

ACTUARIAL ASPECTS OF THE CHANGING CANADIAN
DEMOGRAPHIC PROFILE

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ABSTRACT

Although many of the effects of the "postwar baby-boom tidal wave" are obvious now (e.g., the closing of elementary and secondary schools), many will not reveal themselves for another forty or fifty years. This paper reviews the recently published Canadian literature in this area and highlights the actuarial aspects of the information provided therein.

INTRODUCTION

Nobis cura futuri, the motto of the Canadian Institute of Actuaries, may be roughly translated "We care about the future." Perhaps no profession is better equipped to assist in preparing society for the future than the actuarial profession. This paper was written to provide the future actuary with more tools for this task.

THE CHANGING CANADIAN DEMOGRAPHIC PROFILE

Figure 1 illustrates what we have come to know as the "postwar baby boom." The phrase is a bit misleading in that, while the birth rate did begin to rise in the late 1940s, the real baby-boom years were in the late 1950s and the early 1960s (the peak number of live births actually occurred in 1959). The baby boom would have been traumatic enough on its own, but what makes this demographic phenomenon even more significant is the fact that the boom peak was immediately followed by an extreme trough. In fact, in one decade the Canadian fertility rate went from its highest to its lowest level of this century. The present fertility rate of about 1.8 and birth rate of about 15.4 put Canada below a zero-population-growth rate (estimated at about 2.1 and 16.2, respectively).

The effect of this baby-boom tidal wave can be seen in Table 1. Projection I assumes that the fertility rate drops to 1.50 in 1985 and then remains at that level. Projection II assumes a constant future fertility rate of 1.84. Both projections assume net annual immigration of 100,000.

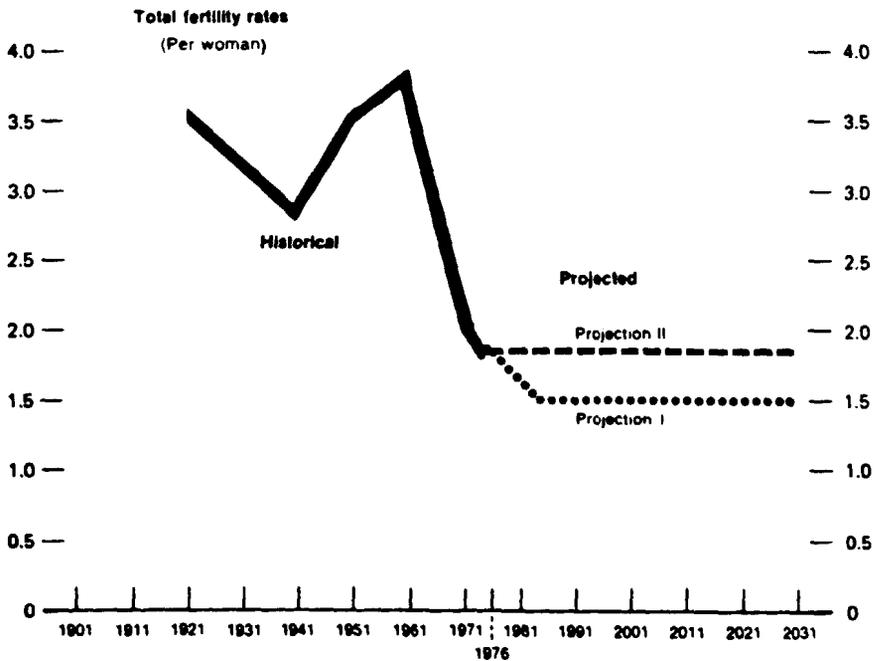
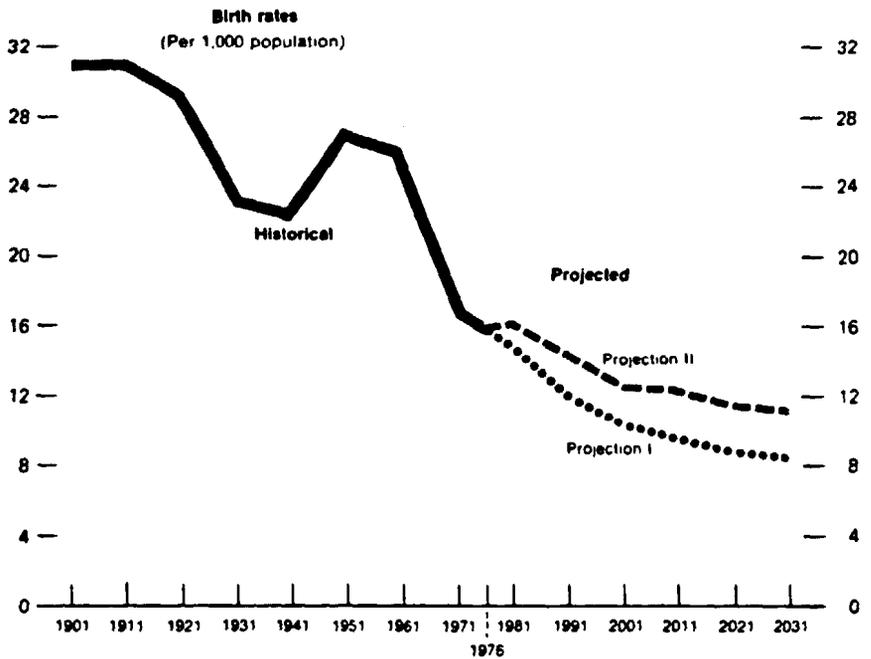


FIG. 1.—Birth rates and total fertility rates, Canada, 1901–2031. (From [23], p. 10.)

Figure 2, provided by the actuary and demographer Geoffrey Calvert, illustrates graphically the effects of these trends. Assuming a constant fertility rate of 1.875 and net annual immigration of 85,000, he illustrates how the baby-boom tidal wave will change the normal population pyramid into a pregnant cylinder.

It must be remembered that these are arithmetic projections, not predictions. No one knows with any certainty what will happen to fertility rates in future decades. Some demographers feel that we are in for a second baby boom in the 1980s as the original boom passes through the child-bearing age group. While a constant fertility rate will lead to an increased birth rate in this decade, Figure 2 shows that there is little reason to believe that the "echo" from the baby boom will create anything more than a small elongated ripple.

Although we cannot be sure of the complete accuracy of our projections, some components are well established. We can be fairly certain about the numbers of people aged 50 and over who will be living fifty years in the

TABLE 1

TOTAL POPULATION AND PERCENTAGE DISTRIBUTION BY BROAD AGE GROUPS, FOR CANADA, PROJECTED TO 2031

YEAR	TOTAL (000)	AGE GROUP		
		0-17	18-64	65 and Over
		Total = 100.0%		
Projection I				
1976	22,905.7	31.6%	59.8%	8.6%
1981	24,299.9	27.8	62.9	9.3
1986	25,581.3	25.3	64.7	10.0
1991	26,672.8	23.9	65.2	10.9
1996	27,552.7	22.5	66.0	11.5
2001	28,250.7	20.9	67.2	11.9
2011	29,167.5	18.8	67.9	13.3
2021	29,387.4	17.6	64.8	17.6
2031	28,838.6	16.8	61.0	22.2
Projection II				
1976	22,905.4	31.6%	59.9%	8.6%
1981	24,408.1	28.1	62.6	9.3
1986	26,001.3	26.5	63.7	9.8
1991	27,463.0	26.1	63.4	10.6
1996	28,692.8	25.5	63.4	11.1
2001	29,757.5	24.2	64.5	11.3
2011	31,642.1	22.2	65.5	12.3
2021	33,020.5	21.7	62.7	15.7
2031	33,726.7	21.0	60.0	19.0

SOURCE.—[23], p. 8.

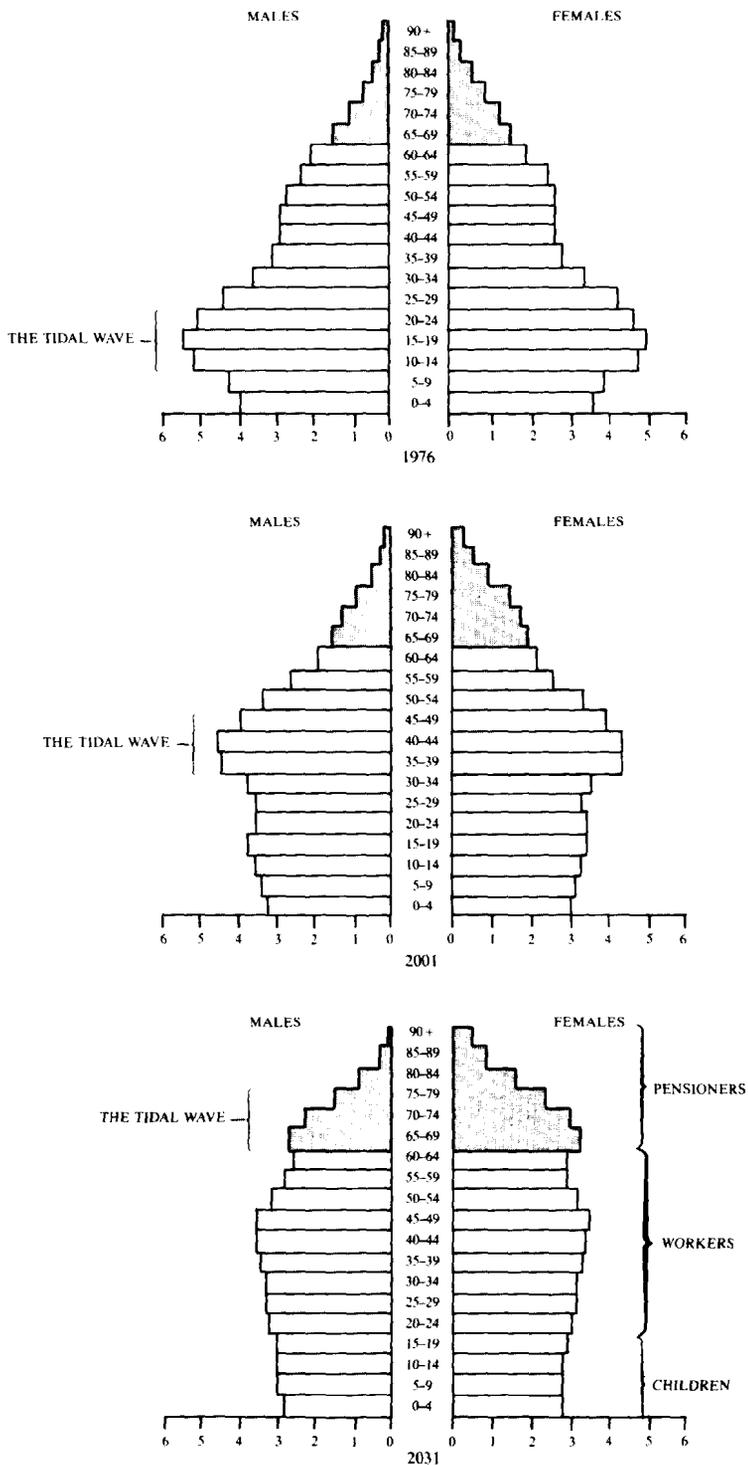


FIG. 2.—Age distribution of Canada's population, 1976–2031. (From [3], p. 17.)

future, because they are already alive. A change in mortality factors would have only a very small effect (in fact, although we will mention the fertility and immigration assumptions used in all of the projections referred to in this paper, the mortality assumption is often ignored because of the very small effect it has on overall results). Changes in immigration can have some effect, but present levels of net immigration (50,000–150,000 per year) are small in relation to the number of Canadians who are already here.

To repeat, then, these are projections, not predictions. A projection is the numerical consequence of the assumptions chosen; the bridge between a projection and a prediction is the validity of the assumptions.

DEPENDENCY RATIO

Table 2, based on a constant fertility rate of 1.8 and net annual immigration of 100,000, shows dependency ratios for Canada both past and present. Of interest is the fact that although youth dependency is already at an all-time low, it is set to go much lower yet. Also, the major increase in the aged population does not begin until after 2011. That means that

TABLE 2
DEPENDENCY RATIOS FOR CANADA, 1901–71;
PROJECTIONS, 1976–2071

YEAR	AS PERCENTAGE OF POPULATION AGED 18–64		
	Population Aged 65+	Population Aged 0–17	Total Dependency
1901	9.3%	74.9%	84.2%
1911	8.2	68.2	76.4
1921	8.7	72.6	81.3
1931	9.8	66.6	76.4
1941	11.2	56.5	67.7
1951	13.5	60.8	74.3
1961	14.3	72.8	87.1
1971	14.4	63.4	77.8
1976	14.4%	52.8%	67.2%
1981	14.8	44.9	59.7
1986	15.4	41.6	57.0
1991	16.7	41.1	57.8
1996	17.4	40.3	57.7
2001	17.5	37.6	55.1
2011	18.7	33.9	52.6
2021	25.0	34.6	59.6
2031	31.7	35.0	66.7
2041	30.3	34.4	64.7
2051	30.6	34.7	65.3
2061	31.0	34.6	65.6
2071	30.6	34.7	65.3

SOURCE.—[18], p. 13.

our society has enough time to react gradually to the changing demographic profile, so that one may hope that the transition will be smooth and bearable.

Further, although the ratio of the population aged 65 and over to that aged 18-64 (the labor force) may appear to reach startling proportions in the next century, Table 3 shows us that these ratios have already been experienced in many European countries where the baby boom peak-trough was experienced in a manner similar to ours but much, much earlier. These countries have survived and are strong economically, so there is no reason why Canada should collapse under this burden.

Many economists have suggested that because our total dependency ratio will be lower in the next century than it is now, all that is required is a shift of resources from the young to the old. Unfortunately, it is not that easy.

It has been shown that in 1976, per capita government-sector expenditures for the aged were 2.5 times per capita expenditures for the young. Table 4 illustrates nicely the consequences of this fact.

First the table shows the total dependency ratio and the aged dependency ratio relative to 1976. We see here that the total dependency ratio through 2031 is never as high as it was in 1976.

Keeping in mind that per capita costs for the aged are 2.5 times those of youth, however, it is possible to determine an *effective* dependency ratio. This ratio drops slightly in 1981 relative to 1976 but then rises to 1.43 in 2031. This is a truer measure of the cost of our aging population. Finally, the authors show what will happen if support costs grow at a rate 1 percent lower than the growth in per capita income. Under this as-

TABLE 3

NUMBER OF PERSONS IN LABOR FORCE PER NONWORKING PERSON AGED 65 AND OVER,
IN TEN INDUSTRIALIZED COUNTRIES, 1950-2000

Year	Austria	Belgium	France	Germany	Japan	Nether-lands	Sweden	United Kingdom	United States	Canada
1950	5.76	3.97	5.12	5.75	13.23	5.97	5.19	5.02	6.79	6.0
1955	4.95	3.68	4.63	5.39	12.68	5.05	4.65	4.64	5.87	5.7
1960	4.31	3.38	4.23	4.92	12.23	4.37	4.11	4.41	5.25	5.8
1965	3.59	3.12	3.82	4.21	11.72	4.14	3.87	4.31	5.05	5.6
1970	3.10	2.90	3.43	3.60	10.59	3.90	3.52	3.92	4.96	5.7
1975	2.96	2.78	3.36	3.40	9.26	3.76	3.19	3.68	4.86	5.5
1980	2.99	2.76	3.38	3.37	8.08	3.69	2.98	3.54	4.79	5.3
1985	3.46	3.05	3.84	3.87	7.39	3.70	2.92	3.62	4.68	5.2
1990	3.42	2.90	3.64	3.78	6.61	3.57	2.91	3.62	4.55	4.8
2000	3.51	2.76	3.45	3.38	5.02	3.45	3.34	3.98	4.83	4.8

SOURCE.—[24], p. 9.

TABLE 4

PROJECTED DEPENDENCY RATIOS RELATIVE TO 1976

	1976	1981	1991	2001	2011	2021	2031
1. Relative crude dependency ratios:							
Total	1.00	0.89	0.86	0.82	0.78	0.89	0.99
Aged	1.00	1.03	1.16	1.22	1.30	1.74	2.20
2. Relative effective* dependency ratios:							
a) Equal growth:							
Total	1.00	0.98	1.02	1.01	1.02	1.20	1.43
Aged	1.00	1.14	1.40	1.48	1.59	2.11	2.72
b) 1% growth differential:							
Total	1.00	0.94	0.89	0.82	0.78	0.86	0.96
Aged	1.00	1.08	1.23	1.23	1.24	1.56	1.85

SOURCE.—[18], p. 15.

* Assuming 1.8 fertility rate and net immigration of 100,000.

sumption, total dependency costs again fall slightly, so that only a transfer of resources from youth to aged is required. What is not presented, but can be construed, is the dependency ratio if support costs grow at 1 percent *more* per annum than per capita income—not an unrealistic scenario!

IMPACT ON HEALTH EXPENDITURES

The Federal Health Act of 1968 offered universal application of a full program of medical services, administered by the public sector, under which benefits would be transferable between provinces. Prior to 1977, the federal government provided cost sharing on the basis of 25 percent of the cost per capita in the particular province plus 25 percent of the cost per capita in Canada as a whole. In 1977 a revised grant system provided the provinces with a larger share of tax, plus cash payments made on a per capita basis (the latter escalates each year at a rate based on the evolution of GNP growth).

Consumption of health services is affected primarily by age and sex and, to a lesser extent, by education, income level, and occupation. Thus, a change in the demographic profile is worthy of analysis with respect to health care costs, especially considering that an estimated \$3.1 billion of government funds was applied in 1976 to health-related expenditures on people aged 65 and over, as opposed to expenditures of \$3.3 billion for the old-age security program in the same year.

One such analysis was done for the Economic Council of Canada by J. A. Broulet and G. Grenier [2]. They assumed that no new huge government programs would be introduced and that the usual supply and

demand constraints can be effectively ignored with respect to health services in Canada (not a free-enterprise service). Thus, they assumed that all costs remained unchanged and they looked only at the effect of demographic changes.

The authors made two projections based on 1976 data. Their low-growth scenario assumed a continuing fertility rate of 1.8 and net annual immigration of 60,000. Their high-growth scenario assumed a fertility rate that rose to 2.2 in 1981 and remained level thereafter, and net immigration of 100,000 per annum. In doing such an analysis, one must remember that health costs present a U-shaped curve with respect to age, as shown in Figure 3.

By analyzing the costs associated with physicians' services and the use of hospitals, the authors draw several conclusions. The per capita cost, which was \$249 in 1976 (in 1974 dollars), would increase under the low-growth scenario to \$292 in 2001 and to \$363 in 2031. Under the high-growth scenario, it would be \$281 in 2001 and \$326 in 2031. Further, the highest *growth rate* in government-insured health expenditures will occur between now and 1986, because in this period the population is both

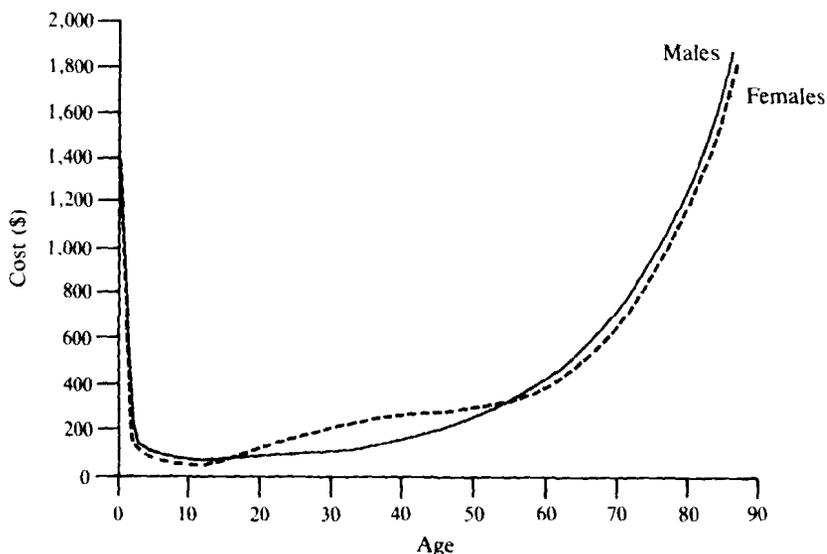


FIG. 3.—Adjusted annual per capita cost of government-insured health services, by age and sex, Canada, 1974. (From [2], p. 49.) *Note:* Expenditures under government-insured health services (the medical care and hospital insurance programs) are proxied, as noted in the text, by the costs associated with physicians' services and the use of public general and allied special hospitals.

growing and aging. Later, while it continues to age, its growth rate declines. The authors show that these costs are manageable within realistic GNP projections (Fig. 4).

Finally the authors make a series of recommendations, including the following:

1. Making consumers aware of the costs and inefficiency of using and misusing the system (e.g., by mailing a personalized annual statement of covered billings).
2. Providing alternate, more efficient, less costly care for the aged (home care and nursing homes instead of hospitals).
3. Encouraging a healthy life-style.
4. Continuing to audit budgets and scrutinize providers closely.
5. Allowing some medical procedures previously handled by professionals to be handled by less qualified personnel.

A related document, *A Prognosis for Hospitals, 1967-2031*, from Statistics Canada [17], looks at the particular problems for hospitals, and makes the following comments.

Hospitals are the most costly sector in the health care delivery system, representing expenditures of \$5.3 billion in 1975, or 3.3 percent of the

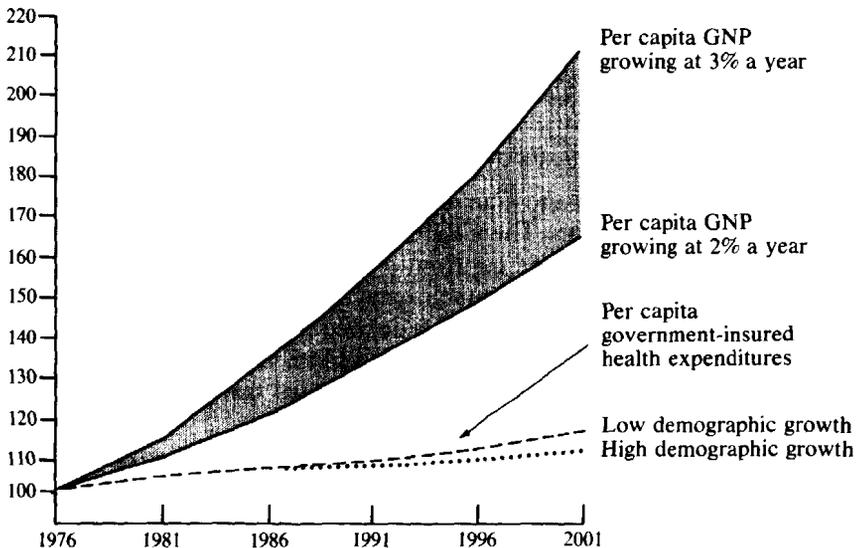


FIG. 4.—Evolution of per capita GNP and government-insured health expenditures at constant relative prices, Canada, 1976-2001 (1976 = 100). (From [2], p. 71. Sources: Statistics Canada and estimates by the authors.)

GNP and just under 50 percent of total health expenditures in that year. Frequency of admission and length of stay increase with age. In 1975, those aged 65 and over represented 8.6 percent of the population but utilized almost 38 percent of total hospital bed capacity. With an increasing proportion of elderly in the population and an increased life expectancy, this usage factor can only increase. The need for hospitalization for someone aged 75 or over is six to seven times that for someone aged 5-14. In 1975, for the age group 75 and over, males averaged 27 days' stay and females 35 days' stay—more than a week more.

Between 1967 and 1975, the increase in annual patient days from 36.9 million to 43.1 million was 1½ times the rate of population growth. By 2031, total hospital patient days are projected to rise to 84 million. But the figure for the elderly is projected to more than triple, from 16 million to 55 million days (or from 38 percent to 65 percent of all patient days). Expenditures in 1976 dollars would rise from \$5.4 billion to over \$11 billion.

The document encourages the transfer of care for the elderly from hospitals to nursing homes or home care. A nursing home patient day is about one-fifth as expensive as one in a hospital (in 1976, \$25 as opposed to \$125), and home care is cheaper still. For nursing homes, the capital investment per bed is roughly 60 percent of that for hospitals. Another reason to encourage home care is the fact that the baby boom is followed by a bust (the peak-trough). Do we want empty hospitals in 2050 as we now have empty schools?

CANADA/QUEBEC PENSION PLAN

A brief description of the Canada/Quebec Pension Plan is helpful in understanding this section. The C/QPP has contributions related to paid work. At present, employees contribute 1.8 percent of eligible earnings to be matched by the employer (self-employed contribute 3.6 percent). Contributions are not required below a defined minimum level of earnings or above a maximum level called the Year's Maximum Pensionable Earnings (YMPE). In the future, the YMPE will equal the average industrial wage.

The retirement pension is defined as 25 percent of career average eligible earnings (in fact it is, in effect, a "25 percent of final three years' average" plan for those earning the YMPE each year). The pensions, which commence at age 65, are indexed to the Consumer Price Index. The C/QPP has a number of very desirable features, such as universality, immediate vesting, complete portability, and indexing.

The C/QPP is not actuarially fully funded, nor is it quite pay-as-you-go. Rather, a contribution rate was established at a level high enough to generate a fund that could be used to help stabilize the contribution rate in future years. Initially, as many workers made contributions but few workers (or dependents) received benefits, significant funds developed, which were, in effect, lent to the provinces. The provinces pay interest on this debt and are expected to repay the debt if and when the cash-flow situation becomes negative.

Unfortunately, when the C/QPP was established in 1966, the 3.6 percent contribution rate was arrived at by assuming a level fertility rate of 2.159. The recently experienced fertility rate of 1.8 is more than 16 percent lower than the 1966 assumption.

In his book *Pensions and Survival*, Calvert [3] points out that the “pension burden” will more than double by 2031 and would more than quadruple if retirement at age 55 were allowed under the C/QPP. For ease of presentation, I have used the notation T_x to represent people aged x and over (as in Jordan, *Life Contingencies*, chap. 8).

Year	$T_{65}/(T_{20} - T_{65})$	$T_{60}/(T_{20} - T_{60})$	$T_{55}/(T_{20} - T_{55})$
1976	15.60%	24.41%	36.10%
2001	18.41	26.65	38.96
2031	33.37	47.66	65.84*

* From [3], p. 21.

Thus, the current ratio of almost seven workers to each pensioner will decline to only three to one by 2031, even if the retirement age remains at 65.

Calvert’s analysis has been criticized for two reasons. First, it does not reflect the effects of a change in either labor force participation rates (e.g., the recent influx of females) or unemployment rates. Second, the C/QPP “tax” is a payroll tax, not a head tax. Consequently, if projected payroll (wage) growth exceeds employment growth, as might be expected if labor productivity grows, projected tax rate increases can be moderated.

The opposite extreme to Calvert’s opinion was expressed by Paul A. Samuelson in an article in the February 13, 1977, issue of *Newsweek*:

The beauty about social insurance is that it is actuarially unsound. Everyone who reaches retirement age is given benefit privileges that far exceed anything he has paid in. And exceed his payments by more than ten times as much (or five times, counting in employer payments)! . . . It stems from the fact that the national

product is growing at compound interest and can be expected to do so for as far ahead as the eye cannot see. Always there are more youths than old folks in a growing population. More important, with real incomes growing at some 3%, the taxable base upon which benefits rest in any period is much greater than the taxes paid historically by the generation now retired.

The Canadian Department of Insurance, in filing *Actuarial Report No. 6 of the Canada Pension Plan as at December 31, 1977* [9], shares neither the total pessimism of Calvert nor the blind optimism of Samuelson.

The report starts by pointing out that the 3.6 percent contribution rate set in 1966 was expected to last for around fifteen years; it would then be adjusted as conditions required. The actuary then presents three possible fund scenarios (Funds A, B, and C) as shown in Table 5. These projections assume a fertility rate of 2.112 after 1985, a net immigration rate of 0.465 percent of the population at time t , and a gap of 2 percent between increases in earnings and increases in the CPI. If any of these parameters turn out to be lower than assumed, increases in the contribution rate would tend to be required slightly earlier and the required level of contribution rate would be slightly higher (and vice versa).

Fund A assumes that the contribution rate stays constant at 3.6 percent. Given this assumption, the CPP fund would be exhausted in 2003, and either the contribution rate would have to be raised (at least to Fund B levels) or other revenue found. Under Fund B, the contribution rate is increased to a level sufficient to meet current expenditures. Because interest is not used for expenditures, the fund is always increasing. Finally, under Fund C, the contribution rate is increased to levels such that contributions plus interest earnings would continue to equal expenditures on a current basis. Given the assumptions used in all three scenarios, the contribution rate will rise from 3.6 percent now to around 9 percent in 2030 if the present CPP benefits are *not* increased. (An analysis of the Quebec Pension Plan would yield similar results.) On the other hand, this contribution rate is not particularly high when compared to the cost of similar schemes in other countries.

The report of the Royal Commission on the Status of Pensions in Ontario (the Haley commission), published in February 1981 [14], included the following comments on CPP funding:

On the (present) partial funding basis, the cost of benefits and expenses will equal contributions in 1986, and the cash flow to the provinces will cease unless contributions are increased. In 1991 all of the interest payments will be required to pay benefits, and if contributions are not increased the C.P.P. fund will start to decline. By 2001, the fund will be exhausted.

TABLE 5

FUND PROJECTIONS

(Fund in Billions of Dollars; Other Dollar Figures in Millions; Contribution Rate as Percent of Contributory Earnings)

CALENDAR YEAR	BENEFITS AND EXPENSES (1)	FUND A* 3.6% CONTRIBUTION RATE			FUND B CASH FLOW TO PROVINCES DECREASES UNTIL ZERO				FUND C CASH FLOW TO PROVINCES DECREASES UNTIL NEGATIVE AND EQUAL TO INTEREST ON FUND			
		Contributions (2)	Cash Flow to Provinces (3)	Fund at End of Year (4)	Contribution Rate (5)	Contributions (6)	Cash Flow to Provinces (7)	Fund at End of Year (8)	Contribution Rate (9)	Contributions (10)	Cash Flow to Provinces (11)	Fund at End of Year (12)
1978	\$ 1,386	\$ 2,096	\$ 710	\$14.3	3.60%	\$ 2,096	\$710	\$ 14.3	3.60%	\$ 2,096	\$ 710	\$14.3
1979	1,752	2,376	625	16.1	3.60	2,376	625	16.1	3.60	2,376	625	16.1
1980	2,152	2,674	522	17.9	3.60	2,674	522	17.9	3.60	2,674	522	17.9
1981	2,553	2,992	439	19.8	3.60	2,992	439	19.8	3.60	2,992	439	19.8
1982	2,993	3,323	330	21.7	3.60	3,323	330	21.7	3.60	3,323	330	21.7
1983	3,427	3,666	238	23.7	3.60	3,666	238	23.7	3.60	3,666	238	23.7
1984	3,901	4,016	116	25.6	3.60	4,016	116	25.6	3.60	4,016	116	25.6
1985	4,415	4,372	- 43	27.5	3.64	4,415	0	27.6	3.60	4,372	- 43	27.5
1986	5,000	4,702	- 299	29.3	3.83	5,000	0	29.7	3.60	4,702	- 299	29.3
1987	5,630	5,038	- 591	30.9	4.02	5,630	0	31.9	3.60	5,038	- 591	30.9
1990	7,794	6,142	- 1,652	34.2	4.57	7,794	0	39.5	3.60	6,142	- 1,652	34.2
1995	12,297	8,579	- 3,718	32.1	5.16	12,297	0	55.5	4.13	9,847	- 2,451	34.7
2000	18,416	11,997	- 6,418	14.5	5.53	18,416	0	76.7	4.84	16,146	- 2,270	34.7
2005	26,766	.....	.....	.....	5.74	26,766	0	105.1	5.26	24,512	- 2,255	34.7
2010	39,850	.....	.....	.....	6.20	39,850	0	144.0	5.85	37,596	- 2,255	34.7
2025	135,629	.....	.....	.....	8.62	135,629	0	370.5	8.48	133,374	- 2,255	34.7
2030	193,314	.....	.....	.....	9.09	193,314	0	507.6	8.98	191,060	- 2,255	34.7
2050	636,210	.....	.....	.....	8.76	636,210	0	1,788.5	8.73	633,955	- 2,255	34.7

* Fund would become exhausted in 2003, and contribution rate would have to be raised to Fund B level or other revenue found.

On a pay-as-you-go basis, where benefits are paid as they fall due without any assets being accumulated, the 3.6 percent contribution rate covers the benefit payments until after 1985. The cost would rise steadily thereafter to a peak of 9.28 percent in 2030.

With full funding (i.e., level premium funding with unfunded actuarial liabilities at 1980 amortized over 50 years) the contribution rates would be required to increase to 12.53 percent in 1980. The fund would increase from \$25 billion in 1980 to \$712 billion in 2000 and \$8.86 trillion in 2030.

On the basis of these observations, the commission recommended that the Canada Pension Plan should be funded on a pay-as-you-go basis (a Fund C basis), with a contingency fund maintained at the level required to satisfy twice the year's benefit and administrative cost pay-out three years in advance.

FUTURE MORTALITY RATES

Canadian data show that there has been a marked acceleration in mortality improvement during the period 1971-76 as compared with the period 1961-71. This suggests that there may be more room for improvement in the future than many believed at the end of the 1960s.

Of special note is the fact that mortality differentials by sex are widening despite a narrowing in life-style. This seems to suggest that one should use a different mortality projection scale for females than for males.

Although it is impossible to prove what led to these lower mortality rates, the following reasons are often suggested:

1. Successful treatment of hypertension.
2. A lower percentage of smokers (especially among males).
3. Improved life-style (diet and exercise).
4. A continued improvement in living standards.

What effect these or other causes (e.g., genetic engineering) will have in the future is unknown. Some feel the effects will be small. Noted British gerontologist and author Alex Comfort has said:

While the expectation of life at birth has increased steadily over the last century, the expectation at 65 years has changed little, if at all, having risen by only 2 years since 1901. It is computed that the total cure of the three leading causes of natural death in the U.S. (cardiovascular, cerebrovascular, and malignant diseases) while greatly beneficial to those who contract them young, would only increase the mean expectation of life at age 65 by 2.5 years.

On the other hand, in the highly competitive world of life annuities, a fraction of a year's change in mean life expectancies cannot be ignored.

THE SPECIAL CASE OF FEMALES

In the past decade, Canadian female labor force participation rates have skyrocketed. The figures shown in Table 6 are almost as important as the baby boom itself; and they explain, at least partly, the dramatic decline in birth rates. In fact, many economists speculate that today's unusually high rates of unemployment can be explained by the entry into the labor force of the baby-boom generation, coupled with the increase in female labor force participation rates.

These increased participation rates have created a new female market for insurance and annuities. According to Shirley Carr (executive vice-president of the Canadian Labour Congress), these figures also explain the increased demands for earlier and fuller vesting in private pensions (since women move in and out of the labor force more frequently than men), plus the greater demand for postretirement indexing (since women live longer than men) [5].

These increased participation rates have had (and will have) several effects on the Canada/Quebec Pension Plan. First, women have demanded special "drop-out" provisions in the Canada Pension Plan so that their years out of the labor force as homemakers will not affect their benefits. Second, women will now be earning C/QPP benefits in their own right to a greater extent. According to the Economic Council of Canada's study *One in Three* [10], "the proportion of women aged 65 and over who will not be beneficiaries of a retirement (as opposed to a survivor's) pension under the CPP and QPP will decrease from 68 percent in 1981 to 12 percent by the year 2031." This is not a complete solution, however, since these same women will be receiving below-average benefits; that is, they will not qualify for a 25 percent pension plan that is available to someone

TABLE 6

FEMALE LABOR FORCE PARTICIPATION RATES

Year	15-19	20-24	25-44	45-64
1970	30.0	58.9	39.0	35.9
1971	31.7	60.6	42.4	36.7
1972	32.8	60.8	43.5	37.4
1973	35.2	62.8	44.7	36.8
1974	36.9	63.3	47.2	37.3
1975	34.9	63.2	50.0	37.1
1976	47.0	67.3	53.7	41.1
1977	46.6	68.8	55.4	41.5
1978	47.8	71.0	58.0	42.5
1979	50.9	71.9	60.0	44.0

SOURCE.—[23].

consistently earning at least the maximum pensionable earnings. In fact, according to another study published by the Economic Council of Canada in 1980, the average female retirement benefit is 8.77 percent of maximum pensionable earnings as opposed to 12.37 percent for the average male (versus the maximum, 25 percent). By 2030 these benefits will have risen to an expected average of only 9.72 percent for females and 15.12 percent for males [8]. Since women may have only moderate increases in their future benefits (over what they would have received as dependents), and since they will not be beneficiaries for many years, the increasing proportion of females in the work force will serve to moderate C/QPP costs, at least for the immediate future.

RETIREMENT AGES

Age 65 is now accepted as the "normal" retirement age in most pension plans in Canada. While there continues to be some pressure (especially from labor unions) for a further reduction in the normal age, there is now almost equal pressure to end mandatory retirement and replace it with something more flexible.

In his report *Retirement without Tears*, [7] Senator David Croll suggests that a policy of flexible retirement become the standard. He lists three reasons why someone at age 65 would find forced retirement distressing:

1. They may be in good health and be quite capable of working.
2. They may be too poor to retire without a severe drop in their standard of living.
3. Their job may be enjoyable and very important to them.

He points out that increased life expectancies at age 65 of 13.95 years for a male and 18.0 years for a female might mean that long periods of one's life will be spent in poverty, aimlessness, and loneliness.

In his recent retirement income study [16], Harvey Lazar points out that early retirement is extremely costly. "Had OAS [Old Age Security] benefits been available at age 60 in 1977-78, the cost of the program would have risen from \$3.7 billion to well over \$5 billion. Had the age distribution expected in 2031 applied in 1977-78 and had benefits been available at age 60, the OAS costs would have been more than \$10 billion." Lazar makes two recommendations as to age at retirement:

1. Extend benefits similar to those of OAS to the chronically unemployed and disabled in the age group 60-64.
2. Make efforts to increase the range of choice available to older employees regarding their retirement age. Making provision for actuarial increases in OAS and C/QPP benefits to those who delay their receipt beyond age 65 would provide more choice to retiring employees. Elimination of mandatory retirement practices would have a similar impact.

MISCELLANEOUS

There are several other areas of interest that may be affected by the baby-boom tidal wave. For example, there is a life-cycle in savings in that the young dissave (or go into debt), those in the middle age group save (by building up assets such as a home or a pension fund), and the old dissave (by using up their savings and pensions). Will the baby-boom tidal wave generation cause national savings trends to rise and fall as they pass through the different age groups? Although much has been written on this, the various authors are not in agreement.

Other topics of interest include the effects on our social security systems of social trends such as increased divorce rates and divorced or unmarried couples living together. Satisfactory statistical analysis has not been done in these areas, so it is extremely difficult to draw any conclusions at this time.

CONCLUSION

This paper was originally drafted as a Study Note for the Society of Actuaries, and it was written with a perceived student audience. Some minor rewriting was done at the time the Society decided to publish this in its *Transactions*.

This paper is a précis of the material listed in the references, which constitute several thousands of pages of original material. It is impossible to write such a précis without leaving out some important points and without allowing one's bias to surface in the decision as to which items to include in the final version. This must be kept in mind.

It is to be hoped that actuaries will have an active role in shaping the security of future generations. Perhaps, in some small way, this paper will assist in the reader in "substituting facts for appearances and demonstrations for impressions."

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DISCUSSION OF PRECEDING PAPER

W. H. AITKEN:

The author has brought together a long list of very important demographic items, the last of which is retirement ages.

The retirement age for Old-Age Security was 70 when Germany introduced the concept in 1889; it was lowered to age 65 in 1916. The United Kingdom started at age 70 in 1908 and changed to age 65 in 1928. Canada started at age 70 in 1952 and moved to age 65 in 1970. The United States started at age 65 in 1937.

Meanwhile the expectation of life has been slowly increasing in all these countries. For example, the Canadian expectation at age 65 for males has increased from 11.8 in 1915 to 17.5 in 1971. And the current expectation at age 70 is slightly longer than the 1915 expectation at age 65. A further slight increase in life expectancy in the future plus the declining ratio of workers to pensioners (seven to one currently but three to one in 2031) suggest extreme difficulty in maintaining age 65. Perhaps the commencement of OAS should be moved back to age 70.

Such an important change would require planning, discussion and legislation; keeping in mind the ratio of workers to pensioners, perhaps it should be done in five steps of one year each.

I wonder if the author could add to his list the results of any studies in Canada with regard to slowly increasing the retirement age.

If the commencement is left at age 65 the CPP cost is projected to increase from 3.6 percent of earnings up to the YMPE to 9 percent in 2030. In addition, there are transfer payments to OAS which could be expressed as a percentage of payroll and would roughly equal the CPP figures.

Since the problem is similar in the U.S., perhaps solutions for both countries could be compared, involving dependency ratios or percentage of payroll or both.

The present state of unemployment and the future prospects for computerization suggest that no increase in retirement age should be made currently. But the future demographic profile and the need for improved national productivity suggest that having more workers between age 65 and 70 will be an important consideration in the future.

GEOFFREY N. CALVERT:

So much has, necessarily, been omitted from this brief but generally useful treatment of a very broad subject that it is difficult to know where to begin to fill the gaps. Therefore I will limit these comments to correcting some inaccurate statements and then add some fresh material.

Concerning the funding of the C/QPP, the author states that the provinces pay interest on the funds they have borrowed from the C/QPP, and are expected to repay the debt if and when benefit flows exceed contributions. This may have been the original theory, but the reality is quite different. Not one cent of interest has ever been paid by any province. The C/QPP has been a godsend to provincial treasurers, but investment in provincial bonds has not been a godsend to the C/QPP. Far from it! It seems clear enough that contribution rates (taxes) will need to be increased before benefit outflows exceed contributions without benefit of interest payments from the provinces. In the meantime, provincial treasurers will happily go on compounding the debt. After all, it is the provinces that control the C/QPP.

In commenting on the ultimate contribution rate needed to support the C/QPP, the author states that this rate is "not particularly high" when compared with the costs of similar schemes in other countries. It is quite surprising to see this comparison made, for it completely omits reference to the underlying OAS/GIS system, which is essentially supported by the same taxpayers, but which is camouflaged by being paid for out of "general revenues." Only when the costs of both the C/QPP and the OAS/GIS systems are combined can one make valid comparisons with the costs of systems in other countries, many of which are in deep financial trouble at this time.

As to Paul Samuelson's somewhat good-natured 1977 comments, I do not think he would say the same things in today's context of a social security system on the very edge of bankruptcy and faced with both short-term and severe long-term problems. Not only does the author sweep aside the demographic outlook that is the subject of this paper, he assumes an indefinitely continuing 3 percent annual growth in real incomes, which is opposite to what the United States has been experiencing. The actual record was as follows:

Period	Average Annual Productivity Growth
1948-54	3.4%
1955-64	3.1
1965-72	2.3
1973-76	1.0
1977-78	0.4
1979	- 1.6, and still falling

I am quite puzzled by the author's statement that my 1976 analysis, published in *Pensions and Survival*, has been criticized (1) for not reflecting changes in labor force participation rates, and (2) because the C/QPP tax is a payroll tax, not a head tax. Pages 25–31 of that book contain a full discussion of labor force participation, increasingly later entry into and earlier exit from the work force, the sweep of women into the work force, and the trend to a shrinking number of hours worked per week. The net effect of these various trends probably would be adverse rather than helpful.

As to the payroll-tax/head-tax matter, has the author overlooked that the *benefits* under the C/QPP are *also* based on earnings levels? And that they are indexed?

The work I did in 1976 was designed to alert Canadians to the basic fundamentals of the demographic outlook before they plunged into a reckless expansion of their public pension systems. In this it seems to have succeeded. With the benefit of six years of hindsight, I would be inclined today to factor in (1) the outlook for increasing longevity, and (2) the probable future crosscurrents which will result from the technological revolution in increasing both productivity and unemployment (or further shortened work hours).

On the first of these points, the actuarial staff of the United States social security system, in its Actuarial Note No. 105, shows that the benefit commencement age which would preserve the same ratio between years in retirement and years at work as existed in 1940 when the system started would be the following:

In 1940	65 years
1980	69.01
1990	70.05 (projected)
2000	71.01 (projected)
2025	72.00 (projected)

If the genetic engineers and biochemists do what they say they will, these figures may have to be revised upward. None of these trends has so far been recognized in Canadian projections of costs under public pension systems, or in proposals to revise these systems. On the contrary, Canada has been experiencing an extraordinary expansion in costs under its various health and social insurance programs, only a part of which has been due to the aging of the population. Still there has been no effort made to project what the future holds when all parts of this picture are combined.

(AUTHOR'S REVIEW OF DISCUSSION)

ROBERT L. BROWN:

I would like to thank Messrs. Aitken and Calvert for their stimulating comments. I will add some personal comments to the original paper, which was solely a précis of existing studies.

The reader must be careful not to misinterpret some of the comments made by Geoffrey Calvert. He says that the provinces have not paid any interest on their loans from the CPP fund. He is correct, but it can be argued that that is true only because the cash flow has, to date, been to the provinces. They are still being charged interest, even if only nominally. If they are physically to avoid making such payments, a political decision to change the funding arrangement will be required. I feel that reality is quite clearly portrayed in the Department of Insurance's Fund A, B, and C analysis.

Mr. Calvert implies an analytical error in omitting OAS/GIS costs when commenting on future CPP contribution rates in their international context. Canada is not the only country that uses a multitiered system of support for their aged dependent population. I still maintain that a 9 percent contribution rate for the benefits provided by the CPP is not particularly high when compared with the costs of other schemes. Along with Messrs. Aitken and Calvert, I am seriously concerned about the total cost of supporting our aged dependents into the twenty-first century, as will be seen later.

I am glad that Mr. Calvert objects to Paul Samuelson's blind optimism. I do too, and included his comments in the original paper for that very reason.

Finally, I want to remind Mr. Calvert that CPP benefits are indexed to the cost of living while contributions are indexed (or will be) to average wages. Real increases in wages have an important effect on the required contribution rate for the CPP, as the valuation actuary so wisely takes into account in his analysis.

Lest the reader assume that Geoffrey Calvert and I are in disagreement, I want to emphasize that these comments are of a technical nature and affect only the decimal points of our respective projections. As to the overall concern with the future of Canada's social security system (GIS + OAS + CPP) I am in overwhelming agreement with Messrs. Aitken and Calvert.

Canada had the most dramatic baby-boom tidal wave of any country in the world if you relate its circa-1959 peak to its trough of the 1970s from which it has yet to recover. In only fifteen years of our history have

we had more than 380,000 live births per annum (1952–66), and yet in that period those *extra* births (over and above 380,000 a year) totaled over one million, representing 5 percent of Canada's 1960 population.

The effects of these one million extra births has already been felt in the school system and is presently being felt in elevated levels of unemployment (exacerbated by rising female labor force participation rates). They inevitably will continue to test our social and economic fabric as they stretch our resources like a pig being digested by a python.

Certainly we must be concerned about our ability to support this tidal wave in its aged dependency years. As both discussants so correctly point out, this problem will be magnified seriously if life expectancies continue to improve. In fact, there is now evidence that we may be seriously underestimating the improvement that will occur in the life expectancy of the aged in the near future.

In a paper entitled "The Deviant Dynamics of Death in Heterogeneous Populations"¹ J. Vaupel and A. Yashin point out that the evidence on mortality improvement provided by a heterogeneous population can be misleading. As mortality is reduced at younger ages, mortality may actually be increased at older ages because more frail individuals survive to those older ages. Hence, the observed rate of progress in reducing the *population* death rate at the older ages will be less than *but will approach over time* the rate of progress in reducing *individual* death rates.

The authors maintain that the rate of mortality improvement over the last two decades (slow in the 1960s and rapid in the 1970s) is completely consistent with their heterogeneity hypothesis.

They conclude that death rates after age 70—and especially after age 80—may decline faster in the future than now predicted, and at an accelerating rate, with a significant consequence: the elderly population may be substantially larger in the future than currently predicted. This is true without any new breakthroughs—solely because the heterogeneity of our population has masked the true underlying individual rate of mortality improvement.

A solution to this problem suggested by Messrs. Aitken and Calvert and the 1979 United States Advisory Council on Social Security is to raise the retirement age.

Early in 1981, I did an analysis of this problem with the assistance of a senior student at the University of Waterloo, Sharon Thaxter-Smith. As did the writers of the United States Advisory Council proposal, we looked for a shift in the retirement age that would avoid the sharp rise in aged

¹ International Institute for Applied Systems Analysis, Laxenburg, Austria, 1983.

dependency ratios that is expected early in the twenty-first century because of the retirement of the baby-boom tidal wave. Hence, our analysis covers the full social security spectrum (i.e., GIS + OAS + CPP).

As the basis of our analysis we used a Statistics Canada population projection that assumed net immigration of 75,000 per annum, mortality that decreases slightly to 1986 and remains level thereafter, and fertility that declines to a level of 1.7 in 1991 and remains constant thereafter.

Based on that population projection and a large number of computer-tested retirement formulas, we chose a model whereby the retirement age, which is presently 65, would be raised by three months each year starting in 2008 until it reached age 70 in 2027. The effect on dependency ratios can be seen in Figure 1.

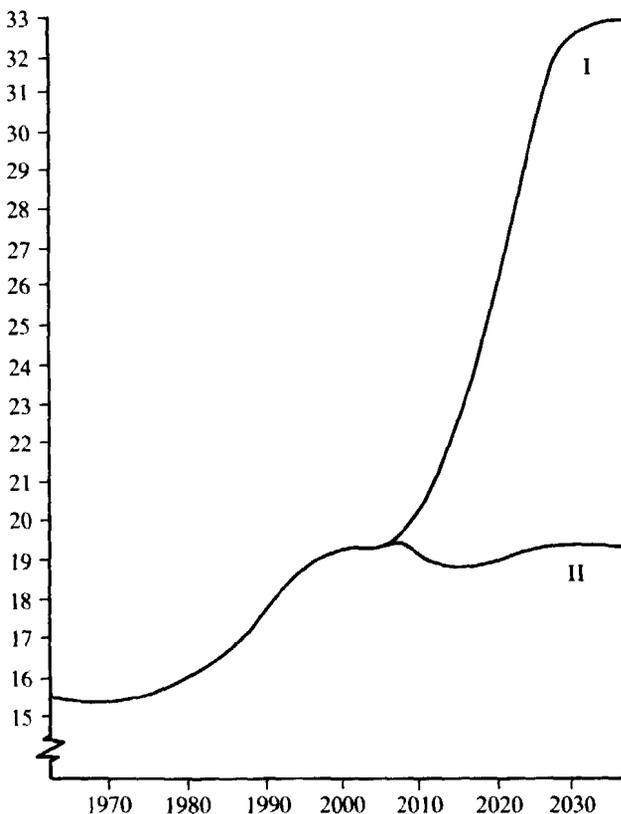


FIG. 1.—Retired population per 100 workers aged 20–64. I: if retirement age remains at 65; II: if retirement age is raised according to the model.

Because the dependency ratio remains fairly level from 1999 to 2007, we decided that this was the best point to start the retirement age change. It would be difficult to postpone it much beyond 2008, as the graph illustrates. This delay should allow those retiring early in the next century time to adjust to the new reality, assuming announcement of the change in the near future.

As can be seen from the graph, there are presently more than six workers per aged dependent. If no change is made in the retirement age, that ratio will go to three workers per retired dependent, a doubling of the pension burden. With our proposed formula, however, the ratio would never reach five workers per pensioner.

As Professor Aitken points out, even with this rise in retirement ages, Canadians will probably spend more time in retirement than they are expected to today.

The Department of Insurance has informed me that they intend to build this model into their CPP valuation program when time permits. It will be interesting to see the results of that analysis.

