IMF WORKING PAPER

WP/94/89

INTERNATIONAL MONETARY FUND

Research Department

Aging Population and Canadian Public Pension Plans

Prepared by Tamim Bayoumi 1/

Approved for Authorization by Peter B. Clark

August 1994

Abstract

Canadian public pension plans are run on a "pay-as-you-go" basis. As the baby boom ages, contribution rates for the two main plans are projected to rise significantly, from their current level of around 5 percent of eligible earnings to over 13 percent by 2030. An alternative is to set contribution rates at their underlying long-term levels. Such a policy would imply a significant rise in current contribution rates, to 10-10½ percent of eligible earnings, but would allow the system to cope with the retirement of the baby boom generation without recourse to borrowing or significant increases in contribution rates.

JEL Classification Numbers:

H55, J14

1/ I would like to thank Jorge Marquez-Ruarte and Christopher Towe for useful comments on an earlier version of this paper.

Contents

	Page
Summary	iii
I. Introduction	1
II. Public Pension Plans in Canada	1
III. Economics of Public Pension Plans	6
IV. Implications of Smoothing CPP Contribution Rates	9
V. Conclusions	11
Text Table 1. Projections of Costs of Public Pension Plans	4
Chart 1. Canada Pension Plan: Projections	2a
Annex: An Overlapping Generations Model of Public Pensions	13
References	17

Summary

Demographic shifts caused by aging populations create a number of problems for policymakers. Among these, one of the more important is the funding of public pension plans. Canadian public pension plans (like those in most other industrial countries) are run on a "pay-as-you-go" basis, in which current contributions are used to pay for current entitlements. This paper explores the economic issues involved in the interaction between an aging population and the public pension system.

The two pay-as-you-go programs in the Canadian public pension system are the Quebec Pension Plan (QPP), which covers residents of Quebec, and the Canada Pension Plan (CPP), which covers all other Canadians. Both schemes are funded by payroll taxes and provide pensions that are related to income. A third program, Old Age Security, provides benefits that are equal across individuals and is funded out of general taxation. The analysis in this paper focuses on the CPP and QPP, whose contribution rates are projected to rise from their current level of 5 percent of eligible earnings to over 13 percent from 2030, reflecting the impact of the baby-boom generation.

A pay-as-you-go pension scheme can provide partial insurance against long-term adverse productivity disturbances by subsidizing generations that experience exceptionally low productivity and taxing those with exceptionally high productivity. It will also produce intergenerational transfers in response to a demographic disturbance. However, in this case, the effects are not so benign. The direction of the intergenerational transfers depends critically upon whether it is benefits or premiums that vary over time to keep the system funded. If benefit levels are maintained over time and premiums are allowed to vary, then the baby-boom generation will gain, since it will face relatively low premiums when working while still receiving the same benefits as earlier generations, whereas the generations immediately after the baby boomers will lose, since they will have to pay high premiums to finance the retirement of the baby-boom generation. This produces fiscal transfers across generations with little economic rationale.

An alternative is to set contribution rates at their underlying long-term levels, which would allow the system to accommodate the effects of demographic change without creating large intergenerational transfers. At current benefit levels, such a policy would imply a significant rise in current contribution rates, from 5 percent of eligible earnings to 10-10½ percent. This would allow the system to build up sufficient reserves over time (on the order of 15-20 percent of output) and enable it to cope with the retirement of the baby boomers without recourse to borrowing or significant increases in contribution rates. To the extent that it is desirable to keep contribution rates stable over time, this analysis implies that there is a substantial level of underfunding in Canadian pension plans.

I. Introduction

Demographic shifts caused by aging populations create a number of problems for policymakers. Among these, one of the more important is the funding of public pension plans. Canadian public pension plans (like those in most other industrial countries) are run on a "pay-as-you-go" basis, in which current contributions are used to pay for current entitlements. Such a system implies that either contribution or benefit rates will vary with demographic trends. In particular, the current bulge in the working population caused by the baby boom generation implies that benefits to current retirees can be funded using a relatively low contribution rate. However, this cannot last. As the baby boomers retire the number of beneficiaries will increase substantially, and current contribution rates will be unable to fund the benefits that are currently offered. The inconsistency between current contribution rates and promised benefits implies an unfunded future liability for the government.

This paper explores the economic issues involved in the interaction between an aging population and the public pension system. The next section describes the three public pension schemes in Canada, the Canadian Pension Plan (CPP), the Quebec Pension Plan (QPP), and Old Age Security (OAS). 1/ It discusses long-term expenditure projections for each program, financing of these expenditures and, in the case of the CPP, estimates of the current level of actuarial liabilities in the system. Section III outlines the economics of public pension plans, while Section IV discusses the economic implications of smoothing contribution rates over time. Conclusions and policy implications are contained in Section V.

II. Public Pension Plans in Canada 2/

The Canada Pension Plan (CPP), which covers all Canadians except those who are resident in Quebec, and the Quebec Pension Plan (QPP), which covers residents of Quebec, are very similar. Both schemes are funded by payroll taxes and provide pensions that are related to income. For example, CPP pensions are available to all those aged 60 or more who have made contributions for at least one year during their working lives. The annual pension is equal to 25 percent of an average of the highest pensionable earnings (calculated according to fixed rules) up to a maximum value, set at

---

1/ Another transfer program targeted at the elderly is the Guaranteed Income Supplement (GIS), which ensures that people aged 65 and over receive at least the necessary benefits to provide for a minimum standard of living. Since this program largely substitutes for insurance benefits provided to those aged less than 65 by provincial governments, it is probably best seen as a part of the social safety net rather than as a program directed specifically at the elderly, and is not analyzed in this paper.

2/ The information provided in this chapter is derived mainly from the most recent actuarial reports for the three programs, which were issued at the end of 1991 (CPP), 1992 (QPP), and 1988 (OAS).

$694.44 per month in 1994. In addition, benefits are given to the disabled, survivors of beneficiaries, and orphans; certain death benefits are also provided.

Currently, approximately two thirds of CPP benefits are directed to contributor pensions, a further eighth comprises survivor pensions, while disability benefits make up the vast majority of the remainder. The importance of retirement and survivor pensions is projected to rise over the future, to about 90 percent of all benefit outlays by 2100, with a commensurate fall in the importance of benefits to the disabled.

The CPP is funded using a percentage levy on all earnings between a basic exemption and a maximum value (the maximum value, which rises in line with average earnings, is $34,400 in 1994, with a basic exemption of 10 percent of this value). In 1993 the contribution rate was 5.0 percent of earnings, and rose to 5.2 percent in 1994, with the cost being split equally between employee and employer. The CPP is funded on a pay-as-you-go basis, with a target level of reserves of twice annual expenditures. 1/ No reserves are being explicitly provided for future benefits. The reason for pay-as-you-go funding given in the actuarial report is that "if normal actuarial funding were to apply to the CPP, it is feared that the colossal investment funds that are generated would lead either to unwarranted government projects or to indirect government control over the private sector through the investment of social insurance funds. The application of the principles of actuarial funding is accordingly usually considered inappropriate in the field of social insurance." 2/

The fund is currently trying to reduce the ratio of reserves to expenditures, since it is higher that the target value. As a result, the 1993 contribution rate of 5.0 percent was below the underlying pay-as-you-go rate of 7.25 percent. The contribution rate is projected to rise steadily in the future, from 5 percent in 1993 to 13 percent in 2030 and 13.24 percent in 2100 (Chart 1 shows projected rates up to 2075). As a result, the gap between the actual rate and the pay-as-you-go rate (which is also rising) will be closed by 2008.

The third part of the Canadian public pension provision is Old Age Security (OAS). Unlike the earnings-related Canada and Quebec Pension Plans, OAS benefits are equal across individuals 3/ and are funded out of general taxation. The benefit in the first quarter of 1994 was $385.81 per month, a sum which is raised each quarter in line with the change in the consumer price index. Given that the benefit is unrelated to earnings or contributions, with no explicit provision for future costs, it is probably

---

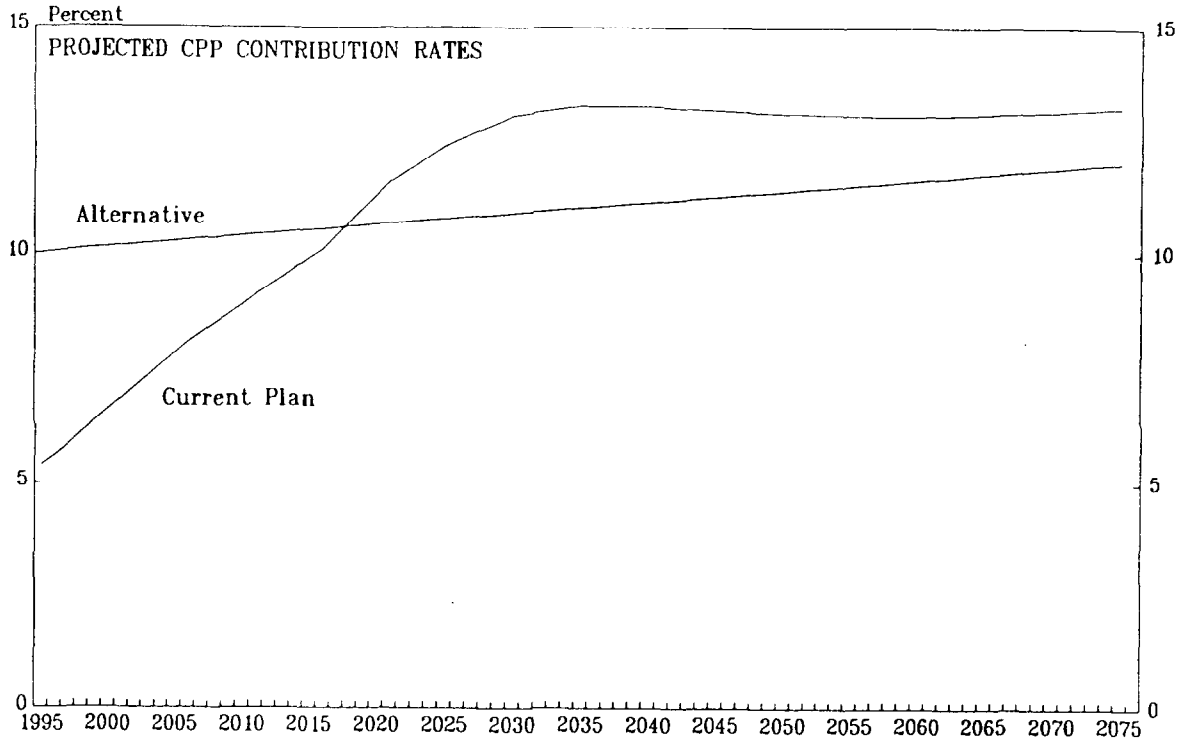
1/ As discussed further below, current reserves are about three times annual expenditures.

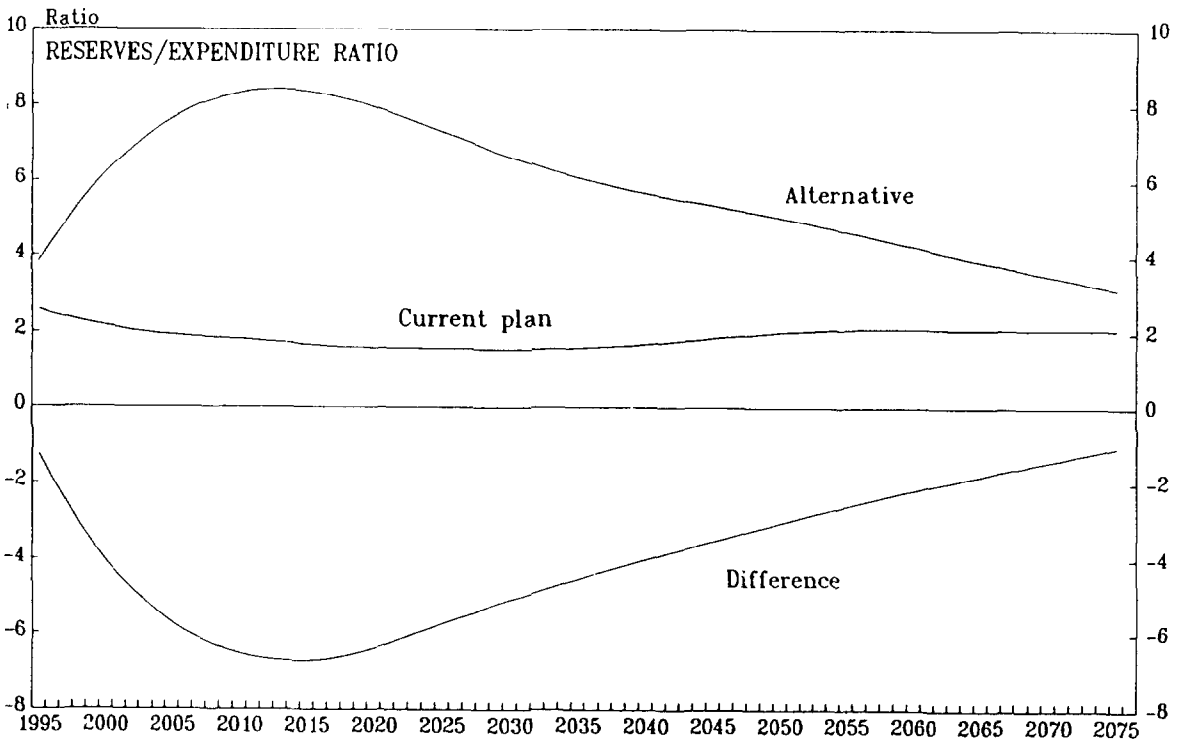
2/ Canada Pensions Plan, Fourteenth Actuarial Report as at December 1991, page 92.

3/ Those with less than the minimum number of years of residence can claim partial benefits.

Chart 1.

CANADA PENSION PLAN: PROJECTIONS





Sources: December 1991 Actuarial Report of the Canada Pension Plan and Fund staff estimates.

best seen as a part of the social safety net. Projections indicate that the cost of this program (as a proportion of earnings) is likely to rise relatively moderately over time, from 3.67 percent of earnings in 1993 to 4.75 percent of earnings by 2030, after which it is projected to fall due to demographic factors, reaching 2.1 percent of earnings by 2100.

Table 1 provides a summary of projected costs for the three funds from 1993-2050 in current Canadian dollars. 1/ Since it is not always easy to tell the cost of the scheme from current dollar estimates due to the effects of inflation, an estimate of the cost relative to earnings is also provided. For the Canada and Quebec Pension Plans this is done by reporting the pay-as-you-go contribution rate (in other words the contribution rate required to cover all expenses). For the OAS scheme costs are reported as a ratio to total earnings. 2/ Unfortunately, since these projections are made using different economic assumptions, the estimates of future costs are not completely comparable across plans (in particular, the OAS projections date from 1988). However they do provide a useful impression of the relative importance of the three schemes over time.

Currently, the combined cost of the Canada and Quebec Pension Plans are slightly larger than those for OAS. The costs of the two earnings-related schemes (measured by the pay-as-you-go rate) move very closely over time, reflecting their close similarities. The pay-as-you-go contribution rates increase over time, almost doubling between 1993 and 2030 (from 7.25 and 7.30 percent to 13.16 and 13.52 percent). The rates then fall slightly to around 13 percent by 2050 as the demographic bulge caused by the baby boom generation starts to level off. Subsequently they begin to rise again, reaching almost 14 percent by the year 2100. 3/ Furthermore, because the current contribution rate of 5 percent is significantly below the pay-as-you-go rate, the actual contribution rate is projected to rise by over two and a half times its current value by 2030.

There is clearly a large funding gap when projected future expenses are compared with current contribution rates, a funding gap that will have to be met either by higher payroll contributions (the assumption made in calculating the pay-as-you-go contribution rate) or lower benefit levels. In particular, the projected increase in the contribution rate may be so high as to prompt a change in either the funding mechanism for the programs or benefit levels. However, while the projected payroll deductions are high, they are not unprecedented. For example, social security payroll deductions in the United States are currently equal to 12.4 percent of

---

1/ Derived from the relevant actuarial reports.

2/ Total earnings are larger than earnings eligible for CPP or QPP payroll deductions. Hence, for the same expenditure level this ratio is lower than that reported for the CPP or QPP.

3/ The QPP has not published expenditure projections after 2050. Hence, the projection to 2100 refers only to the CPP.

Table 1. Projections of Costs of Public Pension Plans

	Canada Pension Plan		Quebec Pension Plan		Old Age Security	
	Current C$ (millions)	Pay-As-You-Go contribution rate (percent)	Current C$ (millions)	Pay-As-You-Go contribution rate (percent)	Current C$ (millions)	Ratio to total earnings (percent)
1993	13,910	7.25	4,246	7.30	15,166	3.67
2000	20,817	7.66	6,764	7.84	21,867	3.59
2010	41,199	8.97	14,358	9.30	36,967	3.54
2020	83,153	11.18	30,525	11.61	70,376	4.15
2030	154,883	13.16	58,150	13.52	128,900	4.75
2040	252,969	13.14	96,801	13.47	193,551	4.31
2050	404,590	12.97	158,125	13.19	274,886	3.72
2100	4,637,132	13.95	...	...	1,886,458	2.12

Sources: Canada Pension Plan: Fourteenth Actuarial Report as at 31 December, 1991. Québec Pension Plan: Analyse Actuarielle du Régime de Rentes du Québec en date du 31 Decembre 1992. Old Age Security Program: First Statutory Actuarial Report as at December 31, 1988. Also, Fund staff estimates.

eligible earnings, with a maximum ceiling for eligible earnings (US$57,600) that is significantly higher than that for the CPP or QPP.

In addition to providing projections of future expenditures and pay-as-you-go contribution rates, the 1991 actuarial report for the CPP also reports estimates of the actuarially fair contribution rate and the unfunded actuarial liability in 1991. The actuarially fair contribution rate is the contribution rate at which the present value of the projected revenue to be generated from the contributions of participants just starting in the system is equal to the present value of the projected future benefits they will receive. The unfunded actuarial liability is the short-fall between actual reserves and the level of reserves required to fund all future benefits for those who are currently over 18 assuming that the actuarially fair contribution rate is levied in the future. Hence, the actuarially fair contribution rate is the value at which individuals on average "pay their own way" in the system, while the unfunded liability is the shortfall of reserves from the funding required to cover future liabilities that have already been accrued.

On the main case assumptions, 1/ the 1991 actuarially fair contribution rate for the CPP is 9.62 percent, almost double the 1993 contribution rate of 5 percent. On the same basis the unfunded liability is $420.4 billion, or slightly more than 80 percent of gross domestic product excluding the gross provincial product of Quebec, and will continue to grow as long as the actual contribution rate is below the actuarially fair rate. 2/

As discussed earlier, the cost of OAS is projected to rise at a slower rate than that of the Canada or Quebec Pension Plans, primarily because benefits are linked to increases in prices rather than earnings. Thus, the cost of the scheme is projected to stay at around its current level of 3.67 percent of earnings into the early part of the next century before peaking at 4.75 percent of earnings in 2030, and then falling steadily to only 2.12 percent of earnings in 2100.

These 1988 projections, however, may tend to underestimate the cost of the program since they assume a long-term growth rate of real earnings of 1.3 percent per annum. The 1991 CPP actuarial report lowered the assumed long-term rate of increase in real wages from 1.3 percent to 1 percent per annum. Using this lower rate of growth, the cost of the OAS program is estimated to peak at 5.25 percent of earnings in 2030 before falling back to around its current cost by the year 2100. Hence, depending upon which "main case" assumptions are used, the cost of the OAS program (as a ratio to earnings) could rise by between 25 and 40 percent by the year 2030 before starting to fall.

The actuarial reports also provide a series of alternative scenarios which use alternative underlying economic and demographic assumptions. For the CPP these projections explore the sensitivity of the results to changes in life expectancy, the birth rate, the level of immigration, rate of growth of earnings, the rate of growth of prices, and a rise in the rate of return on assets; similar results are provided for the QPP and the OAS Program.

Overall, the projected pay-as-you-go contribution rates for the Canada and Quebec Pension Plans appear relatively robust to alternative assumptions, particularly those associated with demographics. For example, a 10 percent reduction in the projected rise in life expectancy lowers the estimated pay-as-you-go contribution rate for the CPP in 2030 from 13.16 to 13.08 percent, while a 0.25 percentage point increase in the rate of growth of earnings lowers the contribution rate in 2030 from 13.16 to 12.77 percent. Hence, barring any radical changes in the economic or demographic structure of Canada, it appears likely that maintaining the current structure of benefits for the Canada and Quebec Pension Plans will

---

1/ Including a long-term rate of inflation of prices and wages of 3.5 percent and 4.5 percent, respectively, and an interest rate of 6 percent.

2/ Calculations of this type for all of the major industrial economies are reported in Noord and Herd (1993).

require an increase in payroll contribution rates to between twice and three times the current rate. The projected cost of the OAS program (as a ratio to earnings) also appears relatively insensitive to demographic factors, but it is somewhat more sensitive to the differential between the rates of growth of earnings and prices. As noted earlier, a reduction in the rate of growth of real earnings from 1.3 percentage points to 1 percentage point would raise projected costs as a ratio to earnings by around 10 percent in 2030.

III. Economics of Public Pension Plans

There has been a considerable amount of work on the economics of pension plans, much of it of a relatively technical nature. 1/ This section will not attempt to survey this literature in any detail, rather it will outline the underlying economic principles involved in public pension plans. It is useful to start by listing the four salient characteristics of public pensions plans, both in Canada and in other industrial countries: they are compulsory, with no let-out clauses or options to choose contribution rates or benefit levels; they involve some redistribution of income within generations (for example, the OAS program has benefits that are equal across individuals but is funded from general taxation into which the wealthy pay more); they are not actuarially sound, but rather operate on some version of a pay-as-you-go basis 2/; finally, they were initiated either immediately before or soon after the Second World War. 3/

In analyzing such features of pension plans, it may be useful to recall the three main justifications for government intervention in a market economy; macroeconomic stabilization, efficiency, and equity. Macroeconomic stabilization over the cycle is unlikely to be important in the design of public pension programs, since they involve long-term financial commitments. 4/

The efficiency principle recognizes that there are certain services which the government can deliver more efficiently than private markets, classic examples being public goods such as defense or street lights. However, it is difficult to think of compelling reasons why the government would be able to provide pension services in a more efficient manner than

---

1/ For a survey of recent work see Bernhard (1993). See also Auerbach and Kotlikoff (1987).

2/ The United States has recently raised social security taxes in order to build up reserves in anticipation of the retirement of the baby boom generation; however it is still very far from being actuarially sound.

3/ In Canada the Old Age Security program came into operation in 1951, the Canada and Quebec Pension Plans in 1966.

4/ This is not to say that their associated payroll taxes play no role in stabilization, which they do. For example, Bayoumi and Masson (forthcoming) provide evidence that social security taxes help to stabilize incomes over the cycle within the United States and Canada.

the private sector. There are numerous private plans in Canada and elsewhere which allow individuals to provide for their own pensions, and that appear to operate smoothly and efficiently. This has an important implication for public pension plans, which is that they probably should not be run on a basis which is actuarially sound for all individuals. Since private sector pension plans allow individuals to invest current income in order to provide an actuarially fair pension, this option is already open and there is no clear reason for the government to provide such a system. 1/

This does not mean that the choice of funding of a public pension plan will have no effect on the economy. To the extent that private saving is aimed at providing for retirement, future public pension benefits reduce it. If the government runs a public pension fund on a pay-as-you-go system it will not replace this private saving with public saving, lowering the capital stock, and hence reducing incomes. 2/ However, this does not mitigate the fact that a public pension system which is actuarially fair for all individuals is probably redundant.

The equity principle recognizes that another of the functions of government is to redistribute income across individuals. Certainly, the compulsory nature of public pension arrangements is consistent with a significant role for redistribution, since such transfers imply transactions which would not be carried out on a voluntary basis. Redistribution itself can be divided into two types, transfers between members of the same generation (intra-generational transfers) and transfers across generations (inter-generational transfers). Intra-generational transfers are a feature of most public pension schemes, and presumably reflect the desire to avoid undue hardship for those individuals who, for whatever reason, have failed to make adequate provision for their retirement. The OAS scheme is clearly aimed at this type of provision.

The most salient feature of public pension funds, however, is that they provide a direct mechanism for inter-generational transfers of resources. This is most obvious in the case of the initial beneficiaries of a pay-as-you-go pension scheme, who receive full benefits from the pension scheme while contributing little or nothing into the fund. More generally, unless a pension scheme is actuarially fair across generations, inter-generational transfers will occur.

The annex provides a formal analysis of the inter-generational transfers implied by a pay-as-you-go pension system in the context of an overlapping generations model. Since the model has no supply side, the analysis is limited to the direct effects of the pension system, with no consideration of the effect on capital formation or labor market decisions.

1/ This point was made by Samuelson (1975) in the context of an overlapping generations model.

2/ Auerbach and Kotlikoff (1989). Blanchard and Fisher (1989, page 113) discuss the situations in which such a change raises or lowers welfare.

As already noted, a pay-as-you-go system of public pensions probably lowers the capital stock.

The impact of three characteristics on inter-generational transfers are highlighted: the underlying rate of growth of output, productivity disturbances, and demographic trends. If the underlying rate of growth of potential output is high, reflecting increases in productivity or working population, then a pay-as-you-go public pension scheme can involve a contribution rate below the actuarially fair value. Hence, in present value terms, individuals receive more than they contribute. It does this by providing a mechanism by which retirees are able to participate in the success of the current working population, a mechanism that is repeated for the current working population when they, in turn, retire. A similar effect comes from increasing life expectancy. 1/

Movements away from underlying trends cause more specific inter-generational transfers. Given the long-term nature of pension schemes, these deviations must occur over long periods of time, such as the low productivity experienced during the great depression of the 1930s, or the existence of the baby boom generation currently. 2/ With a pay-as-you-go system a sustained productivity shock will cause generally inter-generational transfers that are socially beneficial. When productivity is low, both premiums and benefits will be low in real terms. As a result, some of the loss in productivity is transferred from those who are currently working to those who are retired. As productivity recovers, so do real levels of premiums and benefits, hence those who worked through the downturn but are now retired will benefit from the recovery.

A pay-as-you-go pension scheme can therefore provide partial insurance against long-term adverse productivity disturbances by subsidizing generations that experience exceptionally low productivity and taxing those with exceptionally high productivity. Such insurance, which cannot be provided by the private sector since it involves transfers across generations, can raise expected social welfare. It may well explain why public pensions were introduced either during, or in the decades immediately after, the great depression of the 1930s, the largest productivity disturbance experienced in recent times.

A pay-as-you-go pension system will also produce inter-generational transfers in response to a demographic disturbance, such as the baby boom of the early postwar years. However, in this case the effects are not so benign. The direction of the inter-generational transfers depends critically upon whether it is benefits or premiums which vary over time in order to keep the system funded. If benefit levels are maintained over time and premiums are allowed to vary, then the large generation will gain as

---

1/ However, pay-as-you-go systems may also have detrimental effects on capital formation (Auerbach and Kotlikoff, 1987).

2/ By contrast, normal business cycles are unlikely to provide effects of sufficiently long duration to have inter-generational consequences.

they will face relatively low premiums when working while still receiving the same benefits as earlier generations, while the generations immediately after the baby boomers will lose since they will have to pay high premiums to pay for the retirement of the large generation. (This is the scenario envisaged by the steady rise in contribution rates for the Canada and Quebec Pension Plans discussed earlier.) On the other hand, if it is premiums that are left unchanged and benefits which vary over time, then the large generation will suffer because its benefits will be squeezed by the paucity of workers available to fund their pensions. In this case, it is the generations preceding the baby boomers who gain, since the large number of workers provided during the baby boom allow earlier generations to receive large pensions.

These inter-generational transfers in the face of demographic disturbances do not appear to provide any gains in inter-generational equity. Indeed, to the extent that these transfers cause incomes to deviate from their long-term values, a pay-as-you-go public pension plan probably reduces expected social welfare. The basic problem is that the pay-as-you-go rule forces either benefit or contribution rates to vary from their long-run values, and that these variations result in windfall gains and losses across generations that have little clear economic rationale.

A way to retain the advantages of the pay-as-you-go system with respect to productivity disturbances but avoids the inter-generational redistribution caused by demographic shifts is to fix contribution and benefits rates at a level which is consistent with long-term balance of the fund on a pay-as-you-go basis, but to allow the system to build up or draw-down reserves in response to demographic disturbances. The next section explores the implications of such a system for the CPP.

IV. Implications of Smoothing CPP Contribution Rates

Alternative scenarios provided in the Actuarial Report on the CPP were used to produce a simple simulation model of the effects on the funding of the scheme of varying assumptions about long-term values of interest rates, the growth of prices and earnings, life expectancy, fertility and immigration. This model was then used to estimate the financial impact of smoothing contribution rates over time.

First, the long-term contribution rate was estimated by calculating the contribution rate which produced a stable ratio of reserves to expenditures in the longer run given current levels of life expectancy 1/ and assuming current benefits levels are maintained. 2/ Since economic and demographic

---

1/ Life expectancy was held constant in these initial simulations since, for a given level of benefits, increases in life expectancy imply a steady rise in contribution rates, an effect which should be estimated separately.

2/ If benefit levels were reduced, the stable contribution level would be correspondingly smaller.

demographic change without creating large inter-generational transfers. For current benefit levels, such a policy would imply a significant rise in contribution rates, from 5 percent of eligible earning to 10-10½ percent. This would allow the system to build up sufficient reserves over time (of the order of 15-20 percent of output) and enable it to cope with the retirement of the baby boomers without recourse to borrowing or significant increases in contribution rates. To the extent that it is a desirable objective to keep contribution rates stable over time, this implies that current plans for the CPP involves a substantial level of underfunding.

they will face relatively low premiums when working while still receiving the same benefits as earlier generations, while the generations immediately after the baby boomers will lose since they will have to pay high premiums to pay for the retirement of the large generation. (This is the scenario envisaged by the steady rise in contribution rates for the Canada and Quebec Pension Plans discussed earlier.) On the other hand, if it is premiums that are left unchanged and benefits which vary over time, then the large generation will suffer because its benefits will be squeezed by the paucity of workers available to fund their pensions. In this case, it is the generations preceding the baby boomers who gain, since the large number of workers provided during the baby boom allow earlier generations to receive large pensions.

These inter-generational transfers in the face of demographic disturbances do not appear to provide any gains in inter-generational equity. Indeed, to the extent that these transfers cause incomes to deviate from their long-term values, a pay-as-you-go public pension plan probably reduces expected social welfare. The basic problem is that the pay-as-you-go rule forces either benefit or contribution rates to vary from their long-run values, and that these variations result in windfall gains and losses across generations that have little clear economic rationale.

A way to retain the advantages of the pay-as-you-go system with respect to productivity disturbances but avoids the inter-generational redistribution caused by demographic shifts is to fix contribution and benefits rates at a level which is consistent with long-term balance of the fund on a pay-as-you-go basis, but to allow the system to build up or draw-down reserves in response to demographic disturbances. The next section explores the implications of such a system for the CPP.

IV. Implications of Smoothing CPP Contribution Rates

Alternative scenarios provided in the Actuarial Report on the CPP were used to produce a simple simulation model of the effects on the funding of the scheme of varying assumptions about long-term values of interest rates, the growth of prices and earnings, life expectancy, fertility and immigration. This model was then used to estimate the financial impact of smoothing contribution rates over time.

First, the long-term contribution rate was estimated by calculating the contribution rate which produced a stable ratio of reserves to expenditures in the longer run given current levels of life expectancy 1/ and assuming current benefits levels are maintained. 2/ Since economic and demographic

---

1/ Life expectancy was held constant in these initial simulations since, for a given level of benefits, increases in life expectancy imply a steady rise in contribution rates, an effect which should be estimated separately.

2/ If benefit levels were reduced, the stable contribution level would be correspondingly smaller.

variables factors were assumed to move in a smooth manner, results for the period 2050-75 were assumed to approximate the long-term equilibrium. The simulation results indicated that the long-term steady state contribution rate at the current level of life expectancy was between 10 and 10½ percent. 1/ A contribution rate of 10 percent implies a ratio of reserves to expenditures in 2075 which is very similar to the current target value of 2. However, since the reserves/expenditure ratio continues to fall after 2050 (albeit slowly), this contribution rate is probably lower than the true long-term value. A contribution rate of 10½ percent produced a more stable long-run ratio of reserves to expenditures. However, the ratio stabilizes at a relatively high value (over 8).

Next, the trend increase to this long-run contribution rate implied by increasing life expectancy was calculated. This was done by rerunning the initial scenarios, but with the base case assumption about life expectancy and a trend rise in the contribution rate. 2/ The results indicated that a rise of 0.025 percentage points per annum was required to keep the system stable over the long run. Hence, for unchanged benefits levels, increasing life expectancy implies a trend increase in the premium of one quarter of a percentage point per decade.

Chart 1 compares current projections for funding the CPP using a pay-as-you-go system with those implied by using long-term contribution rates (for the purposes of this exercise, the current long-run contribution rate was assumed to be 10 percent). The upper panel shows the contribution rates between now and 2075 under current plans and those implied by using long-run contribution values. Rates under the current plan rise steadily from now until 2030, after which they level off until the end of the simulation period. By contrast, if rates were set at their long-run levels then they would be higher now, but would rise very slowly over time. Hence, while contribution rates would be higher than under the current system for the next 25 years or so using this approach, they would be lower for the remainder of the simulation period.

The bottom panel shows the ratio of reserves to expenditures under the two financing schemes. Under the current system the ratio of reserves to expenditures stays relatively constant over the entire period. By contrast, when contribution rates are set on a long-term basis the ratio of reserves to expenditures rises significantly for a while, reaching a peak around 2015, before slowly falling back to near the initial ratio by 2075. This

---

1/ These contribution rates are above the estimated actuarial rate of 9.6 percent reported earlier. Hence, in present value terms individuals will be paying more into the pension system than they receive in long-run equilibrium. This reflects the fact that, in the main case scenario, the present value of aggregate output is falling over time.

2/ For males the life expectancy at age 65 is assumed to rise from 14.9 years in 1986 to 19.3 years in 2100, and for females the rise over the same period is from 19.1 years to 24.5 years.

profile reflects the buildup in reserves needed in order to provide adequately for the bulge in the number of retirees.

The difference between the two profiles for the ratio of reserves to expenditures is also shown in the lower panel of Chart 1. Since the ratio of reserves to expenditures is relatively stable under the current funding scheme, the path for the difference is essentially a negative mirror image of that implied when contribution rates are kept stable. It peaks at a value of around six times annual expenditures (between 15 and 20 percent of projected nominal output).

Such a policy would have both advantages and disadvantages. As discussed earlier, a stable contribution rate would avoid large intergenerational transfers which have little economic rationale. In addition, to the extent that there are costs associated with compulsory pension contributions, for example through their effect on labor participation, the intertemporal value of these costs are likely to be minimized when contribution rates are stable. 1/

On the other hand, the significant level of public pension fund reserves implied by such a policy produces its own concerns. If these reserves were used to purchase public debt, it would be important to ensure that this does not stimulate larger public sector deficits. If used to purchase private sector assets, such ownership should not used to enforce public policy in an inappropriate manner. In either case, the utilization of the pension fund reserves would require careful consideration. In addition, even if it was considered desirable to move contribution rates to their underlying long-term levels, consideration would have to be given to the speed at which the contribution rates should be raised to these levels in order to avoid unnecessary short-run economic disruption.

V. Conclusions

This paper has examined the effects of an aging population on Canadian public pension systems. Under the current pay-as-you-go system, contribution rates for the Canada and Quebec Pension Plans are projected to rise from their current level of 5 percent of eligible earnings to over 13 percent by 2030, reflecting the impact of the baby boom generation. Currently the working population is relatively large, and hence contribution rates are below long-run values. Later, as the baby boomers retire, contribution rates will have to rise above long-term levels to fund the large number of retirees. This produces fiscal transfers across generations with little economic rationale.

An alternative is to move contribution rates to their underlying long-term levels, which would allow the system to accommodate the effects of

---

1/ This is an example of the general proposition that the welfare costs of taxes are minimized when tax rates are stable (Barro, 1979).

demographic change without creating large inter-generational transfers. For current benefit levels, such a policy would imply a significant rise in contribution rates, from 5 percent of eligible earning to 10-10½ percent. This would allow the system to build up sufficient reserves over time (of the order of 15-20 percent of output) and enable it to cope with the retirement of the baby boomers without recourse to borrowing or significant increases in contribution rates. To the extent that it is a desirable objective to keep contribution rates stable over time, this implies that current plans for the CPP involves a substantial level of underfunding.

An Overlapping Generations Model of Public Pensions

This annex presents an overlapping generations model of the effects of a public pension system. The overlapping generations framework is an obvious candidate for such an analysis since it takes explicit account of the interactions across age groups, making it particularly easy to consider the underlying structure of inter-generational transfers. In order to make the analysis more tractable two important simplifying assumptions are made. The model has no production technology, hence there is no consideration of the effect of a pension system on the supply side of the economy. 1/ The model is also limited to a small open economy facing a fixed real interest rate; hence, changes in factor returns caused by demographic shifts are ignored.

Consider an overlapping generations model in which each generation is made up of n_t identical individuals who live for two periods, t and t+1. In period t, their working years, they earn an endowment e_t. They retire in period t+1 and earn no endowment. They consume c_{1t} in period t and c_{2t+1} in t+1 in order to maximize a utility function $U(c_{1t},c_{2t+1})$ which is the same across generations. They are able to borrow and lend in asset markets using a fixed real interest rate 1+R.

The government provides a compulsory public pension scheme in which each individual pays $\alpha_t e_t$ of their initial endowment to the government in period t and receives benefit $\beta_t e_{t+1}$ back in period t+1. Hence, benefits at rate β_t of endowment in t+1 are paid to generation t in period t+1. The government has access to the same asset markets as private individuals. The pension scheme must be solvent in the long run. This means that if its assets are defined by:

$$A_t = (1+R)A_{t-1} + e_t (n_t\alpha_t - n_{t-1}\beta_{t-1}) \qquad (1)$$

then $\lim A_t \geq 0$ as $t \to \infty$.

The maximization problem for the individual is:

1/ This is an important restriction because one of the effects of a pay-as-you-go system is to lower the capital stock (or raise foreign debt), thereby reducing aggregate income. Moreover, the impact of tax rates on labor market participation is ignored. Blanchard and Fisher (1989, page 113) report that the welfare effect of a pay-as-you-go system depends upon whether the real interest rate is greater or less than the rate of growth of population. If the real interest rate is below the rate of growth of population then welfare rises for all generations, but if it is above the increase in population then welfare falls for all generations except the first.

$$\max U(c_{1t},c_{2t+1}) \quad \text{st. } e_t(1-\alpha_t)+\beta_t e_{t+1}/(1+R)) \geq c_{1t} + c_{2t+1}/(1+R) \qquad (2)$$

Since the real interest rate is fixed, utility depends only on the present discounted value of the endowment available to each individual, as shown in the indirect utility function:

$$V(e_t(1-\alpha_t)+\beta_t e_{t+1}/(1+R)) \qquad (3)$$

Since utility only depends upon the discounted value of endowments, the pension scheme will improve or reduce utility depending on whether the benefit rate β_t is greater than or less than $(1+R)\alpha_t e_t/e_{t+1}$, the contribution rate adjusted for the real interest rate and growth in endowment.

Two possible funding schemes for the public pension system are considered. The first is an *actuarially fair system* in which all individuals receive the accumulated value of their contributions. In this case the relationship between the contribution rate α_t and the benefit rate β_t is:

$$\beta_t e_{t+1} = (1+R)\alpha_t e_t \qquad (4)$$

Substituting this into equation (3) gives $V(e_t)$ regardless of the values chosen for α_t and β_t. Hence, *an actuarially fair system has no impact on the equilibrium*. The reason for this result is that individuals have access to the same asset markets as the government. Accordingly, any public pension system which simply reallocates endowment over time is redundant, since individuals can carry out the same transaction in private markets.

The analysis becomes more complex when *pay-as-you-go* funding schemes are considered. For a pay-as-you-go system the relationship between the contribution rate α_t and the benefit rate β_t is:

$$n_t\beta_t e_{t+1} = n_{t+1}\alpha_{t+1}e_{t+1} \qquad (5)$$

which can be rewritten as:

$$\beta_t = \alpha_{t+1}\, n_{t+1}/n_t \qquad (5')$$

In this case, the equilibrium is a dynamic one in which the benefits for one generation depend upon the contribution rate for the next generation and the relative size of the generations. As a result, the introduction of a pay-

as-you-go system always benefits the first generation, since they receive benefits without paying any money into the system. (Analogously, if the system is terminated, there is always a generation which loses.)

Turning to the situation of a mature system, in which participants both pay into the system and receive benefits from it, consider a steady state equilibrium in which population grows at rate (1+p), endowment grows at rate (1+g), and both contribution and benefit rates are kept fixed across generations ($\alpha_t=\alpha_{t+1}$, $\beta_t=\beta_{t+1}$). In this case the benefit rate β_t, is equal to $\alpha(1+p)$, the contribution rate adjusted for the rate of growth of population. A pension system raises endowment (and hence utility) if the benefit rate is greater than that implied by a fully funded system ($\alpha(1+R)/(1+g)$), hence a pay-as-you-go system with a fixed benefit and contribution rate raises welfare if the rate of growth of the aggregate endowment ((1+p)(1+g)) is greater than the real interest rate (1+R). The intuition is that, when the present value of output is rising, it is possible to raise the welfare of all generations by systematically transferring current resources from the young to the old. 1/

Next, consider the effect of a temporary disturbance to the endowment (a productivity shock). Specifically, assume that there is a temporary fall in endowment e_t below its steady state level. Since contributions for any given generation depend upon their own endowment while benefits depend upon the endowment of the next generation, this will affect the absolute level of benefits received. (This explains why the levels of endowment in periods t and t+1 both enter equation (3).) Compared to autarky, the overall effect is to raise the welfare of the generation which has the lower endowment, at the cost of lowering welfare to the previous generation. 2/ In short, a pay-as-you-go public pension system can "smooth" the effects of a shock to the endowment across generations. Since the utility function is concave, this implies that a pay-as-you-go system raises expected aggregate welfare across generations. 3/

Now consider the impact of a larger-than-expected generation, n_t. Since the public pension system is being operated in a pay-as-you-go manner it is impossible to keep both contribution rates and benefits rates unchanged over time, as can be seen from equation (5'). The effect of the demographic shift depends upon whether it is the contribution rate or benefit rate which is assumed to remain unchanged over time. Consider the

---

1/ This implies some borrowing from the rest of the world. In addition, in a more complex model such a pay-as-you-go system may well have a negative impact on capital formation.

2/ The effect is symmetric, hence, in the case of a temporary rise in the endowment, a pay-as-you-go pension scheme will lower the welfare of the generation with the high endowment, and raise the welfare of the immediately previous generation.

3/ More precisely, in the face of stochastic disturbances to the endowment, a pay-as-you-go system will raise the aggregate value of expected welfare across all generations.

case when benefit rates are kept fixed over time and contribution rates vary. From equation (5') this implies that contribution rates are lower than average for the large generation and higher than average for the following one. Hence, the large generation experiences a gain in income (relative to steady state) while the next generation experiences a loss in income. By contrast, if it is assumed that contribution rates remain unchanged and it is benefit rates which vary, it is the generation *before* the large one that has a welfare gain as benefit levels are boosted by the large number of workers who contribute, while the large generation has a welfare loss due the large number of retirees compared to contributors. Since endowment per capita has not deviated from its steady state value, these reallocations of income produce a reduction in expected aggregate welfare.

Finally, the effect of an increase in life expectancy can be analyzed. 1/ Clearly, the underlying model needs to be modified to accommodate this assumption. A simple adjustment is to assume that while individuals of generation t live for the whole of the period t, they only live for a proportion τ_t of period t+1. Rising life expectancy can then be captured by a rise in the value τ_t. It is assumed that the indirect utility function V(.) is unaffected by this change in life span.

In this case, the pay-as-you-go funding rule implies that the contribution rate, β_t, is equal to $\alpha_{t+1}(n_{t+1}/n_t)/\tau_t$. Since life expectancy (τ_t) is rising over time, both the benefit level and the contribution level cannot remain fixed over time even in the steady state. If it is assumed that it is benefit levels that remain fixed over time, then the condition for the pension system to raise welfare over time is that $(1+g)(1+p)\tau_t/\tau_{t-1}$ is greater than (1+R). This is very similar to the condition derived earlier, except for the addition of the term in τ_t/τ_{t-1}. Since τ_t is rising over time, increasing life expectancy improves the welfare effect of a pay-as-you-go pension system relative to steady state values. 2/ This reflects the fact that with increasing life expectancy current workers tend to contribute less to fund current pensions than they get back after retirement because of their more extended lives.

To summarize, a fully funded pension system has no impact on the equilibrium. For a pay-as-you-go pension system, contribution rates in steady state equilibrium are below their fully funded values if, and only if, the growth of total endowment is greater than the real interest rate. Increasing life expectancy also tends to lower contribution rates compared to their fully funded values. In terms of movements from steady state equilibrium, a pay-as-you-go system improves expected aggregate welfare in response to a temporary shock to the endowment, but lowers it in response to a temporary demographic disturbance.

1/ Similar results can be derived for a reduction in the retirement age.

2/ However, if contribution rates are left unchanged and it is benefit rates which are cut, an aging population has no impact on welfare.

References

Auerbach, Alan, and Lawrence Kotlikoff, Dynamic Fiscal Policy (Cambridge University Press: Cambridge, 1987).

Barro, Robert J., "On the Determination of Public Debt," Journal of Political Economy, Vol. 87, No. 5 (1979).

Bayoumi, Tamim, and Paul Masson, "Fiscal Flows in the United States and Canada: Lessons for Monetary Union in Europe" (forthcoming, European Economic Review).

Bernhard, C., "New Issues in Public Pension Economics," Journal of Economics Supplement 7 (1993), pp. 1-15.

Blanchard, Olivier, and Stanley Fisher, "Lectures in Macroeconomics" (Cambridge, MA: The MIT Press, 1989).

Noord, Paul Van den, and Richard Herd, "Pension Liabilities in the Seven Major Economies," OECD Economics Department, Working Paper No. 142 (1993).

Samuelson, Paul, "Optimal Social Security in a Life-Cycle Growth Model," International Economic Review, Vol. 16, No. 3 (1975).