnings.

47. The third panel presents results based on a simulation which was designed to introduce even more realism into the analysis. These results come from simulating a procedure in which the contribution rate is adjusted each decade to reflect the actual experience of the previous decade. In this simulation, the contribution rate for the first ten years is set at the level used in the first set of simulations — the rate

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appropriate when long-term average rates of increase in wages and interest rates are known with certainty. After the first ten years and every ten years thereafter, however, the contribution rate is adjusted either upward or downward to reflect the contribution rate that would have been appropriate based on the economic environment of the previous decade. The adjustments are assumed to occur at the pace of a 0.5 percentage point change in the contribution rate each year until the new rate is reached (or the decade ends).

48. The results shown in the third panel of Table 2 indicate that this rule produces only slightly better results than did the previous rule. When simulated using the actual annual fluctuations, this procedure causes asset accumulations of from 50 percent to 200 percent in excess of the target. When the simulation uses the reverse of the actual fluctuations, the asset accumulations fall short of the target by some 30 to 40 percent.

### *Combining stocks and bonds*

49. The results discussed thus far are based on simulations in which assets are assumed to be invested at the rate of interest prevailing each year on ten-year government bonds. Table 3 shows how these results change when each of the simulations is repeated assuming instead that asset holdings are divided equally between 10-year government bonds and equities.<sup>10</sup> Introducing equity returns has the impact of increasing the average return that workers can expect, thereby allowing a lower contribution rate. It also introduces somewhat more volatility into the year-to-year pattern of asset returns.

50. The greater volatility associated with the investment in equities does not introduce greater variation in the results of these simulations, however. Introducing equities causes accumulations to become somewhat less predictable in the context of the economic history of the U.K. and somewhat more predictable in the context of the U.S. economic data. In the context of the economic data from Germany, and to a lesser extent Japan, the introduction of equity returns does narrow the range of variation. It is not clear how much to make of the experience in these two countries, however, since during most of these years equity markets were not an important factor in financing retirement programs in either country.

51. Equity investment creates another problem that is not present when portfolios are held mostly in bonds. With equity investment, the value of the pension available to a given retiree is quite sensitive to the exact year in which he reaches retirement age owing to the greater volatility in the value of his asset portfolio. Those who reach retirement age when asset markets are depressed will find that their assets buy a much more modest pension than those who are fortunate enough to reach retirement age when asset markets are unusually high.

52. Simulations using these same historical data suggest that when retirement portfolios are held entirely in bonds, the retirement pension associated with the portfolios accumulated by the average member of any one retirement cohort can be expected to vary by only about 3 percent from the value of the portfolios accumulated by the average member of an adjacent cohort (see Table 4).<sup>11</sup> When half of the portfolio is held in equities, however, the average variation among adjacent cohorts increases substantially, to just over 9 percent. In the case where half the portfolio is in equities, if the average worker in one cohort received a pension equal to the target of 50 percent of average earnings, an identical worker in the next

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<sup>10</sup> Equity returns include both changes in market prices and dividend yields.

<sup>11</sup> These simulations understate slightly the volatility of the bond portfolio by not considering capital gains and losses associated with interest rate changes.

cohort could expect, on average, to get a pension that represented either 46 percent or 54 percent of average earnings. In some years, the variance would be less; in other years it would be more.<sup>12</sup>

### *Summary*

53. In pension plans following the defined-contribution, individual accounts model, actual pensions are quite sensitive to economic conditions over an individual's work career. All of the risk associated with this source of variation is borne by the individual participant. The history of the last half-century suggests that uncertainties about future economic developments can easily cause asset accumulations in defined contribution plans to fall one-third short of the initial target and, just as easily, come in twice as high as the target. In either case, the amount by which the initial target was missed will be translated directly into retirement benefits that were higher or lower than expected.

### *Political risks*

54. An entirely different category of risks arises out of the political process. By definition, all public pension programs are creatures of the state, whether the state's role is to manage the system directly or merely to establish and enforce the rules under which the system will operate. If the state adopts faulty policies or fails to implement its policies effectively, its actions by themselves may cause pensions promised at the beginning of a worker's career to fail to materialize at the end of his career.

55. Pay-as-you-go, defined-benefit pension plans have proven vulnerable to the problem of excessive promises, particularly in those countries where institutions and traditions do not force politicians to consider and/or acknowledge the future cost of current promises. Where cost implications can be easily ignored, irresponsible politicians are able to use promises of higher future benefits as an apparently inexpensive way of securing the support of influential groups. Common recipients of such largesse are the military, the police, civil servants, and workers in transportation, mining, and other key export or public utility industries. Newly-established pay-as-you-go programs can evidence this problem more generally since the low contribution rates associated with the early years can invite general benefit increases that push the costs of the mature system beyond a level that is politically sustainable.

56. The problem arises, of course, as the pension system matures and the cost implications of prior promises become clearer. If it is decided that these costs exceed what society is willing to bear, promised benefits will have to be scaled back. Those caught in the middle of their work career when such benefit reductions are finally implemented will have their retirement plans upset as the retirement benefits they had been told they could expect fail to materialize.

57. Defined-benefit plans (and, to a lesser degree, notional accounts) are also susceptible to the related risk that the political system will find itself unable to enact timely adjustments in the face of unfavorable trends in the underlying demographics of the country. As noted previously, a decline in either birth rates or mortality rates can cause a defined-benefit plan's pension promises to become inconsistent

<sup>12</sup> These results are based on calculations in which the period over which assets could be accumulated was shortened to 33 years (and the contribution rate each year increased accordingly) to allow a comparison among the experiences of 10 consecutive cohorts. All calculations employed the contribution rate appropriate for the respective long-term average economic environment of the country, the same rule used to generate the results shown in the top panel of Table 2. Results for the actual sequence and the reverse sequence are combined to produce a total of 22 observations for each country and each investment policy.

with its contribution promise. Where the political system is unable to come to a consensus about the adjustments to be made, the imbalance may develop into a source of social division and continuing fiscal difficulties for the government. A political stalemate about how to adjust the pension system introduces an additional risk for mid-career workers. Although they may understand that the current promises must be adjusted, they will not know what kind of adjustments ought to be planned for. Moreover, continued controversy is likely eventually to undermine public confidence in the pension program, compromising its social value and increasing the odds of a major disruption of pension promises at some future time.

58. The privately-managed, defined-contribution model is particularly attractive in those countries that have experienced serious problems of excessive promises and political stalemate involving previous pay-as-you-go plans. Under the defined-contribution alternative, the politicians' ability to use pension promises to reward favored constituents loses its attractiveness since, presumably, each such promise will require an immediate transfer of funds to the private pension manager. The defined contribution model also eliminates the potential for political stalemate in adjusting to unfavorable demographic developments by removing the adjustment mechanism from the political process. As noted previously, one consequence of this is that working-age people bear a higher risk themselves, particularly of unexpected lengthening in retiree life-spans. Where the alternative to this is social division and political stalemate, however, the higher risk may be preferable.

59. Shifting from a pay-as-you-go system to a system based on advanced-funded, individual accounts is a difficult undertaking, however, since the implicit unfunded liabilities of the old system must somehow be paid off. This introduces a new pension financing challenge — how to pay transition costs that can easily amount to three percent of a country's GDP every year for a number of years.<sup>13</sup>

60. Governments that are experiencing fiscal problems traceable, at least in part, to imbalances in their pay-as-you-go pension systems may be tempted to try phasing those systems out as part of a strategy for restoring general fiscal balance. They are likely to find, however, that phasing out a pay-as-you-go pension is a greater fiscal challenge than fixing the system if the two alternatives are equally feasible.<sup>14</sup> It is even possible that a government trying to undo the effect of past excessive promises in its pay-as-you-go pension system will end up make a new set of excessive promises in the form of future transition payments that it eventually finds it can not afford.

61. The newer notional defined contribution approach was developed in an attempt to secure some of the advantages of the traditional defined contribution approach without incurring the transition costs. Thus, benefits are calculated as if the system were being run as an advance-funded set of defined-contribution accounts, but it continues to be financed on a pay-as-you-go basis. It remains to be seen whether the change in the benefit calculation method proves to be a sufficient deterrent to irresponsible political interference without the corresponding discipline of having to transfer resources to private pension management companies.

62. In summary, the defined-benefit model probably exposes individuals to the greatest amount of political risk owing to two sources of vulnerability: promises of future benefits don't need to be paid for until later and the adjustments to accommodate demographic changes require overt political action. The

<sup>13</sup> See the analysis of transition costs in Asociación Internacional de Organismos Supervisores de Fondos de Pensiones, *Reformas a Los Sistemas de Pensiones: Argentina, Chila, y Perú*, Santiago, Chile, 1996.

<sup>14</sup> See the analysis in Sheetal K. Chand and Albert Jaeger, "Aging Populations and Public Pension Schemes," Occasional Paper 147, International Monetary Fund, Washington, D.C., December 1996. The conclusion that costs are likely to be *permanently* higher wouldn't necessarily apply, however, if major reductions in future benefit promises could be introduced at the time of the change-over.

defined-contribution model largely avoids both of these sources of political risk, but introduces a new source of risk in that the costs of the transition can be substantial and don't necessarily materialize fully for several years. The notional account model avoids the transition costs and is less susceptible to (but not immune from) the other two vulnerabilities associated with the defined-benefit model. Unfortunately, it is not now possible to quantify the relative amount of political risk in each model or to analyze how that risk might vary from one country to another.

### *Institutional failure*

63. Pension plans which are flawless in their conceptual design can still fail to deliver the benefits they have promised due to weaknesses in the institutions charged with their management. At least three kinds of institutional failure have undermined the predictability of pension promises in the past and therefore must be considered as part of any review of the risks to future pension promises. They are the loss of financial assets through fraud or mismanagement, the inability to collect pension contributions effectively, and grossly inefficient or ineffective administrative arrangements.

#### *Failure to preserve financial assets*

64. A major advantage of the defined-contribution model is the ability to accumulate financial assets in advance to help pay for the pensions. The corresponding disadvantage, however, is that the value of the pension promise depends directly on the effectiveness of the management of these assets. Of the three models, only this model links benefits so closely to successful asset management.

65. A danger in this model is that competition among pension managers for individual account business will lead to excessive risk taking, and, eventually, to financial collapses. So far the institutional arrangements created in Chile have minimized this danger both through tight regulation of the range of investments allowed and by, in effect, preventing firms from competing on the basis of the rate of return that they promise to earn on pension deposits. As these restrictions are gradually liberalized, however, both the potential for gain and the risk of loss increases.

66. Experience in many of the commercial banking systems around the world illustrate the degree of risk that is introduced when the regulation of financial institutions is inadequate. The current focus is primarily on financial problems in some of the developing countries in Asia, but problems in recent years have cropped up in both developing and developed countries. They commonly materialize after a particularly sharp run-up in either real estate or stock market prices turns out to be unsustainable. When the financial situation begins to unravel, investment losses aggregating 10 percent of a country's GDP can suddenly appear.<sup>15</sup>

67. As a practical matter, it is not clear whether the risk of major financial losses such as this should be treated as a risk being assumed by individual participants or a risk that the state will end up assuming on behalf of all participants. In principle, in the defined-contribution model the risk of investment losses is

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<sup>15</sup> For example, "A Survey of Banking in Emerging Markets," *The Economist*, April 12, 1997.

born by the individual participant.<sup>16</sup> In practice, however, governments have often stepped in to protect individuals from the consequences of major financial collapses, even when not legally required to do so.<sup>17</sup>

### *Collection problems*

68. Compliance is a problem in almost all public pension programs. The self-employed and casual laborers present a challenge to even the most sophisticated collection systems. Other things equal, economies with large rural populations or large informal sectors are likely to have greater compliance problems than those in which most are employed among larger firms in the formal sector. Even large employers can pose enforcement problems in some countries.

69. The consequences of noncompliance depend on the design of the pension program. Where pension payments are proportional to reported career earnings, noncompliance will reduce future benefits and produce inadequate retirement incomes, but it will not pose a financial problem for the pension plan. This result applies automatically in both the defined contribution and the notional accounts models. It also applies, however, to pay-as-you-go, defined-benefit plans in which benefits are scaled fairly directly to average lifetime earnings.

70. Noncompliance has a different impact in defined-benefit plans where benefits are based only on years of service or on the combination of years of service and earnings averaged over only a relatively few years. In these situations, noncompliance can reduce plan revenues without necessarily reducing benefit commitments. The consequence is financial problems for the pension plan, which can lead to increases in contribution rates, thereby further increasing the incentive to avoid making contributions. The process can develop the same dynamic and potentially undesirable consequences as excessive political promises.

71. Of the three approaches analyzed here, the defined-benefit model is the only one that is particularly vulnerable to this risk. The risk, however, is uniquely associated with a particular benefit structure and not inherent to all pay-as-you-go, defined-benefit plans. Most of the defined-benefit plans found in OECD countries base benefits on career earnings averages and are relatively immune to this problem. In Latin America and the former socialist countries of Europe and Asia, however, the traditional public plans are structured in the way that makes them much more susceptible to this problem.

### *Effective administration*

72. A powerful motive for reform of a public pension program can be the risk that benefits will be lost as a result of incompetent administration. If administrators are not able to maintain the records necessary to establish entitlement, the value of any pension promise will depend entirely on the ability of the individual participant or some third party to maintain records. Neither is an acceptable arrangement in a dynamic economy. Each increases the chances of fraudulent benefit awards while also raising the possibility that individuals will lack some of the information needed to get all the benefits which have been promised and to which they are entitled.

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<sup>16</sup> Subject to the state-guaranteed minimum pension floor.

<sup>17</sup> Thus, in the case of the financial collapse of the network of individual savings account institutions in the United States, the government eventually ended up assuming (and passing on to the general taxpaying public) losses equal to just under 20 percent of the aggregate deposits in the institutions prior to their collapse, even though technically, the government was not liable for any of the losses.

73. The public sector does not have a monopoly on incompetent administration. However, since national pension programs have traditionally been managed by public sector institutions, most of the egregious examples of incompetent public pension management involve these public sector institutions. The search for an alternative to an incompetent public-sector institution naturally tend to focus on private alternatives.

74. Recent experience in the United Kingdom, however, illustrates the potential risk from fraud and/or mismanagement in the privately-managed, defined-contribution model. Apparently, salesmen for personal pensions in that country convinced several hundred thousand people to make financial decisions that were of benefit to the salesmen but harmed the individuals. Whether the result of overzealousness, incompetence or fraud, the individuals affected have lost pension benefits to which they were otherwise entitled through the failure of private-sector institutions.

75. In summary, each of these pension models functions only as effectively as the institutions that operate it. Promised benefits may be lost due to administrative incompetence, financial mismanagement or fraud. Any of the three problems can arise in any administrative arrangement, although the first has probably been encountered more frequently in the public sector, the second is less of a problem under a pay-as-you-go system, and the third is probably more likely to be a problem for privately-managed pension plans.

### ***Individual risk***

76. A final category of risks involves uncertainty about the working career of each individual. Projections of the pension that can be expected under different pension plans typically assume that an individual is always employed and always earns some constant multiple of the average wage in the economy. While useful for illustrating the general characteristics of different pension approaches, these kind of assumptions are not a very realistic representation of actual work careers.

77. Actual work careers are substantially more varied. Careers are interrupted by periods of illness and spells of unemployment, which may be frequent and prolonged for some people while infrequent and of relatively short duration for others. Moreover, some people enjoy earnings that generally rise more rapidly than the economy-wide average over the course of their careers while others might find themselves displaced in the middle of their careers and forced to accept employment at much lower pay than they had been used to.

78. Public pension plans following the defined-benefit model are often constructed to help individuals with irregular work histories get somewhat higher benefits than they might otherwise be entitled to. A plan might scale retirement benefits to career average earnings, but the career average might be calculated using only the best 25 or 30 years in the work history. In effect, a worker is allowed to ignore the ten or fifteen worst years when the retirement benefit is calculated. Alternatively, retirement benefits might be based on average earnings during only a few of the best and/or most recent years and then adjusted to explicitly reflect the number of years of service for which the individual is credited. Under this approach, it is not uncommon for credit to be given also for years in which the worker was unemployed (but looking for work), in school or in the military.

79. Adjustments such as these are often incorporated into social security programs in order to cushion the impact of adverse life events and promote social solidarity. Although more common in the context of the defined-benefit model, they can also be incorporated in either of the other two models. A

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major difference is that in the other models, the possibilities may be somewhat more limited and the transactions will be more transparent.

80. For example, under the defined-benefit model, adjustments to eliminate the impact of a prolonged period away from paid employment can take the form of allowing each worker to drop a few years out of the average earnings calculation or crediting each worker with a year of service for years spent in other socially approved activities. A similar result can be achieved under either the notional accounts model or the defined-contribution model by crediting the workers account as if contributions had been paid during a year in which the worker did not have paid employment due to being unemployed, enrolled in school, or military service. The additional contribution credits could be issued either at the time of the absence from employment or at the time that a retirement claim was filed. The cost of these credits could be financed either by a direct transfer from another source of funds (such as the education or defense budget or unemployment insurance funds) or by reducing the rate of return that was being credited on accounts in general.

81. Since, at least in principle, it is possible to incorporate solidarity elements into any of the three models, the presence or absence of such elements is not so much an inherent characteristic of the respective model as it is a reflection of the preferences of those who designed each system.

82. What remains to be examined is whether there are intrinsic differences among the approaches in which people with irregular earnings histories receive different treatment under one model than under another in ways that were not designed or intended.

83. This question was explored through a series of examples similar to those used earlier in connection with the analysis of the impact of economic variation. The earlier analysis concentrated on illustrative workers who earned the economy-wide average wage each year starting with the year they turned 22 and ending with the year they turned 64. This analysis consisted of four simulations, each of which focused on a worker with a different irregular variation on the previous regular earnings pattern. The first experienced prolonged unemployment at the beginning of his work career, the second experienced prolonged unemployment at the end of his work career, the third enjoyed sharply rising earnings over the course of his career and the fourth suffered a significant fall in relative earnings during the last third of his career. The retirement benefits of each of these irregular workers was calculated under a pension plan following the defined-contribution model and under a plan following the defined-benefit model and the results were compared to the benefits that regular workers would have received under each plan.

84. The details of this analysis and its results are described in the appendix to this paper. In short, when the defined-benefit model was represented by a plan that scaled benefits directly to career average earnings, very little difference was found between the two models in their treatment of irregular workers. Although benefit entitlements were somewhat more variable under the defined-contribution model, the average benefit awards were similar. The implication is that any systematic difference in the treatment of irregular workers between plans representative of the different models is the result of features that were explicitly built into one plan or the other, not characteristics intrinsic to the models themselves.

## Summary

85. This analysis has been based on the premise that an important attribute in public pension programs is their ability to produce predictable pensions. It has focused on the kind of risks that individual workers are exposed to over the course of their work careers to see how each risk is handled in each of the

three public pension models now being debated throughout the world. The risks include those associated with demographic and economic developments, with political and institutional failures, and with uncertainty about an individual's lifetime employment prospects. The models are the traditional pay-as-you-go, defined-benefit model; the newer advance-funded, individual-account model based on defined-contribution arrangements; and the most recent entrant, the pay-as-you-go, notional account model.

86. The models differ substantially in the way they adjust to different sources of risk. Some are far more sensitive to a particular risk than are others, but each is sensitive to one or more major sources of risk. No model emerges as the least risky under all circumstances.

87. The benefit promises under the classic defined-benefit model are relatively insensitive to unexpected changes in the rate of growth of average earnings or to changes in investment returns, but the benefit promise is exposed to the risk of unanticipated changes in either birth rates or retiree life spans. This model also requires a greater degree of overt political intervention to adjust benefits and contribution rates in response to these unanticipated demographic developments. The advantage of this political intervention is that it provides an opportunity to spread the impact of the demographic changes among the rest of the population, reducing the risk they pose to the benefit promises of an individual retiree. The disadvantage is that where the political system is not strong enough to make the necessary decisions, the need for overt intervention can lead to policy impasse, social discord, and perpetual government budget deficits.

88. Retirement benefits under the defined contribution model are just as sensitive to changes in retiree life spans, but this model transfers the risk of this change completely to the individual retiree. Where the political system is not capable of making overt adjustments, this may actually provide a more predictable result that is provided by the defined-benefit model. Where the political system is stronger, the defined contribution model involves a greater risk that unanticipated changes in retiree life spans will upset benefit expectations.

89. Because of its closer linkage to the decision processes of the political system, the benefit promises under the defined-benefit model have been more exposed to the risk of irresponsible political behaviour. Such behavior often takes the form of promises of future benefits that exceed the ability and willingness of society to pay. These promises must eventually be retracted, upsetting the expectations of people caught in the transition. For reasons that go beyond the scope of this paper, political risks of this sort appear to have been a much greater problem in some parts of the world than in other parts.

90. Where this kind of political risk is a serious problem, the defined contribution model is attractive precisely because its benefits are more insulated from political interference. The transition from pay-as-you-go plans to advance-funded plans is very expensive, however. This can create a new source of political risk if a transition is attempted without facing its fiscal implications responsibly. Moreover, politicians aren't the only people who are prone to promise more than they can deliver. The defined-contribution model requires sophisticated oversight and regulation to assure that fraud or mismanagement in the private sector does not lead either to the upsetting of retiree benefit expectations or to expensive public sector bail-outs of private financial institutions.

91. Individuals face the risk that they will experience prolonged periods of unemployment or that their job prospects will suddenly worsen part way through their work careers. In plans that follow the defined-benefit model, various features are commonly incorporated to offer a measure of protection against these risks. Apparently, however, the defined-benefit model is not intrinsically better at handling these risks than is the defined-contribution model. The differences observed in actual plans stem more from differences in tradition and social preferences than from features inherent in either approach.

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92. A final difference is the rather substantial sensitivity of retirement benefits to unforeseeable year-to-year fluctuations in the economic environment in the defined-contribution model. Were the two approaches similar in their ability to handle all other important risks, this feature alone would argue against relying too heavily on this model as a basic source of retirement income.

93. The notional accounts model is a hybrid that seeks to capture some of the advantages of each of the other two models. It avoids the sensitivity to economic conditions found in the defined-contribution model. Like the defined-contribution model, however, it transfers all of the risk of changes in retiree life spans to the retiree, at least pending a political decision to the contrary. The notional accounts model should be less susceptible to the problem of excessive political promises than is the defined-benefit model, but not as well insulated as the defined-contribution model. By the same token, it is less susceptible to the risks associated with private sector fraud and mismanagement. The model is so new, however, that generalizations are difficult and any assessment may prove premature.

94. None of the models is without risk, but the risks are different. This suggests that societies should give serious consideration to approaches which feature a mixture of the models as a way of reducing the total risk in their pension systems. One way to achieve such a mixture is to mandate participation in two different programs each of which follows a different model, as has been done in Argentina, Uruguay, Switzerland and Finland. Another way is to set up a pay-as-you-go state system and allow opting out of one part of that system, as is the current approach in the United Kingdom and Japan. A third way is to set up a defined-benefit plan which is not adequate by itself for the retirement income needs of middle and upper income individuals and encourage private supplementation, the approach followed in the United States and Canada.

95. Societies can be expected to follow different approaches depending on tastes, traditions, and their own institutional histories. Since political risk can be a major source of uncertainty and likely varies from one culture to another, one should expect that the relative importance of the different models would be different in countries with different political traditions and institutions. Whatever the decision that a society makes, however, it is hoped that the decision will reflect appropriate concern for and careful consideration of the role that the pension system plays in providing participants with a predictable source of retirement income.

## APPENDIX

### Simulations of the impact of variations in individual earnings experience

A series of simulations was conducted to test the impact that irregular earnings histories would have on retirement benefits. For each simulation, it was assumed that assets were accumulated and/or benefits were computed both according to the procedures used under a defined-contribution model and the procedures associated with a representative defined-benefit plan in which benefits are scaled directly to career earnings.<sup>18</sup> The object was to compare the resulting benefit of the workers with irregular earnings records to the benefit that would have been awarded under the same pension plan to a worker who had constant earnings at the economy-wide average. As earlier, the defined-contribution plans were simulated using the actual wage and interest rate data from four OECD countries.<sup>19</sup>

The results of these simulations are shown in Table 5. The first simulation shows the impact on a worker assumed to experience a prolonged spell of unemployment at the beginning of his work career. In this example, the worker was unemployed continuously for the first ten years of his career, between age 22 and age 31, but earns the average wage in each of the subsequent 33 years. This worker ends up, on average, accumulating assets equal to 78 percent of those that would have been accumulated by a worker who experienced no unemployment. By comparison, his benefit under the defined-benefit pension plan would be 77 percent of that earned by his counterpart with a full career.

The second simulation focused on a worker with the reverse pattern. He was employed every year at the average wage for the first 33 years of his career, but was unemployed the last ten years. On average, he also would have received 77 percent of the benefit awarded under the defined-benefit plan to a

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<sup>18</sup> The defined benefit plan was assumed to be a German-style plan based on pension points. Under the plan assumed here, pension points are awarded each year on the basis of the ratio of the individual's earnings to the economy wide average that year. The benefit is defined as the total number of pension points accumulated multiplied by the economy-wide average wage in the year of retirement and further multiplied by a pension factor set as 1.16. A person who worked the assumed 43 years and always earned the average wage would accumulate 43 pension points. The pension factor of 1.16 is derived by dividing 0.5 by 43, producing the target pension of 0.5 times the average wage for this individual. Under this system, a person who only worked 33 years but earned the average wage in each year that he worked would accumulate 33 pension points, regardless of which 33 years he worked. His benefit would be equal to the pension factor, 1.16, multiplied by the number of pension points, 33, times the economy-wide average wage. In other words, he would receive a benefit equal to 38.4 percent of the average wage, or 76.7 percent of the benefit awarded to the full career worker. As noted earlier, the notional account model would produce the same benefit as long as the contribution rate was constant through the work life of the individual and the accounts were adjusted to reflect the increase in the economy-wide average wage.

<sup>19</sup> The simulations here follow the approach under which contribution rates are set at the level appropriate for the long-term trend (Simulation of Tables 2 and 3). The calculations use the 10-year bond rate as the rate of return on invested pension assets.

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colleague who experienced no unemployment. Under the defined-contribution plans simulated here, his benefit would have amounted, on average, to 75 percent of that of his colleague.

The last two simulations focused on workers with individual earnings that either rose or fell (relative to the economy-wide average) over the course of their working career. The worker in the third simulation experienced rising relative earnings. His earnings were assumed to be one half of the economy-wide average for the first 15 years of his career, to be equal to the economy-wide average for the next 13 years, and to be 1.5 times the economy-wide average the last 15 years. In the fourth simulation, the worker started out with ten years of earnings at 1.2 times the economy-wide average. His earnings rose to 1.7 times the average for the next 15 years, but then his fortunes reverse. For the next nine years he earned only 0.4 times the average, and for the last nine years he earned only 0.2 times the average.

The earnings histories of the last two workers were constructed so that relative earnings averaged over the entire 43-year period are exactly the same as the worker with the predictable record of always earning the average. Under the defined-benefit plan, each receives the same benefit as the worker with the regular and predictable earnings record. Their benefits under the defined-contribution plan are also essentially the same as their counterpart with the regular earnings history, however, averaging 102 percent and 97 percent, respectively of the benefit paid someone whose full career was spent always earning the average wage.

None of the models is without risk, but the risks are different. This suggests that societies should give serious consideration to approaches which feature a mixture of the models as a way of reducing the total risk in their pension systems. One way to achieve such a mixture is to mandate participation in two different programs each of which follows a different model, as has been done in Argentina, Uruguay, Switzerland and Finland. Another way is to set up a pay-as-you-go state system and allow opting out of one part of that system, as is the current approach in the United Kingdom and Japan. A third way is to set up a defined-benefit plan which is not adequate by itself for the retirement income needs of middle and upper income individuals and encourage private supplementation, the approach followed in the United States and Canada.

Societies can be expected to follow different approaches depending on tastes, traditions, and their own institutional histories. Since political risk can be a major source of uncertainty and likely varies from one culture to another, one should expect that the relative importance of the different models would be different in countries with different political traditions and institutions. Whatever the decision that a society makes, however, it is hoped that the decision will reflect appropriate concern for and careful consideration of the role that the pension system plays in providing participants with a predictable source of retirement income.

Table 1: Real wage growth, interest rates and implied individual account contribution rates in four OECD countries

Periods	Germany			Japan			United Kingdom			United States		
	Wage Growth	Interest Rate	C R Rate	Wage Growth	Interest Rate	C R Rate	Wage Growth	Interest Rate	CR Rate	Wage Growth	Interest Rate	C R Rate
1st 10 yrs (1953-62)	8.36	3.79	64.19	9.50	5.32	57.68	5.84	0.98	70.51	2.71	1.42	28.61
2nd 10 yrs (1963-72)	6.06	3.87	35.98	7.67	4.32	47.81	5.22	2.49	41.66	1.84	-0.56	39.04
3rd 10 yrs (1973-82)	3.43	2.99	22.43	2.24	2.84	16.58	1.32	-1.23	40.70	-1.21	2.92	5.20
4th 10 yrs (1983-92)	2.66	4.96	9.84	1.26	3.50	9.93	2.68	4.06	13.09	1.02	4.96	5.72
First 21 yrs (1953-74)	7.13	3.75	48.51	8.48	4.60	54.21	5.43	1.71	53.51	2.17	0.33	33.42
Next 22 yrs (1974-95)	2.57	3.99	12.93	1.82	2.98	13.95	1.78	1.92	18.95	-0.13	4.12	5.09
Full 43 yrs (1953-95)	4.77	3.87	25.50	5.02	3.77	28.07	3.55	1.82	32.16	0.99	2.25	13.50

Source: International Monetary Fund, *International Yearbook of Financial Statistics, 1996*; U.S. Bureau of Labour Statistics, Department of Commerce, <http://stat.bls.gov> and author's calculations. Interest rates are for 10-year government bonds.

Table 2: **Impact of different strategies for setting contribution rates for individual accounts**

(Relationship between simulated actual balance at retirement and accumulation target)  
*(100% bonds; all values in percent, except where indicated)*

	Germany	Japan	United Kingdom	United States
<b>Simulation 1.</b> Contribution rate set at level appropriate for long-term (43 year) trend				
Actual sequence	137	132	140	138
Reverse sequence	88	80	73	80
<b>Simulation 2.</b> Contribution rate set at level appropriate for first half				
Actual sequence	261	255	233	342
Reverse sequence	41	40	43	40
<b>Simulation 3.</b> Contribution rate adjusted every 10 years (in line with economic conditions of preceding 10 years)				
Actual sequence	286	153	165	301
Reverse sequence	66	68	64	58
<b>Basic data</b>				
43-year average wage increase	4.8	5.0	3.6	1.0
43-year average interest rate	6.3	6.7	5.6	5.7
Ratio of target accumulation to average wage (no units)	7.5	7.4	7.1	5.8

*Source:* Author's calculations.

Table 3: **Impact of different strategies for setting contribution rates for individual accounts**

(Relationship between simulated actual balance at retirement and accumulation target)  
*(50/50 mix of stocks and bonds; all values in percent, except where indicated)*

	Germany	Japan	United Kingdom	United States
<b>Simulation 1.</b> Contribution rate set at level appropriate for long-term (43-year) trend				
Actual sequence	97	119	132	118
Reverse sequence	113	97	77	85
<b>Simulation 2.</b> Contribution rate set at level appropriate for first half				
Actual sequence	125	173	278	253
Reverse sequence	88	67	35	39
<b>Simulation 3.</b> Contribution rate adjusted every 10 years (in line with economic conditions of preceding 10 years)				
Actual sequence	93	125	188	180
Reverse sequence	100	87	59	66
<b>Basic data</b>				
43-year average wage increase	4.8	5.0	3.6	1.0
43-year average interest rate	6.3	6.7	5.6	5.7
Ratio of target accumulation to average wage (no units)	7.5	7.4	7.1	5.8

Source: Author's calculations.

Table 4: **Simulated impact of a one year variation in year of retirement**

(Mean absolute percentage difference in the ratio of retirement benefits to pre-retirement earnings among adjacent retirement cohorts)

	Germany	Japan	United Kingdom	United States	All four
<b>Bonds only</b>					
Mean difference	3.2	3.6	3.4	2.8	3.2
Standard deviation	1.9	3.4	1.7	1.6	2.2
<b>50% bonds and 50% stocks</b>					
Mean difference	11.6	9.6	7.6	8.1	9.2
Standard deviation	10.7	6.5	4.6	5.5	7.2

*Source:* Author's calculations.Table 5: **Impact of variations in individual employment patterns on retirement pensions**

(ratio of retirement benefit for individual with irregular earnings pattern to retirement benefit for full career worker who always earned the average wage)

	Germany	Japan	United Kingdom	United States	Defined benefit
<b>Simulation 1.</b> Worker unemployed first 10 years, average earnings last 33 years					
Actual sequence		82	82	84	76
Reverse sequence		78	76	82	66
Mean	78				
Standard deviation	5.9				
<b>Simulation 2.</b> Worker unemployed last 10 years, average earnings first 33 years					
Actual sequence		77	78	73	85
Reverse sequence		69	70	66	78
Mean	75				
Standard deviation	6.3				
<b>Simulation 3.</b> Worker with rising earnings					
Actual sequence		104	102	107	94
Reverse sequence		106	104	110	93
Mean	102				
Standard deviation	6.0				
<b>Simulation 4.</b> Worker with declining earnings					
Actual sequence		99	102	93	113
Reverse sequence		89	92	85	101
Mean	97				
Standard deviation	8.9				

*Source:* Author's calculations.