Risks in Pensions and Annuities: Efficient Designs

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ABSTRACT

This paper considers alternatives to disperse the accumulated pension rights during the liquidation phase or retirement. First, the paper classifies the risks that affect pensioners, discusses the defined benefit and defined contribution options, and classifies pension contracts according to the type of risk they transfer to the worker. It considers fixed annuities, variable annuities, CREF annuities, and programmed withdrawals. This part is a description of the production function for pensions and annuities. Second, the paper offers a discussion of the restrictions that should be imposed by mandatory pension systems on the menu of pension contracts. One section discusses whether lump sum withdrawals should be allowed and the other discusses if there should be a mandate to annuitize wealth. The argument that the annuitization should be mandated to prevent adverse selection is rejected on the basis of Chilean evidence.
1. Introduction

Most of the recent literature on pension reform has focused on the design of the accumulation phase, in which workers contribute and earn pension rights over time. In contrast, this paper is concerned with the alternatives to disperse the accumulated pension rights during the liquidation phase. This topic is becoming increasingly critical for countries in Eastern Europe such as Latvia and Poland, who added unconventional pension formulae to their notional account pillars, and for Latin America, as the AFP-type systems move toward maturity and the need to improve the initial Chilean design becomes apparent.

Pension contracts are of interest for all workers that enter the retirement age. For simplicity, let us assume that the worker already chose the amount of resources which he wants to bequest and used it to buy a bequest-annuity contract that provides for his desired pattern of bequests. The remaining portion of his wealth is the one that he chose to consume. The problem is how to liquidate this amount over his remaining life, whose duration is uncertain. Consider two ways to liquidate a fund, in a concrete case where the worker has accumulated wealth equivalent to 60 monthly salaries, where life expectancy is given by the 1985 Chilean mortality table for male annuitants in which life expectancy at age 70 is 13.34 years and for which the annuity factor is 117.32 when the annual real interest rate is 4%:

(1a) \[ P = 60 \times 0.04/12 = 20.0\% \text{ of a monthly salary if he consumes interest alone}; \]
(1b) \[ P' = 60/117.32 = 51.1\% \text{ of a monthly salary if he annuitizes his wealth}. \]

In (1a) the worker consumes just the interest earned, in order to assure himself of a steady pension even if he lives to a very advanced age. In (1b) he liquidates the principal as well, so consumption more than doubles. This happens because \( P' \) eliminates the unintended bequest that exists in \( P \). As the worker already purchased his desired bequest, the unintended bequest is of no value to him. As \( P' > P \) and in both approaches the risk of outliving savings is reduced to zero, the annuity \( P' \) is dominant for every risk averse worker.

The first aim of this paper is to offer an economic road map to the wide menu of pension and annuity contracts that have been devised around the world. Section 2 classifies the risks that affect pensioners and point out which are diversifiable and which are not. Section 3 discusses how to manage non diversifiable risks. The main options are to buy a guarantee from somebody else - the defined benefit option - and to bear the risk
oneself - the defined contribution option. Section 4 classifies pension contracts according to the type of risk they transfer to the worker. It discusses fixed annuities, variable annuities and CREF annuities. Then it offers a discussion of the programmed withdrawal formula, which is shown to be constrained optimal for some preference parameters. Finally, section 4 explains how annuity contracts allow flexibility to choose the retirement age, the time trend of pension payments and the size and timing of bequests. Sections 2, 3 and 4 can be understood as a description of the production function for pensions and annuities.

The second part of this paper offers a preliminary discussion of the restrictions that should be imposed by mandatory pension systems on the menu of pension contracts. Section 5 discusses whether lump sum withdrawals should be allowed in a mandatory pension system. We argue that it is inconsistent to mandate saving for old age and at the same time allow lump sum withdrawals. We propose a compromise in which the size of mandatory savings is reduced, increasing the scope of voluntary savings and free dispersion of assets. This section shows also that prohibiting lump-sum withdrawals is subject to technical difficulties, but that arrangements such as CREF annuities supplemented by a mortality reinsurance pool could be useful to manage them.

Section 6 discusses if there should be a mandate to annuitize wealth in a mandatory pension system, or conversely, whether phased withdrawals should be allowed. The argument that the latter should not be allowed because adverse selection may emerge is rejected on the basis of the Chilean experience. In that country, a large proportion - 42% in 1996 - of those that retire at the legal age choose immediate annuities over programmed withdrawal, so adverse selection is not substantial. A second argument is that prohibition of phased withdrawals is undesirable, unless options such as variable and CREF annuities are available, because if so workers would be forced to purchase investment and demographic guarantees. A third argument is that phased withdrawals must be allowed in order to assure workers refuge from non-benevolent redistributions due to manipulation of official mortality tables. Finally, we consider the argument that paternalistic concerns lead to a prohibition of real annuities that decrease over time - requiring either flat or growing real annuities - and also to a prohibition of programmed withdrawals.
2. Classification of risks in pensions

The main risks in pensions can be divided into three main classes: mortality risk, investment risk and timing risk\(^1\).

(a) Mortality risk. Every pensioner fears the risk of outliving the resources set aside for old age. To decompose this risk, it is useful to consider the duration of life for a group of 1,000 workers of the same age and sex that are about to take a pension.

It is clear that some of them will live just a few years and others will live much more. The risk of living more than the average for the group can be designated as the "individual mortality risk". This risk can be completely diversified away as is the case in annuity contracts and in mandatory defined benefit pension systems. Risk sharing occurs because the resources freed by those that die earlier than expected are used to finance a continuation of pensions for those that outlive the average.

But there is a nondiversifiable component in this risk as well. This is given by the risk that the average longevity of the group turns out to be different from what was initially expected. Such outcomes are frequent, as medical discoveries may lengthen average life while new diseases and environmental disasters may shorten average life, or simply because the insurer makes a mistake when estimating average longevity for clients. We designate this component as "demographic risk" (Valdés and Edwards, 1997).

The financial significance of demographic risk can be seen with a simple actuarial calculation. Taking the official life table for males in Chile, Valdés and Edwards (1997) seek the required permanent increase in the rate of return on assets needed to compensate the financial cost of an increase in life expectancy of two years. Their simulations show that the required permanent increase is 65 basis points per year, which is very significant. Indeed, it is most likely that this increase cannot be achieved, which requires the pension to fall by 4.1%.

Even in a large country such as the United States, demographic risk realizations have exhibited substantial variation. The annual rate of mortality improvement for males was \(-0.19\)% per year in 1954-68 and \(1.56\)% per year in 1968-88 (Social Security Technical Panel, 1991). The cumulative impact of these changes can increase life expectancy substantially. For example, under simplifying assumptions a mortality improvement of \(1.56\)% per year, accumulated over 20 years (1968-88), increases a

\(^1\) We ignore "expense risk". This is the risk that actual future expenses may be larger than anticipated. Expense risk is the subject of some regulation by Insurance Commissioners.
median life expectancy of 15 years to 20.7 years - a total of 5.7 years\(^2\). Adjustment to this shock requires a substantial reduction in pensions or a substantial increase in taxes.

(b) Investment risk. The worker that is about to start a pension owns an amount of resources and wants to use it to finance his expenditure during old age. He needs a store of value to transfer these resources over time. Investment risk is defined as the risk that the purchasing power of this store of value may change over time.

Some aspects of investment risk may be diversifiable and others may not. We argue that this decomposition depends of the institutional setting. In countries with a varied equity market, investment risk can be diversified by forming portfolios composed of many different stocks. If the country has a corporate bond market, diversification can proceed in this dimension too.

Of course, if a country allows residents to invest abroad - not common in developing countries - then investment risk can be diversified much further through international investment in equities, corporate bonds, property and bonds issued by many different governments, not just the local one. However, if the country just has a few local banks, then diversification is limited to certificates of deposit, debt issued by the domestic government and local real estate.

Generally speaking, the non-diversifiable component of investment risk can be subdivided into three main classes:

(i) capital risk. This risk materializes when the investment portfolio falls in price. This may be due to falls in equity prices, impairment of the bond portfolio by corporate or sovereign defaults, or drops in property prices.

(ii) reinvestment risk, or maturity mismatching risk\(^3\). It arises when at least some portion of the assets will have to be reinvested in the future, at an interest rate which is uncertain now. Examples are bonds that are amortized or called, real estate whose lease expires, and dividends paid out by equities.

(iii) inflation risk. We argue below that the classification of inflation risk as non diversifiable depends heavily of the institutional setting.

\(^2\) If the mortality rate \(q\) were independent of age, then it would be related to the median life expectancy \(L\) through the relation \((1-q)L = 0.5\). This can be used to show that for an initial \(L_0 = 15\), a cumulative mortality improvement that reduces the associated \(q_0\) to \(q' = q_0(1-0.0156)^20\) implies that median life expectancy is raised to \(L' = 20.67\) years in the final situation.

\(^3\) This name is used in defined benefit plans and fixed annuities, because reinvestment risk can be driven to zero if the duration (average maturity) of fixed-income assets (guaranteed by their issuer) is made equal to the duration (average maturity) of the liabilities guaranteed by the plan (pensions or annuities).
The relative size of these three risks is of interest. Capital risk is substantial with regards to equities and real estate. Equity prices fell some 50% in the United States during 1973-74, and have fallen by more in some developing countries. This risk can be managed by increasing the share of the portfolio invested in fixed income securities, such as bonds. Reinvestment risk appears to be smaller than equity risk, although still respectable. As an illustrative example, the annuity that can be purchased with a fixed single premium, when life expectancy is 18 years, falls 15% in value if funds are reinvested at 2% real rather than 4% real. This risk can be managed by choosing a portfolio of fixed income securities whose duration (average maturity) matches the duration of expected payments. Inflation risk can easily be larger than equity risk. If inflation rises from 2% to 10% per year, as it did in the United States from the 1960's to the late 1970's, the impact on the real value of the nominal pension to be paid 15 years after issue will drop by 68%. In addition to being the potentially most damaging, inflation risk is the least manageable by individual portfolio managers, so we discuss it further.

The classification of inflation risk as non diversifiable depends heavily of the institutional setting. If CPI-indexed long-term bonds are not available, then funded pension systems cannot offer CPI-indexed ("real") annuities unless a guarantor puts up substantial equity capital, which in turn make real annuities very expensive.

It turns out that if the tax base is the appropriate one, inflation risk may be diversified through the tax system. A government can commit to pay CPI-indexed transfers if enough revenue is levied from aggregates that increase in proportion to CPI inflation. This is the case in pension systems financed with the pay-as-you-go method, which collect taxes on the formal sector wage bill, an aggregate closely related to consumer expenditure. This close relation explains the ability of unfunded pension systems to pay CPI-indexed pensions.

However, this is not a fundamental advantage of pay-as-you-go finance over funded pensions, as has been claimed by Barr (1993, p. 214). CPI-indexed long-term bonds are available in the United Kingdom, whose government has issued CPI-indexed bonds since 1982. In Chile, there have been CPI-indexed mortgages, CPI-indexed bank bonds, CPI-indexed corporate bonds and CPI-indexed Central Bank bonds. Thus CPI-indexed annuities are available both in the United Kingdom and Chile. As the US.

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4In Chile, issuers of CPI-indexed debt are families who buy homes, firms who sell in the domestic consumer market and the government, who collects tax revenue from consumers through the value added tax.
government began to sell CPI-indexed bonds, TIAA-CREF began to offer CPI-indexed annuities.

The ability to diversify inflation risk through the financial market depends heavily on the institutional setting. If tax and regulatory treatment is equalized, privately issued CPI-indexed securities may emerge in the future in Canada, Mexico and the United States, whose governments have already issued CPI-indexed debt.

Inflation risk cannot be diversified fully in the financial markets of countries without CPI-indexed long term debt⁵. The options for insurers and pension plans in those countries are to guarantee inflation risk by putting up equity capital, or simply to transfer this risk to the pensioner themselves⁶. Due to the high standard deviation of inflation for long horizons, the amount of equity capital needed would probably be quite large, so the cost of the guarantee would also be large, making real annuities very expensive. Thus, insurers around the world have chosen the second option and simply pass along inflation risk to pensioners. Because of this, we may say that the nominal annuities offered by insurance companies and pension plans are "defined contribution" regarding the inflation risk, as explained in the next section.

(c) Timing risk. This is the risk of changing exposure to any of the previous risk at an unfavorable time, say shifting into a fixed income portfolio just before interest rates increase, or buying a mortality guarantee just before expense charges fall. The counterpart of this risk is the opportunity of changing this exposure at a favorable time.

Many authors have argued that pension systems that put a deadline (such as a fixed pension age) for the worker to convert his accumulation into an annuity expose workers to timing risk, because this may turn out to be the wrong timing if the underlying equities fall in price temporarily just before purchase⁷. However, we argue in section 4.7 that "timing" risk is a result of allowing workers the freedom to reallocate their portfolio.

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⁵ Some diversification may be obtained by investing in short term debt, because the short term nominal interest rate does respond somewhat to inflation. However, this strategy increases reinvestment risk.

⁶ Escalating nominal annuities, where the annual escalation factor is equal to expected inflation, are not a solution. Such contracts pay a constant real annuity on average, but its purchasing power is still risky. If expected inflation and the escalating factor are both equal to 2% per year but actual inflation turns out to be 4% per year, then the real pension to be paid 15 years after issue will be 25% below expectations.

3. Approaches to manage non diversifiable risk: DB and DC

The methods to deal with non diversifiable risks can be divided into three classes. The first one is to transfer the risk to another agent, through a contractual guarantee, paying a price or risk premium\textsuperscript{8}. The second is to let each participant bear his own share of the aggregate risk. A third approach is to endow a board of trustees with the power to redistribute wealth between agents, in the hope that it might find a mutually beneficial trade that cannot be achieved in an incomplete market. We develop these ideas now.

3.1 Defined benefit and defined contribution contracts

One way of seeing the distinction between defined benefit and defined contribution is that the former has separate provisions setting benefits and contributions, that do not match automatically from a financial point of view. Thus, a guarantor must exist to cover deficits or to absorb surpluses in DB plans. Instead, defined contribution contracts link benefits and contributions in such a way that financial equilibrium always obtains ex-post. Thus, there is no need for a guarantor.

The essential feature of "defined benefit" contracts is that there is an entity that guarantees one or more nondiversifiable risks, such as investment and demographic risk (Davis, 1995, p. 230-4). This entity can be an insurance company, an employer or future generations of taxpayers. This is proven by the fact that when the guarantor of a defined benefit plan goes bankrupt or does not honor its commitment, the plan ceases to be "defined benefit", and its status changes to defined contribution. An example is the fixed annuity contract, where the pension is guaranteed by a life insurance company. The most common guarantor is the government, that stands for future taxpayers.

Now consider "defined contribution" contracts. In this case there is no entity to guarantee benefits directly. Thus, non diversifiable risk must be divided among individual members, who bear their share of the risk directly.

It is sometimes thought that defined contribution plans are characterized by a fixed contribution rate over time. This is incorrect, as the financial equilibrium of a defined contribution plan obtains also with time-varying and even random contribution rates.

\textsuperscript{8} Mitchell et al (1997), who analyze voluntary annuities in the United States, report that the difference between the expected value of annuities and their price or premium is a puzzle. That difference should be due, at least in part, to the risk premium charged by life insurance companies for taking up nondiversifiable investment and demographic risks.
It is sometimes said that a 401(k) plan with a fixed annuity option is DC. This is correct for the accumulation phase only, so it would be more precise to say that such a plan is a mixture in which the accumulation phase is DC and the annuity portion is DB.

### 3.2 Direct and indirect investment risk guarantees

In the case of investment risk, it is possible to purchase guarantees in the financial markets, substituting partially for the pension guarantor. When a defined contribution plan invests in fixed income securities, it purchases the guarantee provided by the issuers, which may be quite reliable. That is why the "defined benefit" pensions guaranteed by the government of a small country may be less reliable than the pensions offered by a "defined contribution" plan invested in debt securities issued by the government of a major economy. In the United Kingdom, some investment banks are offering pensions invested in mutual funds that purchase put options to guarantee their return (Planned Savings, May 1996).

Similarly, when the assets that back defined benefit pensions are invested in fixed income securities, the guarantor relieves himself of most of the costs and rewards of that role, which is implicitly transferred to the issuers of those securities. This procedure allows life insurance companies to operate safely with a high leverage.

However, as financial markets are less than complete, they seldom allow the purchase of as many guarantees as those provided by the direct guarantor of the pension contract, the remaining risk is of major interest.

### 3.3 Contractual and discretionary guarantees

Financial markets trade guarantees that are bilateral contracts. Ex-ante, the contract is designed to maximize its value for both parties. For example, the risk for the pensioner may be smoothed over time by adding experience-rating clauses to the pension contract. However, experience must be measured in an objective way, say by following a market price index, because ex-post the parties will have opposing interests.

An alternative approach is to designate a board of trustees, who should behave benevolently, and entrust it with the task of dividing risks equitably over time between the different classes of beneficiaries of the trust and its guarantor. The trustees are a third party to the contract, who exercise their discretion. The guarantees generated by these

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9 The investment risk for the pensioner can be eliminated if the plan invests in long-term fixed income securities of the same duration of expected liabilities (pensions).
trilateral contracts may be termed "discretionary guarantees". If discretion is used benevolently, it might reduce total risk by redistributing outcomes ex-post in an incomplete markets setting.

An example of risk-bearing through discretion is "participating" life insurance, in which policy dividends are determined by a board of trustees. In the "with-profits" annuities marketed in the United Kingdom, the rate of return credited to annuitants is determined by a board of trustees on their best judgment, rather than through a formula set in the contract. Another example is given by occupational pension plans in the United Kingdom and the United States. But the most prevalent example is given by legislated defined-benefit pension plans, which are usually mandatory, state managed and financed on a pay-as-you-go basis.

When comparing with contractual risk sharing, discretionary risk sharing is subject to a moral hazard problem. By moral hazard we mean that trustees may not act benevolently but rather seek self-interest or the interests of their true principals by virtue of other contracts (Valdés, 1997). If abuse occurs, the guarantee may not be worth much. If discretionary actions go so far that aggregate risk is increased, the beneficiaries become willing to pay to get rid of this "guarantee", whose value becomes negative.

In the case of participating life insurance, the Armstrong Commission (1905) complained about the criteria used by the boards of trustees of life insurance companies to assign available resources between policy dividends and other uses, such as executive compensation. These worries led New York state to issue regulations that require policy dividends to be above a minimum of 95% of net investment income (Black and Skipper, 1994).

In the case of defined-benefit occupational pension plans, the employer announces a guarantee of benefits. However, the employer may reserve the right or power to modify some of the terms of the guarantee. For example, the Goode Report (1993) in the United Kingdom showed that the "guarantee" announced by defined-benefit occupational pension plans in that country was discretionary, because the board of trustees had the legal right to reduce benefits already accrued10. Although trustees have the legal obligation to exercise their power benevolently, the fact is that most of such

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10As pointed out by the Goode Report (1993), who asked for decisive reform in this matter, this situation was the result of considering pensions to be a promise of donation or grant by the employer, and thus subject to unilateral modification. The moral hazard occurs when the worker, in anticipation of such promised payments, accepts a reduction in take-home wages. If this reduction happens, then the pension promise is an accrued right and should not be subject to unilateral reduction. But this means that the guarantee for non diversifiable risks offered by the employer ceases to be discretionary and becomes contractual.
boards are designated by the guarantor (employer). The presence of another contract, in this case the employment contract, that makes the trustee the agent of one of the parties (the guarantor) increases the risk of moral hazard.

This was also the case in "private" pensions in the United States until the approval of the ERISA law in 1974. When Studebaker closed in 1964, the bankruptcy courts confirmed that the workers had no pension rights, even those that had contributed for decades. However, moral hazard with respect to the accrued rights of workers not yet pensioned continues to be possible in the U.S. This happens when the employer-guarantor chooses to terminate a defined benefit plan, maybe to replace it with a defined contribution plan. Some observers claim that ERISA rules are too lax to prevent deliberate underfunding. In addition, according to ERISA the guarantee of the employer to the pension plan is limited to 30% of net worth of the employer (Smallhout, 1996, p. 10-11). Moral hazard continues to be possible in the many developing countries that limit their regulation of company pension plans to the tax aspect.

The most significant instance of discretionary guarantees are legislated pension plans, which are usually mandatory, state managed and financed on a pay-as-you-go basis. In most countries the pension promises offered by these plans do not have the status of property rights owned by the participants, because they can be amended by future laws. For example, the Dini reform in Italy in 1995 reduced significantly the pensions of independent workers (Haman, 1997). If the pension rights of those workers had been expressed as accrued property rights, that reduction would have been unconstitutional. Another example is provided by legislated increases of the retirement age.

Of course, legislators are expected to exercise their power benevolently, but moral hazard is possible because of the constraints imposed on politicians by political competition and because public finances are not transparent to non specialists. Non benevolent use of discretion may have been the rationale in some instances in which legislators have switched the asset mix from funding to pay-as-you-go financing. In the latter, the asset that backs pension promises is the present value of payroll taxes to be levied on future workers. This switch improves the current cash balance in the government, which may use it to transfer wealth to the current generation of taxpayers or transfer recipients. This might benefit politicians by improving their reelection prospects.

If discretion is used benevolently, and guarantee markets are incomplete, it can reduce total risk by redistributing outcomes ex-post. But actions by trustees-legislators may also increase risk, turning the guarantee into a bet or wager. "Political risk" has been
defined as the risk that the rules of the pension system are altered in ways that increase the risk perceived by workers and pensioners (Diamond, 1997).

Considering the wide range of behavior allowed by discretionary guarantees, one might question the usual practice of calling these promises "defined benefit". We can salvage the term by saying that the quality of a discretionary guarantee can vary substantially. In a defined contribution plan there are no guarantees nor promises from others, whatever their quality.

Discretion used ex-post can also be understood as an implicit guarantee. The government retains the right to support unlucky pensioners ex-post, as the British government did after the Maxwell affair in 1992. Discretionary guarantees managed by trustees seem to be in-between contractual guarantees and implicit guarantees. Of course, implicit guarantees are unlikely to be considered a "defined benefit".

3.4 Implications for pension design

The non diversifiable risks in pensions, such as investment and demographic risks, can be either borne by participants (defined contribution) or by an external guarantor (defined benefit). An important question for mandatory pension systems is which is the best design.

Our view is that given the large volume of pension promises relative to the size of an economy, a mandatory demand for guarantees can push the market price of contractual guarantees above voluntary willingness to pay, unless the guarantee can be purchased indirectly in the financial markets. Indirect purchase is helpful in the case of reinvestment risk and, provided CPI-indexed bonds are available, also for inflation risk. However, this is not the case with capital risk and demographic risk. If this presumption is accepted, the practical options for large mandatory pension systems are just defined contribution (no guarantee) and discretionary guarantees.

A discretionary guarantee is an evolving hybrid which relies on boards of trustees, is subject to the dangers of moral hazard and may even lead to risk creation. Trustees that can take action ex-post may increase risk perceived ex-ante, turning the guarantee into a bet or gamble. This is more likely to happen if trustees are perceived as unprofessional or prone to moral hazard. If this is the alternative, the absence of guarantees (defined contribution) might be preferable.

Another lesson of this section is that the choice between the defined contribution approach and discretionary guarantees can be made separately for each type of nondiversifiable risk. For example, the defined contribution approach might be chosen
with respect to capital risk, while discretionary guarantees are chosen for demographic risks.

A general rule to recommend the defined contribution approach over discretionary guarantees, or vice versa, seems unwarranted. Individuals may differ in risk aversion and expectations about the workings of discretionary guarantees, affecting their willingness to pay for such guarantees. Thus, an option is to allow workers to choose between discretionary DB plans and DC plans. However, in a mandatory system many workers may not have the financial knowledge to make such a decision. Thus, the government will have to keep some role, which should at least include careful regulation of discretionary guarantees to improve their performance.

4. The menu of pension contracts

Pension contracts can be classified according to the risks they guarantee or diversify away. Abstracting from the difference between contractual guarantees and discretionary guarantees and lumping them together, we can classify the main pension contracts as in Chart 1.

<table>
<thead>
<tr>
<th>Risk 1: Investment</th>
<th>Risk 2: Demographic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Capital and Reinvestment risks</td>
<td>Division among pensioners</td>
</tr>
<tr>
<td>Guaranteed (Defined benefit)</td>
<td>Variable Annuity</td>
</tr>
<tr>
<td>(Def. Benefit)</td>
<td></td>
</tr>
<tr>
<td>Risk 3: Inflation risk: When the inflation risk is passed along to annuitants, the contract is &quot;defined contribution&quot; in this dimension. Annuities offered by insurance companies and pension plans in many countries are not guaranteed regarding inflation.</td>
<td></td>
</tr>
<tr>
<td>Risk 4: Expense risk: This is the risk that actual future expenses may be larger than anticipated. If it is passed along to pensioners, the contract is &quot;defined contribution&quot; in</td>
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this dimension. Most fixed annuity contracts leave expense risk with the insurer. Variable and CREF annuities pass along the expense of investment management, provided the annuitant can choose between managers. CREF annuity managers may pass along the full expense risk if they participate in a mortality reinsurance pool.

Risk 5: Timing risk: This is the risk of changing exposure to any of the previous risk at an unfavorable time, say quitting equities just before they increase in price, or buying an expense guarantee just before expense charges fall. The counterpart of this risk is the opportunity of changing this exposure at a favorable time.

In what follows we describe briefly each of these contracts. We also describe two other pension contracts which arise frequently: tontines and programmed withdrawals.

4.1 The fixed annuity.

This is the standard annuity contract offered by life insurance companies, occupational pension plans and state-managed defined benefit pay-as-you-go pension systems. There is a guarantor that takes upon itself both the investment risk and the demographic risk. Thus the pensioner is spared from both these non-diversifiable risks as long as the guarantee is maintained.

Life insurance companies hedge most of the investment risk by choosing portfolios concentrated in fixed income denominated in the same currency as the pension contract and by trying to match the duration of the asset portfolio and expected liabilities. This strategy reduces the amount of risk capital that shareholders must put up to back up their guarantee. It is useful to split the investment guarantee further. In the Unites States, life insurance companies and employers that offer defined benefit "private" pensions do not guarantee the inflation risk. Thus, in the direction of inflation risk, these pension contracts are defined contribution in nature. At the same time, they are defined benefit regarding all other investment risks, which are guaranteed. In contrast, CPI-indexed or "real" annuities do guarantee the inflation risk, so they are the only fully defined benefit pensions guaranteeing all risks.

The size of a pure fixed immediate real annuity is set as follows:

\[
(2) \quad P_t = F_t \cdot \left( \sum_{x=t}^{110} q_x \cdot (1 + r)^{-(x-t)} \right)^{-1} \div 12 \ ; \ P_{t+1} = P_t \text{ for as long as the insured lives.}
\]

where:

\[ P_t = \text{monthly pension paid every month, in real terms.} \]

\[ F_t = \text{price of the pure annuity, which may be equal to the balance in the individual's savings account at retirement if the worker does not want any bequest.} \]
worker adds bequests feature to this pure annuity, the price rises in proportion to the expected cost of the bequest, as estimated by the insurer.

$q_x$ = probability that the pensioner will be alive at date $x$ given that he was alive at time $t$, the purchase date. This set of probabilities is chosen by the insurer. Conventionally, $q_x = 0$ for $x \geq 110$ and $q_0 = 1$.

$r$ = real internal rate of return offered by the insurer to the purchaser of the annuity. The purchaser cannot distinguish between $r$ and $\{q_x\}$.

Defining $R$ as the market interest rate on fixed-income investments of similar duration to the expected liability taken up by the insurer, the implicit fee charged by the insurer is the difference $(R-r)$ applied to the value $F_0$ of the annuity contract. This fee includes the risk premium for the investment and mortality guarantees, the administrative cost and profit.

The case of $r = 0$ is interesting because two things happen. First, the implicit fee charged by the insurer rises to be $R\%$ of annuity assets. Second, the expression in parenthesis in equation (2) collapses into the life expectancy at date $t$, as estimated by the insurer. This is precisely the case of the new notional accounts pension system in Latvia and Poland\(^{11}\). In those countries, the government acts as the insurer and calculates the annuity for each individual as $(F_t/Life\text{ Expectancy at date } t)$, so implicitly it sets $r = 0$. Assuming that in a free insurance market $r$ would have been positive, this pension system subjects pensioners to a substantial implicit tax, whose rate can be estimated\(^{12}\) to be:

$$t = 1 - \frac{P_t(r=0)}{P_t(r=R-c)}$$

where: $c$ = cost of provision, including the risk premium for the guarantees involved and administration, expressed as a percentage of assets.

Consider an example. For annuitants with life expectancy of 15 years, in a country where $R = 4\%$ and $c = 1\%$, calculating annuities by simply dividing assets by life expectancy implies levying a tax on pensioners of 20\% of the total accumulation of pension rights at retirement. This tax rate is large enough to induce serious distortions, especially when levied on top of other taxes.

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\(^{11}\) For Poland, see Security through Diversity, July 1996, page 155.

\(^{12}\) The accuracy of the estimate depends of using a life table $\{q_x\}$ that is not biased.
4.2 The variable annuity.

This contract is like the fixed annuity but passes on the investment risk to the pensioner. This is achieved by promising the payment of a number of shares in an underlying portfolio. This number is recalculated annually and evolves over time with a fixed formula. The essentials of the formula used in the United States can be summarized by:

\[(3a) \quad P_{t+1} = P_t \cdot (1+r_t/1+AIR) \quad ; \quad P_0 \text{ is set using (2) with } r = \text{AIR};\]
\[(3b) \quad N_{t+1} = N_t/(1+AIR) \quad ; \quad N_0 = P_0/V_0\]

where:
- \(P_t\) = pension paid to the annuitant over year \(t\) [\$/year].
- \(r_t\) = rate of return actually earned by the portfolio during year \(t\).
- \(AIR\) = "assumed interest rate", a constant number set in the contract.
- \(N_t\) = number of shares to be liquidated and paid to the annuitant over \(t\).
- \(V_0\) = price of the shares of the portfolio at date 0.

Version (3a) of the variable annuity formula shows that the actual monetary value of the pension varies according to the difference between the actual return earned by the portfolio and the AIR. For consistency, both returns must be set either in nominal or in real terms. Version (3b) is obtained from (3a) by dividing by the price of one share of the underlying portfolio at time \(t\) and using the definition of the rate of return on the portfolio. This version allows one to see that the purpose of correcting by the AIR is to take into account that the value of shares in a mutual fund grows over time according to the rate of return, so it is possible to liquidate an ever smaller number of shares and still get the same pension amount per period.

Demographic risk is guaranteed by the insurance company, because (3) applies regardless of the actual mortality of the group of pensioners. If they die more slowly than predicted by the life table, the insurer must cover the loss.

For economists, variable annuities appear natural because the pensioner can choose the type of investment risk he prefers by varying the underlying portfolio. Currently, life insurance companies in the United States allow the annuitant to choose from dozens of portfolios managed by different investment managers, and allow a number of free switches per year.
However, we must point out that variable annuities based on formula (3) do not allow pensioners to eliminate investment risk, even when the portfolio is invested in a long-term fixed income portfolio with the same duration as expected liabilities. This should not happen, as in the case of perfect matching capital and reinvestment risk have been guaranteed indirectly by the issuers of the fixed income securities.

To see that this is the case, consider an example in which the AIR is 4%. Market yields on long term Treasury bonds rise permanently from 4% to 8% during the week in which the pension is recalculated. Thus, the observed rate of return on the bond portfolio is negative, so $1+r_t$ is below 1. As the AIR is fixed at 4%, the pensioner must absorb a reduction in her pension. From this date on, the bond portfolio will yield 8% (the new market yield) rather than 4%, and if market yields do not change further, this will lead to increases in the pension amount over time. However, there is no need for this fluctuation in pension amounts because the fixed income assets continue paying the originally planned cash flow, regardless of market yield. If the bond portfolio has the same duration as expected liabilities, the present value of subsequent increases in the pension is cancels the initial reduction exactly. Formula (3) is inconsistent with marking assets to market prices continuously.

In the United States a second NAIC regulation introduces additional rigidities. The regulation precludes AIR from being higher than 5% per year (nominal). This is part of a regulatory attempt to protect consumers from aggressive sales tactics in which an exaggerated rate of return is promised.

Given the weight of these regulations, the variable annuity market remained small in the United States until the 1980's. As of the late 1960's, more than 95% of variable annuity contracts in the United States were group policies (Poterba, 1997). The sales argument for the variable annuity in the 1960's in the United States was that it affords a (partial) hedge for the inflation risk, when it is invested in securities whose nominal return is partially correlated with inflation, such as equities. This argument turned out to be mistaken in the case of supply shocks, such as the oil shock of 1973.

The 1990's has observed a surge in demand for individual saving in so-called "variable annuities" in the United States. These contracts are a tax-favored vehicle for saving, which have this name only because they include the option to buy a true

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13 See section 6 of the "Model Variable Annuity Regulation", National Association of Insurance Commissioners, 1996, July. This was kindly provided by Mr. Mark Peazy from the NAIC.

14 Most of these contracts have been sold to purchasers that have already hit the annual limits on contributions to IRAs and 401(k) plans and wish to defer taxation on investment earnings. The popularity of this savings vehicle has increased further in the current U.S. environment of rising concern of baby boomers about their retirement and successful investment in equities.
variable annuity as a payout. The other payout option is simply to cash out and almost all savers prefer it\textsuperscript{15}. Thus, in practice the true variable annuity market remains small in the United States and elsewhere\textsuperscript{16}.

4.3 CREF annuities.

These annuity contracts pass along to the pensioner both investment and demographic risk, so they are truly "defined contribution" in most dimensions. This can be done through "participating" or "with-profits" annuities that share investment and mortality risks, and through CREF annuities. The difference is that the former rely to a greater extent on discretionary decisions by the insurer, while CREF annuities use a formula based on objective parameters. Still, CREF annuities can be made to rely on some discretion as well, as explained below.

CREF annuities were invented by Duncan (1952) and have been marketed successfully by TIAA-CREF in the United States ever since. TIAA-CREF is a non-profit organization that manages a multiemployer occupational pension plan that serves college and university professors, and which manages over 180 billion dollars in assets. Bolivia's recent pension reform allows CREF annuities as one of the two payout options, together with fixed annuities. Peru will allow, starting in December 1997, a scheme of self-insurance of mortality risk for groups of pensioners without dependents, which is related to CREF annuities (Superintendencias, 1996, p. 134, 523).

CREF annuities promise the payment of a number of "annuity units" in the underlying portfolio. The price of annuity units is recalculated annually with a fixed formula, which accounts for:

(i) the difference between the actual rate of return earned by the underlying portfolio and the projected interest rate;

(ii) the difference between the actual mortality experience of the group of plan members and the expected mortality for that group according to the life table used; and

(iii) changes in expected mortality (new mortality tables). A board of trustees exercises its discretion here.

\textsuperscript{15} I thank Mr. Jonathan L. Wooley, Chief Individual Annuity Department Actuary at New York Life Ins. Co., for this information. He is not responsible for my interpretations of this fact.

\textsuperscript{16} Palmer (1997, p. 17) proposed recently the adoption of a modified variable annuity for the Swedish notional account system. Equation (3a) would apply with \( r_t \) redefined to be the actual growth rate of the aggregate nominal wage bill, while AIR is redefined as a so-called "norm" rate of return that represents the expected rate of growth of the real wage bill. This proposal was not accepted in Sweden.
The formulae for the CREF annuity are\(^{17}\):

\[
\begin{align*}
(4a) & \quad P_{t,i} = V_t \cdot N_i \quad \text{where} \\
(4b) & \quad V_t = F_t / \left[ \sum_x \sum_i N_{ix} \cdot a_{ix}(AIR,q_{xt}) \right] \quad \text{and} \\
(4c) & \quad N_i = F_i / [V_0 \cdot a_i(AIR,q_{x})]
\end{align*}
\]

where:
- \(P_{t,i}\) = pension amount for individual \(i\) in year \(t\).
- \(V_t\) = price of one "annuity unit" for year \(t\).
- \(N_i\) = number of annuity units owned by individual \(i\).
- \(F_t\) = market value of the aggregate funds at the beginning of period \(t\). This depends on the actual rate of return and actual mortality experience.
- \(N_{ix}\) = number of annuity units to be paid to member \(i\) of age \(x\).
- \(a_{ix}\) = actuarial factor that indicates the expected present discounted number of times that annuity units will be paid to member \(i\) now age \(x\), according to the current mortality table.
- \(AIR\) = assumed interest rate used to determine \(a_{ix}\).
- \(q_{xt}\) = mortality table used to determine \(a_{ix}\) as of recalculation \(t\).
- \(F_i\) = single premium paid by individual \(i\) to purchase a CREF annuity.
- \(V_0\) = price of one annuity unit when individual \(i\) bought his annuity.

This formula may also be described as a mutual insurance company specialized in variable annuities, or as a group programmed withdrawal\(^{18}\). If in a given year the number of deaths among annuitants is less than expected, then the annuity for survivors is reduced proportionately in the next annual recalculation.

A potential problem with the CREF annuity is that the management company has a conflict of interest when it has the freedom to select the mortality table when dealing with new annuitants. To attract a new annuitant, the management company can offer her a better pension, net of commissions, by being slightly optimistic about her risk, which in this case means selecting a pessimistic mortality table for her. A better pension offer allows the management company higher sales growth for the short term. In standard annuities, such a mistake will bring future losses for the insurer. In CREF annuities it is other annuitants, who already have bought a contract, who are forced to subsidize the new annuitant through the mortality experience adjustment. This shows up as successive

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\(^{17}\) See Duncan (1952), pages 339-40.

\(^{18}\) See Díaz and Edwards (1994), who offer a description of the CREF annuity in Spanish.
downward adjustments in the price of annuity units (see (4b): the term $a_{ix}$ turn out to be larger than anticipated), which in turn reduce the level of pensions paid to all annuitants.

The uses of this strategy are not restricted to increase profits. The board of the management company may set mortality tables to pursue other agendas it may have. For example, it may redistribute in favor of selected minorities by producing favorable mortality tables for them and may choose not to acknowledge the actual mortality tables for other minorities such as smokers.

Although some market forces such as reputation limit the extent of this problems, it merits some improvement in contract design. In the U.S., some states have taken the extreme position of prohibiting the CREF annuity for commercial insurers. For example, in New York state, Regulation 47, section 50.6, states that "mortality actually experienced shall (not) adversely affect the dollar amount of payments", which effectively bans CREF annuities\textsuperscript{19}. Greenough (1990, p. 120-1) reports that in 1952 the Insurance Commissioner Bohlinger decided not to authorize competitive insurance companies to market the CREF annuity contract in New York. However, TIAA-CREF is exempted from this regulation by a special-purpose law passed in 1952.

The NAIC (National Association of Insurance Commissioners) has taken a more liberal approach since 1975. The Model Variable Annuity Regulation, adopted as of 1996 by 23 states including California, Georgia, Louisiana and Virginia, requires in section 6.D that:

(1) The mortality factors shall be stipulated in the contract;

(2) The mortality factor shall be determined from the "Annuity Mortality Table for 1949, Ultimate", or any modification of that table not having a lower life expectancy at any age, or, if approved by the commissioner, from another table.

Requirement (1) prohibits the CREF annuity in its purest form, because the mortality table cannot be adjusted over time as mortality expectations change (see (iii) above). Still, the NAIC regulation does allow the flexibility of adjusting pensions in proportion to the difference between actual and expected mortality.

Requirement (2) prevents the management company from attracting new business by assigning artificial mortality tables to new annuitants that imply higher pensions, because low life expectancies are prohibited. This solves the potential moral hazard problem explained above. However, as the official 1949 table does not acknowledge the impact of income on mortality, this regulation prevents equitable pricing for poor customers.

\textsuperscript{19} Valdés and Edwards (1997) quote Mr. Jack Fitzgerald, from the New York Insurance Commission for pointing out that regulation.
Recently, Valdés and Edwards (1997) have suggested alternative regulations that also eliminate moral hazard, with the advantage of allowing adjustment over time of mortality expectations. They propose to require management companies to transfer the power of modifying the mortality table that applies to each potential new buyer to an independent committee of actuaries-trustees. In addition, they suggest to require the management company to keep some amount of capital invested in CREF annuities, such as 1% of assets, to assure that the manager makes financial losses when unfavorable mortality experience occurs.

CREF annuities based on formula (4), as variable annuities based on (3), do not allow pensioners to eliminate investment risk by choosing a portfolio invested in fixed income securities with the same duration as expected liabilities. Thus, the CREF annuity reported in the lower left-hand side of Chart 1 is not available in the United States.

4.4 Programmed withdrawal or 'income withdrawal'.

The programmed withdrawal approach is not included in chart 1 because it fails to diversify away (insure) a diversifiable risk, namely the individual longevity risk. The programmed withdrawal formula used in the Chilean AFP system since 1981 and in the UK personal plans since 1995, for a single pensioner, is:

\[ P_t = F_t \cdot \left( \sum_{x=t}^{110} q_x \cdot (1 + r)^{-(x-t)} \right)^{-1} \div 12; \quad \text{Bequest} = F_t \text{ if the individual dies at } t. \]

where:

- \( P_t \) = maximum monthly pension after recalculation in year \( t \).
- \( F_t \) = balance in the individual's savings account at the beginning of \( t \).
- \( q_x \) = probability of being alive at date \( x \) given that the pensioner is alive at date \( t \).

Conventionally, \( q_x = 0 \) for \( x \geq 110 \) and \( q_{110} = 1 \).

- \( r \) = a real rate of return on investment. Both \( r \) and \{\( q_x \}\} are set by the regulators or by exogenous market indices.

The notion behind the programmed withdrawal formula is that the pensioner may spend at, a maximum, an amount that assumes he lives for the average life expectancy and earns return \( r \) on his fund. However, if he turns out to survive by the next recalculation, then he is doing better than average (he is 100% alive rather than 95% alive), so his pension must be adjusted downwards ceteris paribus. Thus, formula (5) does not insure individual longevity. This can also be seen in that \( F_t \) is the individual's savings account balance at the beginning of \( t \).
property, rather than a collective fund managed by the insurance company as in variable annuities and CREF annuities. Expression (5) may also be used by an individual to calculate how much to draw down his voluntary savings each year.

In Chile \( r \) is currently set as the average observed return during the past 10 years in the particular AFP where the pensioner is requesting the programmed withdrawal, while \( \{q_x\} \) is set by the regulators and is the same used to determine the annuity-related liabilities of life insurance companies. In addition, the Chilean formula considers also the payment of a small sum for funeral expenses. Administrative charges are deducted from the monthly withdrawal, so the net withdrawals are below those indicated by (5). If a pensioner is legally married or has dependents, his programmed withdrawal must be calculated using the joint survival probabilities, so a sort of mandatory bequest is involved. The bequest is inherited by the relatives that survive the spouses and dependents. Argentina and Peru apply similar formulae.

In the United Kingdom the recalculation is done every three years, not annually so (5) must be modified slightly. In addition, the income withdrawal is temporary, because by age 75 the pensioner must have purchased an annuity. In the UK \( r \) is set as the gross redemption yield on UK gilts (High Coupon, 15 years) from the FT-Actuaries Fixed Interest Indices, as published daily by the Financial Times newspaper for the 15th day of the calendar month preceding recalculation, and then rounded down to the next 1/4\% (0.25\%) (Finance Act 1995, section 58, Schedule 11). Comparing with Chile, we observe that \( r \) is set in a forward looking manner, which is better than the Chilean method. However, \( r \) is a nominal interest rate in the UK, rather than a real rate as in Chile. For positive inflation this implies a higher initial pension and a steeper reduction in real benefits for the UK, and the slope of real benefits is random as it depends of realized inflation. In the UK, \( \{q_x\} \) is set by the Government Actuary on the basis of a single life, but the surviving spouse that inherits the fund must either purchase an annuity or request income withdrawals. Administrative expenses are considered by reducing \( F_t \) by 2\% before use in (5), and there is no funeral benefit.

Programmed withdrawal should not be confused with minimum outgo rules applied to third pillar pensions in order to limit the fiscal cost of tax exemptions. Examples are the minimum outgo requirements applied in the U.K. to personal pensions, the RRIF option in the Canadian RRSP\(^{20}\) and in the Czech government-matched voluntary pension plans introduced in 1994.

\(^{20}\) Canada introduced RRSP in 1957, which is a fiscal incentive scheme for voluntary saving for old age. Initially the only payout option allowed were annuities, but in 1978 the RRIF was introduced, which is a type of programmed withdrawal. The Canadian RRIF is a minimum
The programmed withdrawal formula set out in (5) is not derived from utility maximization. It is instructive to inquire what are the preferences that would make it optimal. The utility-maximizing programmed withdrawal under the constraint of no annuitization, assuming a single pensioner that does not desire to bequeath and whose preferences can be described by an additive utility function of the CES type, solves the following system

\[ P(x + 1) = P(x) \cdot \left[ \frac{1 + r_x}{1 + \delta_x} \cdot \frac{q_{x+1}}{q_x} \right]^\sigma \]

\[ F_t = \sum_{x=t}^{110} P(x) \cdot \prod_{z=t}^{x-1} (1 + r_z)^{-1} \]

where the additional notation is:
- \( r_x \) = projected real rate of return earned on savings in future year \( x \).
- \( d_x \) = utility discount rate at age \( x \), which describes the pensioner's preference for consumption at age \( x \) as compared to age \( x+1 \).
- \( s \) = parameter that is both the elasticity of intertemporal consumption and the inverse of the degree of relative risk aversion.

Note that the second equation is not weighted by survival probabilities. This is necessary to make sure that the consumer will not die in debt. If preferences are such that the utility discount factor \( d_x \) coincides with \( r_x \), for all ages \( x \), we find that the optimal path solved out from (6) is:

\[ P_t = F_t \cdot \left( \sum_{x=t}^{110} (q_x)^{\sigma} \cdot \prod_{z=t}^{x-1} (1 + r_z)^{-1} \right)^{-1}; \text{Bequest} = F_t \text{ if the individual dies.} \]

Thus, assuming that \( s = 1 \) (the Cobb-Douglas case) and that the regulators use the term structure of interest rates observed in the market to set \( r \), then (7) turns out to be exactly equivalent to (5). The programmed withdrawal is optimal for these preference parameters, under a no annuitization constraint.

The intuition for this result is that because of mortality risk, the consumer prefers to consume more now - when he is alive - rather than later. This justifies the fact that the

withdrawal limit, not to a maximum limit. Some provincial governments in Canada impose a maximum limit to RRIFs that hold funds transferred from pension plans under their jurisdiction, for "consumer protection" reasons. I am grateful to Keith Horner for this information.

\(^{21}\) See Yaari (1965) equations (2) and (19).
programmed withdrawal pension falls over time provided the pensioner survives\textsuperscript{22}, until it hits the first-pillar pension. The fact that older pensioners get systematically lower pensions than younger pensioners is not deemed a defect, but rather the optimal policy for the preference parameters indicated.

Empirical estimates of \( s \) are closer to 0.5 than to 1 (Auerbach and Kotlikoff, 1987). The programmed withdrawal pension in (5) falls too steeply and bequests are smaller than what an individual with \( s = 0.5 \) would choose. But (5) is not restrictive for these people, as it sets only the maximum that can be withdrawn each month. The individual with preferences represented by \( s \leq 1 \) can save and reinvest the excess he does not want to consume immediately. Thus, formula (5) constrains only individuals with \( s \geq 1 \textsuperscript{23} \).

Overall, the programmed withdrawal has four drawbacks:

a) No portion of wealth is annuitized, so this contract is inefficient. The amount of annuitization demanded does not depend on the degree of risk aversion, because all risk averse consumers want to diversify risk when it costs nothing to do so (Yaari, 1965)\textsuperscript{24}.

b) Only a single bequest profile is allowed. In contrast, annuity contracts offer flexibility regarding bequests, as the pensioner may stipulate what any designated survivor will receive, which may be in the form of a continuation annuity, a lump sum of fixed or variable size or any other profile of payments. The programmed withdrawal forces the pensioner to leave bequests with a particular time and risk profile, so it is inferior regarding bequests.

c) In a programmed withdrawal it is impossible to find a portfolio that reduces investment risk to zero. As the date of death is uncertain, the pension liability for an individual is random. Consider a case where the portfolio is invested in long-term fixed-income securities with the same duration as the individual's expected pension liability. If interest rates rise, then the value of assets falls and the expected pension liability falls by the same amount, so expected payments for the future remain the same. However, the bequest amount remains subject to investment risk, because if the pensioner dies after the rise in interest rates the bequest will be smaller.

d) In the case where the programmed withdrawal pays joint pensions for spouses, as in Chile, longevity risk is diversified among spouses which increases welfare.

\textsuperscript{22} Under uncertain investment returns, the optimal path also depends on risk aversion.

\textsuperscript{23} When individual preferences do not meet the condition that \( \delta_x = r_x \), as is likely in the general case, the analysis becomes more complicated.

\textsuperscript{24} The amount of annuitization demanded does not depend on the demand for bequests either, because that demand can always be served by an annuity contract that includes bequests and annuitizes the portion of wealth that is to be consumed.
(Kotlikoff and Spivak, 1981). However, it also induces a betting game called tontine between the spouses, because the survivor gets a bequest and increases his or her pension in the next recalculation. Tontines are described in the Appendix. The tontine aspect of the programmed withdrawal increases individual risk, so welfare does not increase as much as it could. In Britain income withdrawals are calculated on the basis of a single life, so there is no explicit tontine. However, this is more risky because an implicit tontine exists anyway, through bequests, while the individual-based calculation implies that the pension starts higher than in Chile and that it falls more steeply conditional on survival of both spouses.

4.5 Retirement, partial work and payment in annuity contracts

All the annuity contracts presented in Chart 1 can be adapted to individual preferences in other dimensions, additional to those discussed up to now. This section summarizes the most interesting options.

(a) Bequests. The most popular bequest clauses in annuity contracts in the United States are those that specify a "minimum guaranteed period of payment" (MGPP) and a "minimum guaranteed reimbursement" (MGR)²⁵. In MGPP the insurer guarantees payment of pensions during a minimum number of years chosen by the worker, say 5 or 10, even if the annuitant dies before. The worker designates the beneficiary for the event of an early death. In MGR, the insurer guarantees to continue paying pensions until the cumulative sum of pensions paid equals the price of the annuity (initial premium) in nominal terms, even if the annuitant died before. Annuitants are also allowed to change heirs after the contract starts operation, except in cases where adverse selection might occur.

It is possible to add bequest clauses to annuity contracts in a wide variety of forms, with certain or contingent amounts and any desired timing. Thus, the bequests offered by annuity contracts are superior to the single bequest profile offered by the programmed withdrawal. In addition, part of the demand for bequests may be satisfied by inter-vivos transfers.

(b) Timing of premium payments. Our discussion has assumed that the annuity is purchased with a lump sum at retirement and starts paying immediately. An alternative is

²⁵ Black and Skipper (1994).
for the worker to buy an annuity with a lump sum paid to the insurer before the annuity starts paying, and invested by the insurer in the meantime. The date at which payments start can be chosen by the worker, either at purchase time or later on. The extreme opposite alternative if for payment to occur after the annuitant dies. For example, in a reverse mortgage the individual obtains an annuity in exchange for bequeathing his or her property to the insurance company.

More generally, an annuity can be purchased with many small installments distributed over time, such as the contributions of each year.

(c) Pension age and deferred annuities. Individuals are uncertain about when will they want to start to receive pension payments, because they are unsure about when they will wish to retire. Therefore, workers value the option to choose between early and late pensions.

However, this flexibility is desirable only if adverse selection is properly taken into account. This is because there are two extreme ways to achieve this flexibility. In the saving method, the insurer invests the premiums but the worker refrains from locking into an annuity, until the time in which he actually wants to start receiving a pension, keeping open the option to ask for a lump sum withdrawal until that date. At that point he decides whether to purchase an annuity, and if so, buys a single premium immediate annuity.

The alternative is to buy a deferred annuity much younger, say at age 50. The deferred annuity specifies a table of ages and pension levels, indicating the pension level that will apply for each age in which the individual may ask for payments to start. The amount of the pension rises with the pension age chosen, in order to keep constant the actuarial cost of the annuity. The crucial aspect of a deferred annuity is that the individual locks some share of his wealth into annuity-type payments at an early age, abandoning the option of increasing the share of his wealth withdrawn as a lump sum (or in several lump sums or in the form of bequests). The precise type of annuity can be selected later.

The principal difference between saving and deferred annuities is that deferred annuities are less vulnerable to adverse selection, as explained in section 6 below, and thus are less expensive for workers (Brugiavini, 1993). Another difference is that choosing a deferred fixed annuity implies larger demographic and investment guarantees than in the saving method, so are more expensive on this count.

A third difference is that buying deferred annuities now implies taking timing risk, because the worker does not know whether annuity rates will improve or worsen thereafter. This is mitigated in mixed approaches where the insurer offers a schedule of annuity prices, but also allows the individual to opt for a lump sum withdrawal.
Deferred annuities must also accommodate the fact that individuals go on saving for old age after the purchase date (say age 50), so the size of the annuity that they will actually be able to afford at age 65 is unknown as of age 50. To accommodate this, deferred annuity contracts in the United States specify a table of conversion factors by age. These factors indicate the amount of pension per unit of actual final savings, for each age in which the individual may ask for payments to start.

(d) Partial retirement. Many older workers do not wish to withdraw from the labor force at one stroke, but prefer to take up part-time jobs until they become much older. In this case, workers might prefer to start with a reduced pension to be increased later. Deferred annuities can provide the desired time profile of payments by the simple method of allowing the worker to switch on each tranche of their pension at different ages. The conversion factor for each tranche depends of the age at which is turned on, and the table of conversion factor is set at the age of purchase of the deferred annuity.

It is easy to accommodate the reduced financial needs of those who reenter the labor force: the worker just has to spend the excess pension amounts buying additional tranches of deferred pensions.

(e) Escalation, price indexation and wage indexation Some workers prefer a constant annuity and others prefer a falling or growing annuities. Annuities provide the flexibility to choose any escalation factor, which may even vary over time in a predetermined way, provided that the expected value of total payments is kept constant.

Indexation is different because it requires the escalation factor to vary in a way that cannot be predetermined at the time of purchase. Instead, the escalation factor tracks some random variable according to a predetermined rule. Variable annuities provide this service, as they allow the worker to choose the random variable according to which his pension will be adjusted.

For example, real or "price-indexed" annuities follow the actual realizations of the CPI. To obtain this return pattern, the worker may choose a variable annuity where the underlying portfolio are CPI-indexed fixed-income bonds. If the insurer guarantees that the duration of the portfolio will always remain the same as the duration of expected liabilities, it is in effect offering a fixed real annuity.

Of course, CPI-indexed or "real" annuities pay an initial pension that is smaller than the one paid by a constant nominal annuity, but the latter pays less if the pensioner survives to an advanced age. Because of this, it has been argued that it is not clear that workers are better off with CPI-indexed pensions (World Bank, 1994, p. 330). This is a
mistake, because as long as workers are risk averse, they are better off with a falling CPI-indexed annuity (escalation factor less than one) than with a nominal annuity, which is subject to inflation risk.

Wage-indexed annuities are harder to produce in the financial market, unless the government or other entity issues bonds indexed to average real wages. In the meantime, a variable annuity invested in an underlying portfolio built of equities and bonds issued by corporations that cater to the consumer good sector might offer good tracking performance. Such a variable annuity allows the pensioner to receive an income that is closer to being constant relative to average wages than a fixed real annuity.

4.6 Timing risk and portfolio freedom

As mentioned before, many authors have argued that a weakness of defined contribution pensions that impose a deadline (such as a fixed pension age) to buy an annuity is that they may force the worker to transform his accumulation at the wrong time, say when annuity rates are relatively high.

We argue that this "timing" risk is not due to the deadline to buy annuities, nor a weakness of the defined contribution pension approach, but a result of allowing workers the freedom to reallocate their portfolio. To see this, assume that the accumulation is partly invested in equities, and that the pension system forces workers to transform it into an annuity. However, imagine that the annuity is a variable annuity (explained in detail 4.2) which is invested in the same portfolio as the accumulation. It is clear that the fixed conversion date (deadline) does not expose the pensioner to any further investment risk, because the changes in price of both portfolios are perfectly positively correlated\(^{26}\).

Moreover, drops in the prices of underlying equities are unpredictable: no one knows whether a drop in prices is "temporary", or whether a rise in annuity rates is temporary.

As long as the worker does not have the right to change portfolio, he does not suffer timing risk. This is the case in defined-benefit pensions, because pensioners are not allowed to participate in the profits from exceptionally good investment decisions made by the plan sponsor or, in the case of fixed annuities, by the life insurance company. Although defined benefit plans eliminate timing risk for the worker, this comes at the cost of eliminating the upside in investment risk. What is a timing "risk" for some may be a timing "opportunity" for others. The freedom to reallocate a portfolio allows workers to

\(^{26}\) This argument can be extended to cover the risk that annuity conversion factors just increased temporarily, by replacing the variable annuity for a CREF annuity (see below).
move away from the efficient frontier but, if the frontier is shifting, also allows them to remain close to the efficient frontier risk. Timing risk could be eliminated from defined contribution plans provided that: (i) workers are forced to choose a single benchmark portfolio when they enter the pension system. Members can be allowed to switch between trustees and fund managers, but only among the funds that follow the initial benchmark portfolio; and (ii) the allowed pension formulae passes along to pensioners the investment risk of the underlying portfolios (this implies that all pensions must be of the variable annuity type, so other payout methods, such as fixed annuities and lump sum withdrawals are prohibited).

The South American AFP systems meet the first condition currently, because each AFP is allowed to manage a single fund, and the natural benchmark uses by workers to compare AFPs is the average return of all AFPs. However, the second condition is not met, as workers are allowed to switch to a fixed income portfolio by buying a fixed annuity. In Mexico, the first condition will not be met once fund managers begin to offer several funds each.

However, it is not clear that elimination of timing risk is desirable. Many workers change in their degree of risk aversion as they age or as they learn. Such workers may be willing to bear some timing risk in order to obtain the portfolio they want. If portfolio adjustment is deemed necessary because older pensioners become more risk averse, but the financial prowess of most workers is in doubt, it appears natural to delegate the task of managing timing risk to professional portfolio managers. Workers as of age 50 could be given the option to buy a "portfolio adjustment" service, for which they would have to pay an appropriate performance fee. Such management contracts might be the default option. For workers that insist in managing their portfolio freedom on their own, it appears useful to consider a regulation to reduce the size of the gamble taken each time they reallocate their portfolio. This regulation could limit the amount of reallocation to a maximum percentage of the portfolio per year, say 10%. Such a limit assures diversification of the timing risks and also accommodates changing risk aversion of members.

A mistaken diagnosis may lead to ineffective policies. The British authorities introduced in 1995 a temporary programmed withdrawal option in the personal pension system to allow workers to limit the "timing" risk. Pensioners are allowed choose to defer their purchase of an immediate annuity, provided that they take the programmed withdrawal in the meantime, and provided they are younger than age 75. This was allowed in Chilean AFP system since 1981, with no age limit. In our view, these
measures are likely to be ineffective regarding timing risk, because a change in portfolio has to be made anyway and changes in asset prices are unpredictable.

Chile also allowed further combinations in 1988 (and Peru in 1993) by introducing a hybrid pension option in which the worker chooses a temporary programmed withdrawal to be continued by a deferred annuity bought at the time the programmed withdrawal started. This hybrid plans allows workers to lock in what they deem to be favorable annuity rates, but this implies betting on timing risk. The Chilean Superintendency proposed in 1996 to open the option to switch to a short term fixed income portfolio up to 5 years before the regular pension age of 65. All these measures are ineffective in eliminating timing risk, because a change in portfolio is made anyway.

5. Should lump sum withdrawals be allowed?

These final two sections analyze government policy towards pension design, including issues of adverse selection. When a worker retires from a mandatory pension system, the range of payout options he may be allowed runs from lump-sum withdrawals to programmed withdrawals and CREF annuities (see Chart 1). The considerations involved in these decisions are numerous, and the literature on this topic is in its infancy. In the survey that follows we identify two questions: should lump-sum withdrawals be allowed? If the previous question is answered with a negative, then should the programmed withdrawal be allowed?

Lump-sum withdrawals give complete freedom to the worker regarding dispersion of his life-long savings. In contrast, programmed withdrawals limit the rate at which the funds may be consumed. As shown in section 4.4 the programmed withdrawal formula is restrictive for preferences with $s \geq 1$, i.e. for those less risk averse, and also for those with high utility discount rates.

5.1 International practice

Lump-sum withdrawals are not allowed in the mandatory pension systems in Western Europe, Japan, the United States, Canada, Eastern Europe, the former Soviet

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27Some authors have argued that this hybrid allows workers to insure their individual longevity risk without buying investment guarantees for the temporary period in which a programmed withdrawal is received (Superintendencias, p. 134). This is a mistake, because the same result can be obtained if the worker chooses a programmed withdrawal and later on buys an immediate annuity.
Union, the Middle East. They are not allowed either in most of the old systems in Latin America, which pay benefits solely in the form of pensions. There is an ILO recommendation not to pay lump-sum benefits.

The other extreme is given by provident funds. One of the defining characteristic of provident funds is that they allow withdrawal of 100% of the accumulated savings in the individual account in a single lump sum. Another characteristic is that individuals are not offered an annuity or programmed withdrawal option by the social security institution, but rather must buy it by themselves in the financial industry, if available.

Provident funds were set up by the United Kingdom in its former colonies, including India, Indonesia, Malaysia, Singapore, Sri Lanka, Nepal, Fiji, Kiribati, Western Samoa, Solomon Islands, Nigeria, Tanzania, Kenya, Zambia, Uganda, Swaziland, The Gambia, Barbados and Trinidad-Tobago28. These schemes vary enormously in coverage and the real rate of return earned. Only the provident funds in Malaysia and Singapore have substantial national coverage and have paid a positive real rate of return, although below the one available in the local financial market. In most of these schemes, the accumulation can be withdrawn as a lump sum at age 55. In the Hong-Kong pension scheme to be implemented in 1998, the full amount of the accumulation is paid as a lump sum at age 65.

The intermediate cases are the following: In Singapore, workers are required to purchase a minimum pension before drawing the remainder of the balance (World Bank, 1994, p. 226).

In Australia there is a two-tier social security system. The "age pension" pays a flat benefit to some 60% of the elderly population. This benefit is means-tested and it is financed from general revenue. On top of it, Australia introduced in 1993 the Superannuation Guarantee, a mandatory pension system that aims to finance earnings-related pensions (non-means-tested), on a defined-contribution basis. The Superannuation Guarantee pays a single benefit: a lump-sum when the individual worker reaches age 55 (which is being increased to 60 by 2020).

In the UK, the personal pension option allows to take up to 25% of the fund in a tax-free payment, at the date of retirement.

The AFP systems of Argentina, Chile and Peru allow retirees to withdraw a lump sum, provided the balance in the individual account is high enough as of the date of pensioning. The amount of this "free-disposal surplus" is the difference between the balance in the individual account and a reference sum fixed by legislation. In Argentina,

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the reference sum is the largest between 70% of the average taxable amount reported by that individual during the previous five years, and three times the universal basic pension\textsuperscript{29}. In Chile, the reference sum is the largest between 70% of the average taxable amount reported by that individual during the previous ten years and 120% of the minimum pension. In Peru the reference sum is 80% of the average taxable amount reported by that individual during the previous ten years (Superintendencias, 1996).

In addition, many occupational pension plans, organized by employers, pay benefits as a single lump sum, or at least offer it as an option. This is also the case in third pillars, where voluntary savings can be withdrawn as a lump sum, but paying a tax penalty.

5.2 Taxpayer protection and higher national saving

This section reviews two arguments that are used frequently to justify a prohibition of lump-sum withdrawals.

(a) Protecting taxpayers. The notion is that as long as workers receive an annuity, they will not be able to qualify for social assistance and future taxpayers will be safe from the claims of older poor people.

This argument is sometimes spiced by adding that some wily poor workers may spend too fast to take advantage of the social assistance net provided by taxpayers. Of course a truly wily worker does not have to make himself poor, but just appear to do so, by transferring his wealth to relatives or out of sight from the state. It has been argued that this is the case in Australia, where a many workers that receive lump-sums from their occupational plans find ways to become eligible for the age pension, even though it is means-tested, a practice called "double-dipping" (Bateman et al, 1992).

Taxpayer protection has deeper implications than just prohibiting lump-sum transfers. Another implication is that as long as a pensioner can finance by himself a pension that is high enough to keep him ineligible for social assistance, he should not be forced to contribute. This is precisely the design of the Colombian AFP system, introduced in 1994. In Colombia there is no mandate to build up of savings large enough to pay an earnings-related pension. Instead, workers become free from the mandate to contribute when their accumulation can buy an immediate pension equal to 110% of the minimum pension (Ayala, 1995). This approach could be extended by setting workers

\textsuperscript{29} In addition, the free-disposal amount cannot exceed 500 times a universal basic pension.
free from the mandate to contribute when their accumulation can buy a deferred pension starting at age 65 at least as large as the minimum pension.

Even when the state makes the mistake of forcing someone to save more than the amount needed to protect taxpayers, the second best policy is to allow the individual to withdraw as a lump sum all the surplus over that amount. This explains an aspect of the design of the other South American AFP systems, where lump sum withdrawals of "surplus" savings are allowed only if the remaining amount is enough to finance a basic or minimum pension.

However, the taxpayer protection argument has been questioned by those that point out that future taxpayers are free to be generous towards the poor (old or young), and it is inappropriate to force someone to buy himself a pension only to "protect" other individuals from being stimulated to be generous in the future (Ferrara, 1980). Moreover, it has been argued that taxpayer protection helps the rich (who will pay more taxes in the future), while the workers that are credit-constrained and forced to save are poor, so this policy is regressive. Maybe the government should spend more in enforcing the means-tests in its social assistance safety net for the old rather than attempt to protect taxpayers in this round-about way.

(b) Increase national savings. It has been argued that a prohibition of lump sum withdrawals delays spending of mandatory savings, increasing the stock of financial assets owned domestically, as compared with an option like a lump sum payout at some set age. This prohibition is indeed effective in increasing savings if the financial market puts some constraints on the amounts of unsecured consumer debt each individual may issue.

However, increasing savings cannot be the ultimate aim of economic policy. Forcing higher saving could reduce national welfare, in addition to redistribute welfare inequitably.

5.3 Flexibility versus paternalism

In this section we discuss what seems to be a basic tradeoff, between flexibility and paternalism. It is thought that many workers that are myopic when young continue to be myopic when old. One hypothesis is that irresponsible workers prefer to spend all their savings during their late 60's even if that means falling into poverty afterwards. Thus, benevolent legislators should help them by mandating some sort of phased payout (programmed withdrawals or annuities). Another argument in the same line is that since
workers were already forced to save large amounts, legislators and the state is obliged to assure an orderly and efficient disposition of those assets, preventing the losses caused by myopic behavior.

The paternalistic streak in mandatory social security also appears in the bequest area, which is represented by survivors' insurance. Such insurance does not limit itself to create an estate that would be allocated according to the desires of the bequeathing worker. To the contrary, it usually forces the worker to allocate the estate in the form of survivor pensions - not lump sums - and to the beneficiaries identified by the law - and nobody else.

Paternalism is consistent with the practice in Argentina, Chile and Peru of allowing a free-disposal surplus if the remaining amount is enough to finance an earnings-related pension, defined as a proportion of average past individual wages. This requirement assures that the apparent past standard of living is preserved even for myopic workers.

On the other hand, allowing lump-sum withdrawals allows individuals maximum flexibility to adapt their financial resources to their particular needs. For example, an individual may need a lump sum to pay a health treatment that will improve his quality of life, or may want to help relatives or friends in distress.

Other workers may want to start a small business in which they can earn a risk-adjusted and amenities-adjusted rate of return which is much better than the one available in the financial markets. This may be particularly important for the feasibility of plans to retire gradually from the labor force.

However, these same arguments can and have been used to attack the mandate to contribute during the working years. It appears difficult to reconcile a justification of a mandate to contribute with this defense of the freedom to withdraw the resulting savings in a lump sum.

One compromise is to reduce mandatory contributions and aim for a relatively small replacement rate. This can be achieved by reducing the contribution rate (a percentage of taxable salary) or by reducing the taxable ceiling, or both. As the relative significance of mandatory savings falls, the authorities can reduce flexibility in the payout formulae and limit the payout options more strongly, knowing that flexibility can be attained anyway by disposing wisely of voluntary savings. Only in this setting paternalism could justify prohibiting lump sum withdrawals in most cases. A concrete rule could be to allow a worker to take free-disposal surpluses only if his accumulation can finance a pension larger than some fixed replacement rate, expressed as a percentage of a representative number of his taxable wages.
At this point it is useful to raise the related issue of whether a paternalistic pension system should allow workers to get a pension as early as they wish. Conventional defined-benefit pension systems with salary-based benefit formulae have treated the early retirement issue by applying less than actuarial reductions to early pensions, creating implicit subsidies to early pensions. Actuarially equitable systems strip those implicit subsidies away, and must face the underlying tradeoff between paternalism and flexibility.

The cost of freedom to ask for an early pension is that myopic workers may be enticed by the promise of a "double salary" for ages 55-65 (approximately), implying a substantially reduced standard of living after age retirement. The benefit of granting workers this freedom is that they get the flexibility of choosing the degree and timing of their withdrawal from the labor force. Again, it seems difficult to reconcile total freedom to pension early with a mandate to contribute, which causes the same types of cost.

Early pensions are related to lump-sum withdrawals because one way to spend a projected free-disposal surplus as of age 65 is to start a pension at an earlier age. Thus, a compromise between paternalism and flexibility could be approached in the same way as for lump-sum withdrawals: an early pension would be allowed only if the accumulation can finance a pension larger than a fixed replacement rate of a representative number of his taxable wages, using the same percentage as for lump sum withdrawals.30

In order to coordinate these rules with the mandate to contribute in a consistent way, that mandate should be suspended when the accumulation becomes large enough to finance a deferred pension starting at age 65, which is larger than a fixed replacement rate, using the same percentage as for lump sum withdrawals.

### 5.4 Technical difficulties in prohibiting lump-sum withdrawals

Consider a case where many workers want at least a portion of their savings back as a lump sum, either because of a good reason or just because they are myopic. It turns out that a fixed annuity option combined with free individual pricing of annuities allows them to get their way. This has been found to be the case in the annuity market in the Chilean AFP system.

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30 This "same percentage" rule is not currently applied in Chile. The percentage for a lump sum withdrawal is 70%, while the percentage for an early pension is 50%.
To see this, we must explain first why most - but not all - annuity contracts are long-term, or more precisely, irrevocable. If annuity contracts were reversible, at any moment an annuitant might choose to surrender his contract to the insurer in exchange for a lump sum, equal to the liability to him recognized in the insurer's balance sheet. However, reversible annuities are vulnerable to adverse selection. An annuitant that becomes afflicted with a mortal illness that takes some time to come to an end will have a large financial incentive to surrender his annuity contract during that period. By doing this he can obtain a lump sum based on average survival probabilities, while if he keeps the contract the expected payments are just those based on his own survival probabilities, which have just fallen due to the sickness. The financial incentive to surrender is substantial\(^{31}\). To prevent this type of adverse selection, annuities are irrevocable, which means they are long-term contracts.

Given the long term nature of the contract, it is an easy matter to attach a lump-sum withdrawal to an annuity. The insurer must simply reduce the annuity amount to an individual that asks for a lump sum amount, which in effect is the principal amount of the lump-sum withdrawal\(^{32}\).

If regulations do not allow the company to pay out a lump sum directly to the pensioner, as happens in Chile, the company can pay the lump sum as an extra commission to a free insurance agent, who in turn passes it on to the worker. The worker is then willing to accept the reduction in his annuity amount. This is current practice in the Chilean AFP system (Martínez, 1997), where reported commissions to free insurance agents have reached in some cases the range of 8-9% of the accumulated savings at pension age. Apparently, the pure intermediation cost is close to 1.5% of the accumulated savings at pension age, on average.

This indirect mechanism is not identical to a lump-sum withdrawal for two reasons. First, reserve regulations introduced in 1988 force insurers to finance the lump sum payment with equity capital, not with the cash income. Thus, the Chilean lump sum might be best called a consumer loan, due to the implicit margin charged by insurers. Second, the consumer loan is kept by the insurance agent if the pensioner does not know about it. This latter outcome is highly inequitable and suggests that Chilean regulations will be reformed.

\(^{31}\) This can be avoided in theory by allowing the insurer to reevaluate the risk (the mortality table) of any annuitant who seeks surrender. In this setting the insurer has an incentive to cover itself by assuming the worst, which implies a very low surrender value. This is equivalent to make the contract irrevocable.

\(^{32}\) In the case of an irrevocable CREF annuity, the management company can finance the consumer loan by increasing the commissions charged on the pension.
It must be noted that the current level of such hidden consumer loans in Chile is reduced by the fact that the pension paid to each worker must be larger than 50% of the average taxable salary of that worker, unless he is above age 65 (men) or 60 (women), and most are below those ages (see Table 1). It is likely that if this limit did not apply, commissions to free insurance agents would be higher than 8-9%.

Among the methods to avoid this outcome, the following are available:

(a) authorize lump sum withdrawals. If the worker is not informed, he is spared from the loss of the loan to the insurance agent. Even if the worker is informed, he is spared the margin charged by insurers on consumer loans. The objection to this approach is that the paternalistic concerns described before are abandoned.

A compromise might be achieved if the lump sum withdrawal is limited to a percentage of the accumulation. For example, in UK personal pension plans, 25% of the accumulation can be withdrawn in a single tax-free amount. A problem with this approach is that it does nothing to prevent a worker from withdrawing more than the maximum authorized percentage, as the indirect procedure observed in Chile is still wide open.

(b) rely on the limit on early pensions. The Chilean Association of Insurance Companies (AIC) proposed recently a different compromise, based on the early-pensioning option. Early pensioning is allowed in the Chilean AFP system for those that can buy an immediate annuity which is at least as large as 50% of the average taxable wage over the last ten years. Thus, one way to spend a projected free-disposal surplus as of age 65 is to start the pension at an earlier age. This implies that those "myopic" workers that want a free-disposal surplus as soon as possible can get it in the form of an early pension.

According to the AIC compromise, the amount that would be required to remain in the account after a free-disposal surplus is paid would be reduced from the current level based on a 70% replacement rate, to make it the same to the amount required for early pensioning, which is based on a 50% replacement rate. Thus, workers that did not get a pension as early as they could are given the right to ask for all the excess accumulation in the form of an explicit lump sum withdrawal (Martínez, 1997).

This compromise relies entirely on the limit on early withdrawals, which is not vulnerable to consumer loans because it is defined as a minimum replacement rate. The

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33 Of course, the common replacement rate might be set at 70% rather than 50%.
problem is that the compromise does not deal with the issue of consumer loans to workers that do not get an early pension. After the legal age is met, the minimum replacement rate for annuity purchasers is the minimum pension. Thus, workers that are unable to get an early pension can still obtain a substantial consumer loan. Moreover, workers that might get an early pension can choose not to do so but wait until the legal age, and then ask for a large consumer loan equal to the excess funds after purchasing an annuity sized as a minimum pension.

(c) restrict the freedom to price annuities. This approach would attempt to prevent unusually large drawdowns by requiring - for example - that the internal rate of return of each annuity sold be above some minimum linked to current long-term market interest rates. Such a minimum internal rate of return would not consider payments to insurance agents as payouts and would be based on official mortality tables.

This approach implies increasing government involvement in the pricing of annuities, which may increase political risk. In addition, it may be quite ineffective for technical reasons. There is evidence that lower-income workers have higher mortality, but this is unlikely to be recognized in official mortality tables because of political reasons, as is the experience in traditional pay as you go systems. Thus the annuities sold to the poor by competitive insurers should be higher than expected on the basis of the official mortality table, and they would exhibit unusually high internal rates of return even if no consumer loan is involved. This creates the space for substantial consumer loans for lower income workers, which are likely to be the most myopic.

(d) prohibit long-term contracts in pensions. This approach recognizes that significant consumer loans cannot be arranged if the pension management contract is short term. For example, the programmed withdrawal formula does not offer consumer loans. To see why, consider a worker that accepts unusually high management fees in exchange in order to get a consumer loan. The higher fees must be paid over an extended period of time to allow recovery of the consumer loan. However, as the worker can switch to a different provider within short notice, the probability of recovery is small and the management company is unwilling to extend consumer loans. Maybe this factor helps to explain why programmed withdrawals have such a small market share of the early pension market in Chile (see Table 1).

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34 This result assumes that minimum residence commitments are limited in duration or that exit commissions in the event of early exit are limited in amount.
Apparently, this option would imply that insurance of individual mortality risk would not be available. This is incorrect. CREF annuities where the management companies join a reinsurance pool for 100% of demographic risk can also operate with short-term management contracts, which make consumer loans difficult. Within such a reinsurance pool, a pensioner can switch management company with short notice, without causing adverse selection. The reason is that the savings caused by members that are starting a terminal illness benefit the pool as a whole and not just the last management companies that served them (for a detailed presentation of this proposal, see Valdés and Edwards, 1997). Such a reinsurance pool is contemplated in the new Bolivian AFP system.

This option implies restricting pension options to programmed withdrawals and CREF annuities that have joined a mortality reinsurance pool. Therefore, the cost of this option lies in that annuities that include mortality guarantees, such as fixed and variable annuities, are prohibited. The workers that are willing to pay a risk premium to obtain such guarantees could be made worse off. Although the reinsurance pool could offer mortality guarantees, it would be a monopoly supplier.

This appears to be just another facet of the basic dilemma of mandatory pensions: paternalism - in this case, eliminating consumer loans to myopic workers - versus flexibility. In this instance, the flexibility cost is compounded by restricting innovation in the area of demographic guarantees.

6. Should annuitization be mandatory?

The previous section inquired whether lump-sum withdrawals should be allowed in a mandatory pension system, and we answered mostly in the negative. This section asks whether annuitization would be mandatory in a mandatory pension system, or equivalently, whether a programmed withdrawal option should be allowed. In addition, we discuss whether pension payments should be required to be either flat or growing in real terms, prohibiting annuity contracts that pay a decreasing real amount.

6.1 International practice
Again, the countries that mandate annuitization in their mandatory pension pillars are much more numerous than those that allow a programmed withdrawal option. In the conventional state-managed defined-benefit pension system found in the European Union, Japan, Canada, the United States, Brazil, the Philippines and many other countries, the only payout option is an annuity (with a discretionary guarantee). The same happens in the funded and privately managed BVG pension system in Switzerland.

Among the countries with a mandatory defined contribution pension systems during the accumulation phase, Bolivia is the only one that mandates annuitization. This is because the only allowed options are fixed annuities and CREF annuities35 (which must join a national reinsurance pool for mortality risk). Poland is planning to mandate fixed annuities in its funded pillar. The opposite policy is followed by the AFP systems in Argentina, Chile and Peru. They do not mandate annuitization because they allow a programmed withdrawal option.

The British personal pension system, created in 1988, introduced the "pension fund drawdown" in 1995, but kept a mandate to annuitize in a limited form. The law requires pensioners in pension fund drawdown to switch to an annuity before age 75 (Planned Savings, 1996). This arrangement can also be described as allowing workers to defer the purchase of an annuity up to age 75, provided they draw a monthly amount that cannot exceed what is specified by the "pension fund drawdown" formula.

This overview shows that mandated annuitization is the general practice. It is only with the appearance of the newer privatized systems that this mandate has been questioned.

6.2 The adverse selection argument for mandating annuitization

It has been argued that if mandatory pension systems allow workers that reach pension age to choose from a menu of pension options that include non-annuitized forms of spending, such as programmed withdrawals, significant adverse selection will result, reducing the efficiency of the annuity markets and making all workers worse off.

The type of adverse selection considered here is one where workers are more informed about their own mortality prospects than insurers. This information asymmetry means that insurers must price annuities according to average mortality (conditioned on what may be observable to the insurer, such as age, sex and maybe income). But prices based on average mortality implies a relatively high price for individuals that know that

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35 The transition in that reform means that CREF annuity markets in Bolivia will not open until the year 2005.
their mortality is below the average. Some of those individuals choose not to buy an annuity and choose instead a programmed withdrawal. But then the average mortality for those that do purchase annuities is higher than for the whole group, forcing insurers to raise prices further. This generates another round of adverse selection. In the final equilibrium the annuity market performs worse than optimally.

The evidence from the voluntary annuity market in the United States has been interpreted by some observers as proving that adverse selection is a major problem. Friedman and Warshawsky (1990) report that only 2 per cent of the elderly population own individual annuities. Dollar sales (premiums) of individual annuities in 1991 were 11.5 billion were just 0.6% of dollar sales of life insurance in the United States. The small size of the voluntary market, together with the large difference in mortality rates between annuitants and non-annuitants, has been interpreted as proof of serious market failure.

However, insurers have limited the impact of adverse selection by introducing deferred and group annuities. In a formal model of the annuity markets, Brugiavini (1993) finds that deferred annuities dominate immediate annuities, in the sense that only deferred annuities are sold in equilibrium. The reason is that individuals when they are 50 have less private information about their mortality prospects at age 65 than when they are 65. In the United States, individuals with average earnings may hold up to 30% of their wealth in occupational pensions, which are deferred and group annuities.

In addition, the small size of the voluntary market for individual annuities can be explained by other factors, such as the following:
(i) Poverty. The price of an annuity that pays a replacement rate of 50% of wage income is close to the price of a dwelling. However, most lower income people of ages 60-65 simply have not saved enough money to buy an annuity.
(ii) Family annuities. The fact that children and relatives offer implicit annuities either in exchange for a bequest or just out of generosity reduces the demand for market annuities. This is specially so in areas of the world where extended families are tightly knit.
(iii) Social security. The presence of mandatory annuities paid by assistance-oriented social security, including "first-pillar" pensions and free health provision for the poor, also reduce demand for voluntary annuities.
(iv) Individual annuity prices might be high because of high selling costs. The technology for selling individual annuities is expensive, as it requires a lengthy personal explanation to each customer, usually provided by a salesperson. This has spawned the appearance of

other selling technologies, such as engaging the employer through a group plan, but these technologies coexist\textsuperscript{37}.

(v) High profit margins on marginal sales. The complexity of annuity products might preclude price competition and could allow much product differentiation. A high profit in each additional annuity contract is compatible with free entry and normal returns for the marginal insurer if that profit is dissipated in high search costs and mobility barriers that prevent new entrants from reaching the markets served by incumbents. The high degree of price dispersion reported by Friedman and Warshawsky (1990) supports this view of the voluntary annuity markets\textsuperscript{38}.

(vi) Investment and demographic guarantees are too expensive. Annuities include contractual guarantees for investment and demographic risk, which might be in short supply at the prices that retirees are willing to pay. On the other hand, it is generally thought that pensioners are indeed risk averse, so they would be willing to pay substantial premia. This is discussed again below.

This literature does not take into account that adverse selection should be smaller in mandatory pension system as compared to voluntary annuity markets, because of the following three reasons:

a) A mandatory pension system attacks directly one of the explanations for the small size of voluntary annuity markets: that many workers reach retirement with little savings with which to buy an annuity.

b) A mandatory system reduces adverse selection by providing information. Risk classification according to income is easy in any mandatory pension system which allows workers to buy annuities at retirement, because the account balance is a very good indicator of lifetime income and is immediately available to insurers\textsuperscript{39}. It should be noted that when insurers classify risks according to income they prevent the regressive wealth redistribution associated to a merger of the mortality tables of low and high income groups.

\textsuperscript{37} Jan Walliser reports that commission for insurance agents in the state of New York are around 7\% of the annuity premium (price), in private communication.

\textsuperscript{38} The accounting data for the United States for 1989-91 reported by Valdés (1994) shows that sales cost plus other costs and accounting profits were 17.4\% of premiums of individual annuities and only 7.1\% of premiums for group annuities.

\textsuperscript{39} To see the importance of this factor, Walliser (1997a) reports that in his simulations women are subject to adverse selection loads that are 20\% below those of men, and he attributes this to the lower variance in the factors determining survival, especially income, for women.
c) A mandatory pension system provides information about who is about to buy an annuity, allowing many insurers to reach each worker at the same time. The resulting competition may be less subject to product differentiation than the small voluntary annuity market in the United States, leading to smaller margins and better prices.

The empirical evidence from Chile supports the notion that adverse selection is a minor issue in mandatory pensions systems. In that country, a large proportion - 64% in 1996 - of those that retire in the AFP pension system choose immediate annuities, 3% choose deferred annuities and only 33% choose programmed withdrawals (see Table 1). Even in the segment of the market where the law requires low-income pensioners to choose the programmed withdrawal, the market share of immediate annuities is 37%.

<table>
<thead>
<tr>
<th>Table 1: Market share of pension formulae: Chilean AFP system 1996</th>
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<td>(flow market share: change in stock of live pensioners)</td>
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<tr>
<td>Immediate Annuities  Programmed Withdrawal Temp. P.W. + D. A.</td>
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<tr>
<td>(number)           (number)                             (number) (number)</td>
</tr>
<tr>
<td>Total change       Im. Annuity Mkt. Share (%)</td>
</tr>
<tr>
<td>(number)           (number)                             (number) (%)</td>
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42
To see the impact of such a large participation of annuities, assume that Chilean pensioners exhibit the same dispersion of mortality rates as those in the United States, where the 1% that buys annuities have a mortality rate which is half of the population mortality (Mitchell et al, Table 2). Assuming a normal distribution of mortality rates we can infer the standard deviation of mortality, which turns out to be 21.5% of the mean. This implies that the 37th percentile of lowest mortality will have a mortality rate just 8% below the mean, and on average, annuitants may have a 15-20 percent lower mortality than non-annuitants. The difference in mortality is even smaller for orphans and vanishes for early pensions. This shows that in mandatory systems the inefficiency associated to adverse selection affects substantially fewer people than in the U.S. market and costs less for each affected person.
The adverse selection that might remain in a mandatory pension system where programmed withdrawal is an option can be reduced further by allowing group annuities organized by employers and by allowing individual workers to sign deferred annuity contracts much before retirement, say as of age 50. Thus we conclude that adverse selection does not justify mandating annuitization.

6.3 Taxpayer protection and increasing national saving

It may be argued that annuitization should be mandatory to protect future taxpayers from the demands of the workers that choose the programmed withdrawal option and turn out to live more than expected, and thus have their pensions reduced to very low levels (see section 4.4). In addition, some wily workers might choose the programmed withdrawal option over annuities precisely because they can draw on taxpayer support if they die late and leave a higher expected bequest to their own families if they die early. As mentioned before, the taxpayer protection argument has been questioned on the grounds that it leads to regressive policy.

An alternative route that avoids this criticism is to improve enforcement of the means-test in the social assistance safety net for the old, for those individuals that choose the programmed withdrawal. One way to do this might be to legislate that those that choose the programmed withdrawal option be subject to a bequest tax related to the expected value of state support they might receive if they survive too much. This tax would be charged to the account balance at death. In this way, those that die early would be able to leave a smaller bequest, and would finance state support for those that die late. With such an amendment, the programmed withdrawal could not be used to exact more taxpayer support.

It has also been argued that the promotion of national saving requires at least to avoid a mandate to annuitize. The programmed withdrawal option leaves uncertainty about of date of death with the worker, which might induce him to increase voluntary saving for the precautionary motive. However, if individual mortality risk induces the worker to save more, he can easily avoid this sacrifice by purchasing an annuity. Thus, taking this argument seriously really leads to prohibition of annuitization and allowing just programmed withdrawals. This policy is likely to reduce welfare, even if national saving is increased.

6.4 Forced purchase of guarantees
When a mandate to annuitize takes place in a context where the menu of admissible pension contracts is also tightly regulated, as is the case of Argentina, Chile and Peru, then the combination of both restrictions might impose significant costs.

For example, if only fixed annuities are allowed, then a mandate to annuitize means that workers are forced to purchase investment and demographic guarantees, whose supply price might be higher than willingness to pay, as discussed in section 3. If discretionary guarantees are allowed, then moral hazard may create new costs, as explained in section 3.

In that context, a non-annuitized option such as the programmed withdrawal is an escape valve. It allows individuals an option to avoid the purchase of investment and demographic guarantees. This, combined with the danger that an uninformed worker might lock himself into a costly option for life, were among the reasons that induced Chilean legislators to introduce the programmed withdrawal option in the AFP system (Piñera 1991, p. 69; Büchi 1993, p. 114).

A more efficient way to achieve the same result is to allow variable annuities and CREF annuities. As these annuities do not include guarantees for investment returns nor for demographics, their supply price is not influenced by the cost of providing such guarantees, and the cost of uninformed decisions is limited. On the other hand, as CREF annuities diversify the individual mortality risk, they should be preferred to programmed withdrawals by all risk-averse individuals.

### 6.5 Redistribution through actuarial regulation

Up to this point, this section has found that a mandate to annuitize is costless as long as some safeguards are taken, such as allowing variable annuity and CREF annuity options. In this context, a paternalistic concern for "myopic" workers implies prohibition of both decreasing real annuities and of programmed withdrawals.

However, this section discusses whether the authorities may use their role in determining mortality tables to redistribute wealth among annuitants. It has been argued that allowing workers a non-annuity pension option offers them refuge from non-benevolent redistribution.

The government must intervene in the area of mortality tables because they are an essential input for solvency regulation for fixed and variable annuities, who guarantee demographic risk. In addition the guarantee funds that reinsure defined-benefit plans impose minimum standards on the mortality tables used by the plans (Smallhout, 1996). Now we consider non-benevolent uses of this power.
First, the authorities may choose to "invent" an artificial mortality table with the aim of benefiting a particular group, which may or may not be deserving. For example, an artificial mortality table may be issued to value liabilities caused by fixed annuities sold to workers with more than 20 years in coal mining. This table would be artificial in the sense that it is not based on hard actuarial data about that particular group. In order to benefit this group, the table must be artificially pessimistic, assuming excessive mortality rates\textsuperscript{40}.

Second, the authorities may impose "price equality" regulations, which involve artificially merging the mortality tables of distinct groups. As an example, assume that the authorities force insurers to charge the same to men and women of the same age and smoking condition. This is a form of price discrimination, as it treats unequals (with respect to mortality) as if they were equals. In fixed, variable and CREF annuities, this regulation forces redistribution between men and women annuitants, but the insurance or management company does not suffer. As usual, this redistribution of wealth comes at the cost of some distortions, such as incentives to rely more on salespeople because they can be directed to reach the more profitable clients (men) rather than the loss-makers (women).

Thus, it is a fact that the authorities can redistribute wealth by manipulating the mortality tables that are used in annuities. However, redistribution is also feasible in the programmed withdrawal formula. A law may be passed that taxes the account balance of all those workers in programmed withdrawal, and it may direct the revenue to supplement the pensions or even the individual account balances of the deserving groups. So, programmed withdrawals do not offer refuge for the taxed groups.

However, taxes on programmed withdrawals must be more transparent regarding the taxes and subsidies involved - closer to explicit taxes and transfers financed with general revenue - than manipulation of mortality tables. If the redistribution achieved is socially desirable, then it should withstand a transparent public discussion.

Thus, for some political processes allowing workers a non-annuity pension option could serve the role of forcing a transparent discussion of such issues. For political processes in which the taxed groups are well represented, the difference in transparency may be small. In this latter case, the conclusion of this section is that a mandate to annuitize can be made costless if the appropriate safeguards are taken, and that a

\textsuperscript{40} Valdes and Edwards (1997) argue that, because of competition and other adjustments, such an attempt to redistribute wealth is ineffective in the case of fixed and variable annuities, but is counterproductive in the case of defined benefit occupational plans and CREF annuities.
paternalistic concern for "myopic" workers implies prohibition of both decreasing real annuities and of programmed withdrawals.

6.6 Paternalism and prohibition of decreasing real annuities

Annuitzation provides higher welfare that programmed withdrawals for all risk averse individuals, so one might think that annuities would enjoy unanimity.

However, consider the case of an individual that prefers to consume more in the present than in the future. This implies that he prefers an annuity whose size decreases over time, i.e. an escalation factor smaller than 1.0. But if the government prohibits decreasing real annuities, either because of paternalistic concerns about "myopic" individuals that wish to dissave too rapidly, or because of fiscal concerns about too many old people relying on the minimum pension, a programmed withdrawal may find demand.

A "myopic" consumer that does not have a demand for bequests would still prefer a flat real annuity over a programmed withdrawal. The reason is that the programmed withdrawal pension starts at the same level as a flat annuity (compare (2) and (5)), but the former drops subsequently if the pensioner survives. The flat annuity pays a higher level of pension in all periods except the first, in which the two pension amounts are equal.

However, a "myopic" individual that wants both to consume rapidly part of his wealth, and also to leave the remainder of his wealth as a bequest might behave differently. If he could choose freely, he would select an annuity combined with bequests, where the part of his wealth devoted to consumption would pay a decreasing real annuity, while the part of wealth devoted to bequests would be tailored to his wishes. But if he is forced by the government to buy only flat real annuities, he might be willing to sacrifice part of his desired pattern of bequests in order to improve (from his "myopic" point of view) his pattern of consumption. In this case, he might prefer the programmed withdrawal.

The implication is that a paternalistic government that prohibits decreasing real annuities should prohibit programmed withdrawals as well. If it does not do so, then programmed withdrawals may offer an escape route for individuals that want to consume relatively more in the present and at the same time wish to leave some bequests. Thus, paternalistic concerns recommend the prohibition of programmed withdrawals, in addition to requiring annuities to be either flat or growing. In the Chilean AFP system, there is a regulation on annuities prohibiting decreasing real pensions. This is inconsistent with allowing the programmed withdrawal, which on average also pays a decreasing real pension.
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Appendix: Description of Tontine-like annuity contracts.

A tontine is a contract in which a number of people invest some amount into a partnership, which must reinvest the funds for a number of years, say 20. When that term expires, the proceeds are divided prorata between the surviving partners. Thus, each partner is betting that he will live at least 20 years and the others will not. This class of contract was invented by Italian banker Lorenzo Tonti and was first proposed as a form of public debt to the French Parliament in 1653 by Cardinal Mazarino to shore up Louis XIV's finances (Salas, 1957). It was first implemented in 1689 as a form of public debt and subsequently became popular all over Western Europe (Espasa-Calpe, 1928). Historically, the tontine was the first contract that applied the law of large numbers to life contingencies.

In the annuity version of the tontine, the annuity pays out as a pension just the accrued interest on the aggregate investments, dividing it prorata among survivors. The pension for each survivor increases in amount as partners die. If the management company (the government) gets back the total capital when all die, then it must offer some supplement to initial pensioners to make the deal attractive. Alternatively, the tontine is renovated with new generations of members and lasts indefinitely.

Tontines are excluded from Chart 1 because they are bets or gambles in addition to being annuities. For any additional year of survival the tontine does not pay just the amount needed to cover the additional living expenses associated to surviving, but pays more. The excess is the prize in the implicit betting game.

Tontines have been outlawed in most developed countries due to several reasons. First, the betting aspect of tontines generates perverse incentives that may induce assassination. Second, their regulation is part of more general efforts to tax or regulate gambling. Third, tontines have a reputation of being scams because in many cases were badly designed and fell prey to adverse selection. For example, it was common that they accepted members of different ages charging the same premium. In several cases tontines were tied to pyramid-like scams, although this is not a logical necessity.

The programmed withdrawal formula behaves like a tontine when there are two or more participants in the pool. When a worker is mandated or chooses to buy a joint pension for the spouse, and it is calculated with the programmed withdrawal approach, the death of one member of the couple leads to an immediate increase in the pension of the surviving member.

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41 Apparently he took the idea from charitable organizations in Florence, Luca and Siena, in which the parents of newborn girls deposited a small amount in exchange for a prize to be paid if the girl survived to marry at age 18, in which case the prize would be her dowry (Salas, 1957).
42 This problem may arise also with ordinary life insurance. To prevent it, most countries have introduced the doctrine of "insurable interest", which requires life insurance to cover losses only, preventing the payment of prizes. When a tontine annuity is stripped from its betting feature, a normal annuity remains.
43 The CREF annuity also exhibits tontine-like behavior when the number of participants in the pool of annuitants falls to two or a few people. With more than 20 members, this has no practical importance.
44 This implicit betting cannot be eliminated without annuitization. If couples are forced to buy
separate individual pensions, the surviving spouse would still receive an unintentional bequest from the dying one, which would allow her to increase her pension.