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RETIREMENT INCOME SECURITY - IS FULL FUNDING THE ANSWER?

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Summary

An analogy is drawn between the funding of an individual pension plan and a paygo social security system. For both plans, the total expected value of benefits can exceed the total expected value of contributions.

For the individual pre-funded plan this is true because of the discount factor, δ, representing investment income earnings. For the paygo social security system, the analogous 'discount' factor is denoted r, and is the total of real growth rates of the labour force and real productivity gains per worker, that is, real growth in wealth production.

The paper then presents arguments to show that a fully-funded social security scheme is no more secure economically than a paygo scheme. Both schemes rely on the ability of the economy to create and transfer wealth. That is, for real retirement income security the funding mechanism is irrelevant.

Retirement Income Security - Is Full Funding the Answer?

1 Introduction

Virtually all western industrialized nations have in place significant retirement income security schemes. Some plans (e.g. social security) are funded on a pay-as-you-go (paygo) or quasi-paygo basis, while others (e.g. employer-sponsored pension plans) are funded on an actuarially fully-funded basis.

At the same time, these nations have populations that are aging, partly because of enhanced life expectancy, but more importantly because of the decline in birth rates since their peaks in the late 1950's.

As will be shown, retirement-income security schemes are sensitive to demographic shifts. In particular, an aging population gives rise to pressures for increased social security contribution rates as the ratio of retirees (beneficiaries) to workers (contributors) increases (most sharply after 2015). However, fully-funded schemes are also at risk as will be seen.

This paper explores the true actuarial basis of funding security for retirement-income schemes.

2 Paygo vs. Individual Actuarial Funding

If an individual wishes to retire at age 65 with an annual income of one unit payable continuously, then an actuary can determine the required contributions by setting the present value of all contributions equal to the present value of all retirement income benefits at a defined age. Thus, if one assumes that contributions start at age 20, the formula would be

$$C \int_0^{45} e^{-\delta t} \frac{\ell_{20+t}}{\ell_{20}} dt = e^{-45\delta} \frac{\ell_{65}}{\ell_{20}} \int_0^{\infty} e^{-\delta t} \frac{\ell_{65+t}}{\ell_{65}} dt$$

which solves for

$$\begin{aligned} C &= e^{-45\delta} \frac{\int_0^\infty e^{-\delta t} \ell_{65+t} dt}{\int_0^{45} e^{-\delta t} \ell_{20+t} dt} \\ &= \frac{\int_{65}^\infty e^{-\delta x} \ell_x dx}{\int_{20}^{65} e^{-\delta x} \ell_x dx} \end{aligned}$$

The plan is funded by contributions made between ages 20 and 65, contingent on survival; benefits are paid for ages 65 and beyond, also contingent upon survival. Total expected contributions are not as large as total expected benefits because of the discounting effect of the rate of investment return, δ.

Moving to paygo funding, assume a paygo plan wishes to pay annual income of one unit payable continuously to all citizens alive aged 65 and over. Contributions will be made by all citizens aged 20 to 64 inclusive.

Because, in a paygo system, contribution income is immediately distributed as benefit outgo, there is no discounting for investment income.

Thus, in a stationary population, the contribution formula is simply

$$C\,(T_{20} - T_{65}) = T_{65},$$

or

$$C = \frac{T_{65}}{T_{20} - T_{65}}.$$

For more general applicability, assume the population is stable (rather than stationary) with intrinsic rate of increase, r.

Assume it is now time z, and the rate of live births is now $B(z)$. Those now alive aged x were born at time $z - x$ in a birth cohort of size

$$B(z - x) = B(z)e^{-rx}.$$

Thus the paygo funding formula is

$$C \int_{20}^{65} B(z)e^{-rx} S(x) dx = \int_{65}^{\infty} B(z)e^{-rx} S(x) dx,$$

or

$$C = \frac{\int_{65}^{\infty} B(z)e^{-rz}S(x)dx}{\int_{20}^{65} B(z)e^{-rz}S(x)dx} = \frac{\int_{65}^{\infty} e^{-rz}\ell_x dx}{\int_{20}^{65} e^{-rz}\ell_x dx}.$$

Hence the formula used to determine the required contribution rate for a paygo social security scheme is analogous to the formula used to determine the required contribution for an individual pre-funded retirement scheme. Further, the ability to have total expected paygo benefits that exceed total expected paygo contributions depends on the 'discount' rate r. As presented, this means that the paygo discount rate is the intrinsic growth rate, r, for the stable population.

The funding of social security is normally dependent only on active workers, however. Thus, one needs to analyze the intrinsic rate of increase, r, not of the general population, but rather of the active labour force. For example, increasing the labour force participation rate of females, or increasing net immigration of qualified workers, is as helpful to the funding requirements of a paygo system as an increase in the birth rate.

Thus the required contribution rate for a paygo scheme is dependent upon the ratio of beneficiaries to workers. This ratio is dependent upon all of the following demographic variables: mortality, fertility, migration, and labour force participation rates. Further, most paygo schemes have a contribution formula such that contributions increase at the same rate as average wages, whereas benefits (at least retirement benefits) increase at the same rate as inflation. Thus, to the extent that there is real productivity growth (net of inflation), this real productivity growth, as a rate per annum, can be added to the labour force intrinsic growth rate to determine the total paygo discount rate (call it r') for the period between the average contribution date and the average benefit payment date [1].

[1]It is often argued that retirement benefits should be indexed to average wages versus the cost of living. In this way, retirees would share in the enhanced standard of living produced by the workers. This particular side issue will not be explored further in this paper.

Hence the 'discount' rate, r', for the paygo social security system is the total of the growth rate of the labour force and the growth rate of its productivity. In other words, r' is the growth rate in wealth production for society as a whole.

3 Demographic Context

As stated earlier, all western industrialized nations presently have aging populations. Population aging here will mean "growth over time of the proportion of old persons according to some chronological age (usually 65), in the total population" (Chen 1987).

There are two causes of this population aging. One is enhanced life expectancy; the other is a recent drop in the rate of live births.

Statistics for Canada indicate significant improvement in life expectancy, especially for females.

TABLE 1
Life Expectancy

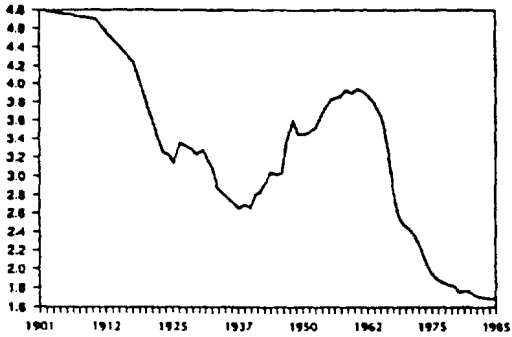
Year	at birth		at age 65		at age 75	
	male	female	male	female	male	female
1921	58.8	60.6	13.0	13.6	7.6	8.0
1941	63.0	66.3	12.8	14.1	7.5	8.2
1961	68.4	74.2	13.5	16.1	8.2	9.5
1981	71.9	79.0	14.6	18.9	9.0	11.9
1986	73.0	79.7	14.9	19.1	9.1	11.9

Source: Statistics Canada (Nagnur Dhruva 1986)

Life Tables, Canada and the Provinces, 1985-87.

Canada has also experienced a falling fertility rate since 1959, as seen in Figure 1.

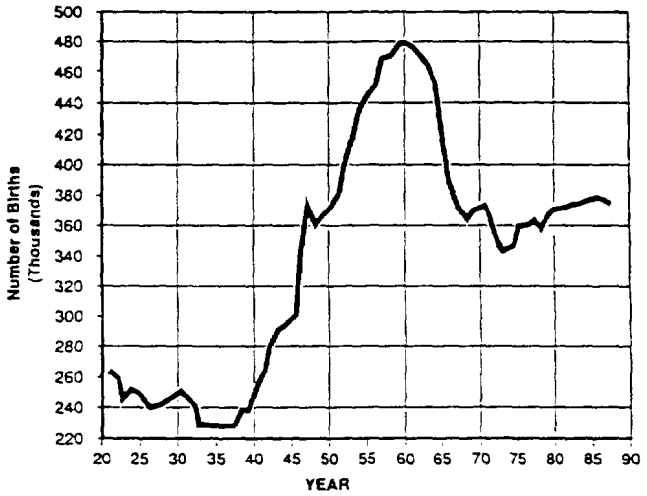
FIGURE 1
FERTILITY RATES (CANADA)



Source: Statistics Canada, Current Demographic Analysis. Fertility in Canada. Catalogue 91-524E 1984, 121-122

More important to the funding of a paygo scheme are the actual number of live births. Again, Canada experienced a significant drop in the number of live births in the period from 1959 to 1972, as seen in Figure 2.

FIGURE 2
NUMBER OF LIVE BIRTHS (CANADA)



Source: Statistics Canada, Current Demographic Analysis. Fertility in Canada. Catalogue 91-524E 1984, 121-122

TABLE 2

PROJECTED PERCENT INCREASE IN POPULATION 65+ 1985 to 2025

COUNTRY	% INCREASE
India	264
China	238
Hong Kong	219
Canada	135
Australia	125
Japan	121
Israel	116
U.S.	105
France	67
Italy	51
W. Germany	36
U.K.	23
Sweden	21

The shift in the ratio of expected retired-beneficiaries to expected worker-contributors is the chief concern around the future viability of western paygo schemes. The shift is caused by both the enhanced life expectancy of the elderly and the declining number of live births (both included in these projections).

Of all the western industrialized nations, Canada displays the largest shift in its funding ratio. Although India, China and Hong Kong face more rapidly aging populations, their social security promises are modest when compared to the rest of the countries listed.

Many commentators in Canada (*e.g.*, see Canadian Institute of Actuaries, 1993) have raised concerns about whether or not the next generation of workers will agree to contribute a much higher percent of their wages to fund the social security retirement benefits now being promised. The Canadian government has now initiated a more formal discussion of this matter. Similar concerns with respect to paygo funding requirements exist in most other western industrialized nations.

4 The Advantages of Paygo Funding

In general, the following are advantages of government-sponsored paygo schemes:

1. The entire working population can be covered relatively easily.
2. Benefits can be immediately vested and are fully portable, important features for the mobile work force of today.
3. Because contribution income immediately becomes benefit payout, no problem exists with indexation of benefits to wages. A source of 'actuarial discounting' for years with real productivity gains exists if benefits are indexed to cost of living and contributions are indexed to average wages (the norm).
4. Administrative costs are usually very low per unit of cash flow.

Governments can instead sponsor fully-funded schemes as opposed to paygo schemes, with several disadvantages including the following:

1. Fully funded schemes are susceptible to erosion by inflation. This destroyed several fully-funded schemes in Europe earlier in the century and is probably the main reason that virtually all government-sponsored social security schemes are funded on a pure or quasi paygo basis.
2. Government control of the large amounts of capital accumulating under a fully-funded scheme is a concern. If this money is 'invested' in government bonds, then it provides a easy source of deficit financing and provides an incentive for deficit spending. If invested in the private sector, any fully-funded social security scheme would have assets capable of controlling the country's entire available supply of equities. This 'back-door' government control may not be generally supported.
3. Who will decide how to invest this capital? How does one avoid political influence?
4. With the large accumulation of assets, continuous pressure will exist to enhance benefits.
5. In any transition from paygo financing to full-funding, one generation of workers will have to pay almost double contributions, to both pre-fund their own benefits and also pay for the paygo benefits not previously funded (equal to the present paygo actuarial liability). This would not likely prove acceptable, making it difficult, now, to switch to a fully-funded basis.

Despite this, full-funding of social security has its supporters, even some actuaries, who believe that the method would improve security of plan benefits to participants. But is security enhanced?

5 Is a Fully-Funded Scheme more Secure?

If the assets backing a fully-funded social security system are government bonds, then future social security benefits will be financed by a combination of worker contributions, payment of interest on the bonds, and liquidation of bonds as needed. All of these funds flow from productive workers. It should make no difference to these workers, in total, whether they pay increased benefits to retirees through increased contributions to a paygo system, or through a combination of contributions, bond interest, and bond liquidation in a 'fully-funded' scheme. Investing in private sector bonds or other private assets does not change this reality.

The real issue is the balance between production of goods and consumption demands.

In his book "The Economics of the Welfare State", Nicholas Barr (1987) states:

> "The widely held (but false) view that funded schemes are inherently 'safer' than PAYGO is an example of the fallacy of composition [a]. For *individuals* the economic function of a pension scheme is to transfer consumption over time. But (ruling out the case where current output is stored in holes in people's gardens) this is not possible for society as a whole; the consumption of pensioners as a group is produced by the next generation of workers. From an *aggregate* viewpoint, the economic function of pension schemes is to divide total production between workers and pensioners, *i.e.* to reduce the consumption of workers so that sufficient output remains for pensioners. Once this point is understood it becomes clear why PAYGO and funded schemes, which are both simply ways of dividing output between workers and pensioners, should not fare very differently in the face of demographic change".

[a] It is a fallacy of composition to assume that because something is true for an individual it will *necessarily* be true on aggregate. For instance, if I stand on my seat in the theatre I will get a better view, but if everybody does so, nobody will get a better view.

Social security pensions, whether funded on a paygo or fully-funded basis, are a means of

wealth transfer from workers to retirees. The crucial variable is, therefore, creation of wealth. The only way that a fully-funded social security scheme would enhance the true security of benefits is if two effects were to result. First, there would have to be an overall increase in gross national savings. Second, assuming increased savings, such an increase would have to raise total output or total wealth. While there is extensive literature on this matter (*e.g.* see Barr (1987) or Aaron (1982)), no conclusive evidence exists to support any enhanced real security by the full-funding of social security schemes.

According to Rosa (1983 p. 212) the experiences of Sweden and Japan in running state funded schemes:

> "offer powerful evidence that this option may only invite squandering capital funds in wasteful, low-yield investments [which] should give pause to anyone proposing similar accumulations elsewhere".

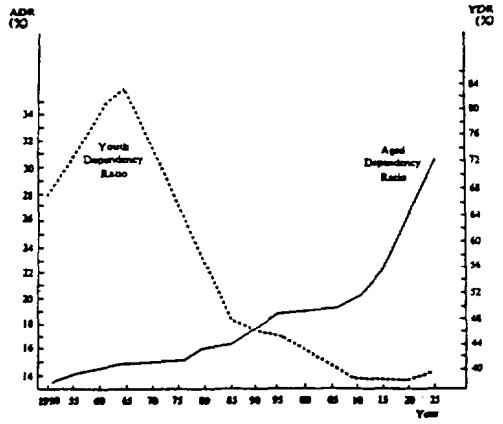
Thus one can conclude that the method of funding social security schemes is virtually irrelevant in regard to their inherent security, even their security in an environment of significant demographic shifts.

The critical factor facing society is the impending shift in the ratio of retiree-consumers to worker-producers. How will we produce enough wealth to supply the consumption demand? This production/consumption equilibrium will be the focus of the remainder of the paper.

As stated, the real issue is not the method of financing, but rather the ability to transfer wealth. However, the same factors that have created these paygo funding problems also provide a partial solution.

The decline in live births in the 1970's also results in a decline in the transfer of wealth required to provide education and health care to the dependent young. Thus, while the number of dependent elderly is increasing, the number of dependent young is decreasing as indicated in Figure 3, based on Canadian data.

FIGURE 3
YOUTH AND AGED DEPENDENCY RATIOS



Source: Province of Ontario, 1979 p.19

The Youth Dependency Ratio presented is simply the number in the population aged 0 to 17 divided by the population aged 18 to 64. Similarly the aged dependency ratio is the number aged 65 and over to those aged 18 to 64.

If the transfer of wealth required to educate and provide health care to the young was equal to the transfer of wealth required for health care and retirement income security for the elderly, then no problem would exist, since the Total Dependency Ratio (youth plus aged) is no higher in 2025 than it was in 1960.

That is not the case, however.

Analysis for Canada (Foot, 1982) has shown that government expenditures on the elderly are 2.5 times those for the young (per capita). Therefore, any analysis that attempts to derive a shift in the age of entitlement for retirement income security should include the lower demands for wealth by the youth sector and also include the differing transfer factors for the young versus the elderly.

Such an analysis has been done on Canadian data (Brown and Iglesias, 1989). The authors developed a statistic called the Labor Force Expenditure Dependency Ratio (LFEDR) defined as

$$LFEDR = \frac{(1.7 \times Y) + (1 \times U) + (4.244 \times A)}{LF}$$

where

Y = Youth, 0-19

U = those collecting Unemployment benefits

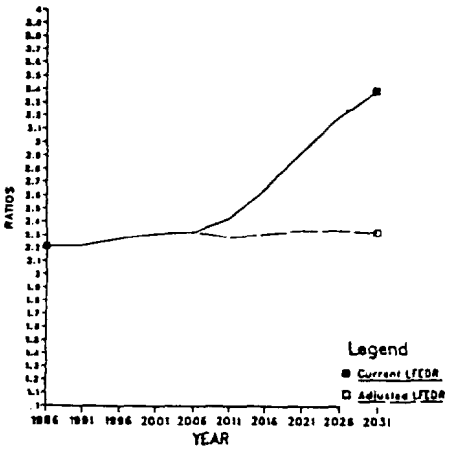
A = Aged, 65 and over

LF = the projected labour force

The weights of 1.7, 1, and 4.244 were derived by Foot (1982, p.17) and depict relative wealth transfer weights for the young, the unemployed, and the elderly. Statistics Canada population projections were used for the model's projected input variables. The labour force was projected to include trends of increasing female labour force participation, but assumed that male labour force participation rates would remain stationary.

The statistic referred to as LFEDR could also be called a Wealth Transfer Index. It is a single statistical indicator of the supply of (denominator) and demand for (numerator) wealth. As shown in Figure 4 (Brown and Iglesias, p. 38), this Wealth Transfer Index does not change very much until 2006.

FIGURE 4
WEALTH TRANSFER INDEX



Source: Brown and Iglesias, p.38

After 2006, it increases rapidly as the population ages, and, in particular, as the baby boom generation retires and the labour force turns to the baby bust generation for wealth creation. Brown and Iglesias determined an increase in the age of entitlement for wealth transfer to the elderly that would keep the Wealth Transfer Index constant at its 2006 level, as indicated in Figure 4.

This shift in the age of entitlement can be determined by finding K such that

$$LFEDR(2006) = \frac{(1.7 \times Y) + (1 \times U) + (4.244 \times A_{65+K})}{LF_{65+K}}.$$

This model has two assumptions that are not obvious. First, as the age of entitlement increases, the elderly who lose some of their early social security retirement income benefits are expected to remain in the labour force with the same participation rates as those now

aged 60-64. Second, it is assumed that there will be a slight improvement in health for those aged 65 to 69.

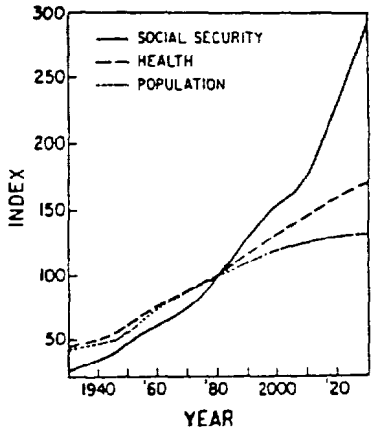
This latter assumption is not as dramatic as the reader might believe, for several reasons. First, improvement in the health profile of Canadians has occurred with the improvement in life expectancy (see Wilkins and Adams, 1983). Second, the most significant increase in health care costs arises after age 69 (see Marshall, 1987, p. 555). Finally, the impact on total wealth transfer from retirement income security is much greater than the impact of health care delivery.

Denton and Spencer (1984, p. 14) have shown that between 1980 and 2030 health care costs will rise 69.8 percent while social security costs will be three times their 1980 level in 2030 (see Figure 5), solely because of population aging.

FIGURE 5

INDEX OF SOCIAL SECURITY COSTS

(1981 = 100)



Source: Denton and Spencer, 1984, p.14

Given these assumptions, the model developed by Brown and Iglesias shows that the Wealth Transfer Index will remain level at its 2006 value if the age of entitlement shifts upward from 65 in 2006, by two months each year (starting in 2007) until it reaches age 69 in 2030. No further adjustment is necessary.

This is a remarkable result. As indicated earlier in Table 2, Canada will have the most rapidly aging population of all western industrialized nations over the period 1985 to 2025. Thus, if a shift in the age of entitlement from 65 to 69 creates a constant Wealth Transfer Index for Canada, then a smaller shift would do the same for all other western industrialized nations. Further, the Brown-Iglesias model does not include the effects of real productivity gains (*i.e.* real growth in wealth creation). Such gains, if not fully transferred to the elderly in their retirement income benefits, could be used to reduce further the age shift indicated.

The other powerful advantage of the age-of-entitlement alternative is its flexibility. Having determined an acceptable wealth transfer index, public policy makers are assured that there will be an age-of-entitlement shift that will exactly match that index requirement. Such an index could vary from time to time and place to place.

Raising the age of entitlement to government-sponsored retirement income does not mean that the only option is for workers to wait to retire. They can continue to retire whenever they wish. It just means there will be an extra need for private responsibility for the provision of retirement income prior to the new age of entitlement (*i.e.*, higher personal savings rates).

In this regard, it bears repeating that the announcement of any shift in the age of entitlement should be made well in advance of its occurrence to allow time for workers and employers to respond appropriately.

Clearly, if the baby bust generation will not agree to significantly higher contribution rates for social security (*i.e.* higher rates of foregone consumption), then the baby boom generation must be convinced to take reduced benefits (but only in line with the actuarial value of the relatively small contributions they are making today).

No economy can accommodate a sudden switch of all members of the baby boom (who

will reach age 65 between 2015 and 2030) from productive members of the labour force to passive retired consumers. Total production plus imports must equal total consumption plus exports.

A sudden drop in production with no change in consumption, would require increased imports, thus eroding the nation's balance of trade. Also, prices for domestic goods would increase. While the productive labour force may be able to achieve wage increases to offset the resulting inflation, the passive retireds will not, and will see the value of their assets, and their ability to consume, erode, until a new economic equilibrium is achieved. It would be preferable to have some of the baby boomers remain productive members of the labour force for a longer period, to achieve a consumption-production equilibrium without inflation. One cannot avoid the reality that wealth must be created before it can be transferred.

6 Conclusion

Real security for retirement income schemes is not a function of the method of funding (*i.e.*, paygo versus fully-funded), rather it is the ability to the economy to create and transfer wealth. This paper has analyzed the ability of all western nations to find an acceptable wealth transfer equilibrium given their aging populations. Because Canada has the most rapidly aging population among these western nations, Canadian data were used in the analysis.

The paper presents an age-of-entitlement model that can be used to achieve *any* acceptable wealth transfer ratio. The Canadian data show that the maximum age shift that would be required to solve the problems projected over the next half century is a shift in the normal retirement age from 65 to only 69 (a proposed graded shift starting in 2007 and being finally achieved in 2030). No western nation should require a shift more dramatic than that.

It is the author's hope that this model will prove helpful in the public policy analysis that all western industrialized nations will pursue in the quest for a new wealth transfer equilibrium, and intergenerational equity.

7 Bibliography

Aaron, Henry J.: Economic Effects of Social Security, 1982, The Brookings Institute, Washington, D.C.

Barr, Nicholas. The Economics of the Welfare State 1987, Stanford University Press, Stanford, California.

Brown, Robert L. and Iglesias, F.A.: Social Security Funding Stability: An Age of Eligibility Model, 1989, University of Waterloo, Institute of Insurance and Pension Research, #89-01.

Brown, Robert L.: Economic Security in an Aging Population: Implications to the Design and Marketing of Group Products. Transaction of the Society of Actuaries, 1994, Volume 46. To appear.

Canadian Institute of Actuaries: Canadian Retirement Income Social Security Programs. Report of the Task Force on Social Security Funding. November, 1993, Ottawa.

Chen, Yung-Ping: "Making Assets out of Tomorrow's Elderly". 1987. The Gerontologist 27(4): 410-16.

Denton, F.T. and Spencer, B.G.: Prospective Changes in the Population and their Implications for Government Expenditure, 1984, QSEP Research Report No. 98 (June), McMaster University: Program for Quantitative Studies in Economics and Population.

Economic Council of Canada: One in Three - Pensions for Canadian to 2030, 1979, Ottawa.

Felligi, Ivan, P.: Can We Afford an Aging Society? 1988, Canadian Economic Observer (October), Ottawa, Statistics Canada.

Foot, David K.: Public Expenditures, Population Aging and Economic Dependency in Canada, 1982, Institute for Policy Analysis, University of Toronto.

Hohn, Charlotte: Population Policies in Advanced Societies: Pronatalist and Migration Strategies, 1987, European Journal of Population, 3: 459-81.

Latulippe, Denis: Retirement Policy - An International Perspective. Transactions of the Society of Actuaries, 1993, Volume 45, To appear.

Marshall, Victor, W.: Aging in Canada, Social Perspectives (2nd Ed), 1987, Markham: Fitzhenry and Whiteside.

Ménard, Jean-Claude and Potvin, Sonia: Actuarial Adjustment Factors: Methodology and Considerations Applicable to a Social Insurance Plan. Canadian Institute of Actuaries, October 1992, Ottawa.

Myers, Robert J.: Implications of Population Change on Social Insurance Systems Providing Old-age Benefits, 1985, Insurance, Mathematics and Economics 4(1) (January).

Office of the Superintendent of Financial Institutions: Canada Pension Plan Fourteenth Actuarial Report as at December 31, 1991, Ottawa.

Pifer, Alan and Bronte, Lydia: Our Aging Society: Paradox and Promise, 1986, New York W.W. Norton and Company.

Province of Ontario: Issues in Pension Policy, 1979, Ministry of Treasury and Economics, Ontario Treasury Studies, No. 16.

Statistics Canada (Nagnur, Dhruva): Longevity and Historical Life Tables 1921-1981 (Abridged), Canada and the Provinces, 1986, Ottawa: Ministry of Supply and Services.

United States Department of Commerce: An Aging World: International Population Report Series P-95:78, 1987 (September), Washington: Bureau of the Census.

Weitz, Henry: The Foreign Experience with Income Maintenance for the Elderly, 1979, Economic Council of Canada, Ottawa.

Wilkins, Russell and Adams, Owen: Health Expectancy in Canada, Late 1970s. Demographic, Regional and Social Dimensions. American Journal of Public Health 73(a): 1073-80 (1983).