Office of the Superintendent of Financial Institutions
Bureau du surintendant des institutions financières

Canada Pension Plan

Fourteenth

Actuarial Report

as at 31 December 1991

Canada

CANADA PENSION PLAN

FOURTEENTH STATUTORY ACTUARIAL REPORT AS AT 31 DECEMBER 1991

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CANADA PENSION PLAN

FOURTEENTH STATUTORY ACTUARIAL REPORT

AS AT 31 DECEMBER 1991

I- Introduction

This is the Fourteenth Statutory Actuarial Report since the inception of the Canada Pension Plan (CPP) in 1966. It has been prepared in compliance with subsection 115(1), of the Canada Pension Plan Act, which provides that a periodic report shall be prepared at least every three years by the Chief Actuary in the Office of the Superintendent of Financial Institutions (OSFI). The previous triennial report is the Eleventh Actuarial Report, as at 31 December 1988, which was tabled in the House of Commons on 22 January 1990.

The Canada Pension Plan was subject to a series of amendments as of 1 January 1992 pursuant to the adoption of Bills C-39 and C-57. The effect of these amendments was covered in the Twelfth and Thirteenth Actuarial Reports which were tabled 25 November 1991 and 27 April 1992, respectively, in the House of Commons. No other amendments with a material effect on CPP financial projections have been made since the preparation of the eleventh report.

II- Key Ultimate Demographic and Economic Assumptions

The full set of assumptions (demographic and economic, short-term and ultimate, key and secondary) underlying the main financial projections of this report is described in Appendix B.

The subset of main key ultimate assumptions is briefly described below. The year indicated in brackets corresponds to the ultimate year, i.e., the first year within the projection period (1992 to 2100) for which the values specified by the assumptions become constant.

	Previous Report	This Report
Rate of increase in earnings:	4.8% (1996)	4.5% (2000)
Rate of increase in prices:	3.5% (1996)	3.5% (2000)
Nominal annual rate of interest:	6.0% (1998)	6.0% (1998)
Mortality:	1985-87 Canada Life Tables adjusted for improvements in life expectancy (2100)	1985-87 Canada Life Tables adjusted for improvements in life expectancy (2100)
Net annual immigration to Canada (percentage of population):	0.4% (1986)	0.4% (1986)
Total fertility rate:	Canada: 1.85 (2010) Quebec: 1.80 (2010)	Canada: 1.85 (2000) Quebec: 1.80 (2000)

III- Results of the Actuarial Examination

1. Main findings

A reference to main table 1 of the financial projections below shows that:

- The retention to 2016 of the contribution rates included in the current 25-year (1992 to 2016) schedule is projected to result in the Account/Expenditure ratio gradually falling, from 3.25 at the end of 1991, to 1.65 at the end of 2016, as compared to 2.00 at the end of 2016 for the previous (thirteenth) report.
- In accordance with the *15-year formula* provided for in the CPP legislation, the projected constant annual rate of additive increase applicable, for 5 consecutive years starting in 2017, to the previous year's contribution rate, is 0.30%, as compared to 0.25% for the previous report.

Notwithstanding the relative recency of the most recent complete actuarial examination of the CPP (i.e., the eleventh report as at 31 December 1988), several new factors have affected the current examination as at 31 December 1991, some positively, some negatively. One way of analysing the effect of these various factors on the previous report's projections is by looking at the step-by-step evolution of the pay-as-you-go rate (the ratio of the year's expenditure to the year's contributory earnings) from the previous report to this report. This approach is useful because the CPP contribution rate generally corresponds to the pay-as-you-go rate minus a small margin resulting from the prescribed maintenance of an account equal to about two years of expenditures.

Section 2 below presents a concise application of this approach. It indicates that the primary factor contributing to a steeper decline in the projected Account/Expenditure ratio is the short term assumed impact of the early 1990s economic recession. Aspects of this impact include:

- reduced contributions from 1992 to 1995, attributable to the assumed sustained high levels of unemployment until 1995,
- increased payments of disability benefits, as is typical for a period of economic downswing, and
- higher proportions of CPP contributors electing to retire before age 65, and particularly at age 60.

In summary, the financial projections shown in this report generally indicate that the status of the CPP Account is currently consistent with the objectives of the Act, and that the plan long term projected cost (i.e., contribution rate) is not materially different than that of the previous report; specifically, the rates projected in this report are slightly higher for 2017 to 2100, except for 2045 to 2060 during which time they are slightly lower. However, the Account/Expenditure ratio is expected to experience a trough that is earlier (i.e. 2030 versus 2035) and deeper (i.e., 1.54 versus 1.68) than that projected in the previous report. The appropriateness of the existing schedule of contribution rates will, of course, be reviewed by federal and provincial Ministers of Finance in 1995 as required by section 113.1 of the CPP Act.

2. Comparison with previous report

Main tables of financial projections 1 and 3 show the projected pay-as-you-go rate reaching 7.71%, 12.41%, 12.97% and 13.95% of contributory earnings for the years 2000, 2025, 2050 and 2100, respectively. The chart below indicates the reasons for the differences between the pay-as-you-go rates shown in this report and those of the previous report.

RECONCILIATION OF PAY-AS-YOU-GO RATES

	1992 %	1995 %	2000 %	2025 %	2050 %	2100 %
Thirteenth Report rates:	6.85	7.20	7.49	12.24	13.07	13.78
I- **Data** (1)						
A- Demographic (2)	0.00	-0.01	-0.03	-0.23	-0.33	-0.07
B- Economic (3)	-0.10	-0.01	0.10	0.34	0.19	0.17
C- Benefits in pay (4)	-0.12	-0.05	-0.06	-0.16	-0.17	-0.13
Sub-Total I	-0.22	-0.07	0.01	-0.05	-0.31	-0.03
II- **Assumptions**						
A- Demographic						
i) fertility	0.00	0.00	0.00	-0.01	-0.01	-0.01
ii) migration	0.00	0.00	0.01	0.02	0.01	0.01
iii) others (5)	0.15	0.18	0.16	0.05	-0.03	-0.06
Sub-Total A	0.15	0.18	0.17	0.06	-0.03	-0.06
B- Economic (6)	0.35	0.12	0.04	0.40	0.55	0.63
Sub-Total II	0.50	0.30	0.21	0.46	0.52	0.57
III- **Methodology** (7)	-0.06	-0.03	-0.05	-0.25	-0.31	-0.37
Total I + II + III	0.22	0.20	0.17	0.16	-0.10	0.17
Fourteenth Report rates:	7.07	7.40	7.66	12.40	12.97	13.95

(1) Experience update, i.e., replacement of previously projected values by actual values.
(2) Actual fertility rates (higher than previously assumed) for 1988, 1989 and 1990.
(3) Update of proportions of earners and average employment earnings for 1988 to 1990, of the 5-year average distributions of earners and earnings for 1986-1990, and of earnings and prices increases for 1989-1991.
(4) Including the effect of experience factors to reflect differences between previous projections and actual results.
(5) Mainly disability incidence rates, proportions of contributors married at death, and spousal age distributions.
(6) 1992 to 1995: recession of the early 1990s;
2000 and later: reduction from 1.3% to 1% in the ultimate gap between earnings and prices rates of increase.
(7) Various improvements in valuation methodology; see Appendix B.

3. Term of securities

The Canada Pension Plan provides that the Fund (i.e., the portion of the Account in excess of the Operating Balance of estimated expenditures for the ensuing three months) shall be available for the purchase of securities of the provinces. The term to maturity of the securities is 20 years or such lesser term as may be fixed by the Minister of Finance on the recommendation of the Chief Actuary when he deems it necessary to meet any payments that will be required.

Main table 1 below, which assumes the maintenance of the existing schedule of contribution rates until year 2016, and the application of the *15-year formula* thereafter, indicates that the Account is expected to continuously increase until the end of the projection period (year 2100). Even if the Account were expected to decrease eventually, there should, for the following two reasons, be no need to shorten the 20-year term of the securities:

(a) The present standard of a 20-year term for the securities provides for a desirable stability in investment earnings. The shorter the term of securities, the lesser the stability in investment earnings. For example, if the interest rate on new loans were to decrease sharply over a short period of time, the average yield on the Fund would then decrease more rapidly if the securities had a shorter term; the Fund would accordingly decline more rapidly, thus leaving less time and flexibility for the implementation of any required corrective actions (e.g., increases in the contribution rate in order to maintain the Account/Expenditure ratio at the prescribed level).

(b) Although loans to the provinces correspond to long-term (20-year) government securities, section 112.(1)(c) of the Act gives the Minister of Finance full authority, whenever required to meet the payment of CPP expenditures, to redeem provincial securities before their maturity date, provided that a six-month advance notice is given. This authority on the part of the federal Minister of Finance provides the Fund with a degree of liquidity that would not be appreciably improved if the 20-year term for securities were reduced.

4. Main tables of financial projections

This section contains three main tables of financial projections developed on the basis of the set of main assumptions:

Main table 1: Account Projection using the contribution rates of the existing 25-year (1992 to 2016) schedule and those resulting from the *15-year formula* thereafter (see Appendix A, section 11).

Main table 2: Projection of expenditures, by type, in millions of dollars.

Main table 3: Projection of expenditures, by type, as a percentage of contributory earnings, that is, pay-as-you-go rates.

MAIN TABLE 1
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13024	-4181	4490	309	42352	3.04
1993	7.25	5.00	9593	13910	-4317	4492	174	42527	2.87
1994	7.36	5.20	10467	14809	-4342	4498	156	42683	2.71
1995	7.40	5.40	11476	15731	-4255	4492	237	42920	2.58
1996	7.37	5.60	12666	16663	-3997	4484	487	43407	2.47
1997	7.48	5.85	13769	17595	-3826	4477	650	44058	2.38
1998	7.53	6.10	15017	18529	-3512	4449	936	44994	2.30
1999	7.58	6.35	16409	19596	-3187	4451	1263	46257	2.22
2000	7.66	6.60	17942	20817	-2875	4447	1572	47829	2.15
2001	7.75	6.85	19634	22213	-2579	4416	1836	49666	2.09
2002	7.85	7.10	21463	23729	-2266	4325	2059	51725	2.04
2003	7.95	7.35	23437	25356	-1919	4201	2282	54007	1.99
2004	8.05	7.60	25594	27114	-1520	4214	2694	56701	1.95
2005	8.16	7.85	27894	29006	-1112	4196	3084	59785	1.93
2006	8.28	8.10	30354	31043	-689	4265	3576	63361	1.90
2007	8.45	8.30	32688	33272	-584	4365	3781	67142	1.88
2008	8.60	8.50	35287	35721	-434	4504	4070	71213	1.86
2009	8.78	8.70	38002	38369	-367	4656	4289	75502	1.83
2010	8.97	8.90	40860	41199	-339	4833	4494	79995	1.81
2011	9.13	9.10	44056	44222	-166	4988	4823	84818	1.79
2012	9.33	9.30	47330	47478	-148	5191	5043	89861	1.76
2013	9.56	9.50	50718	51022	-304	5459	5155	95016	1.73
2014	9.77	9.70	54422	54806	-384	5739	5354	100371	1.71
2015	9.98	9.90	58331	58828	-497	6030	5533	105903	1.68
2016	10.22	10.10	62373	63103	-730	6330	5600	111503	1.65
2017	10.46	10.40	67275	67652	-377	6642	6266	117769	1.62
2018	10.69	10.70	72555	72507	48	7001	7049	124818	1.61
2019	10.93	11.00	78134	77670	464	7425	7889	132708	1.60
2020	11.18	11.30	84072	83153	919	7900	8819	141527	1.59
2021	11.42	11.60	90342	88965	1377	8432	9809	151336	1.59
2022	11.68	11.80	96093	95111	982	9007	9989	161325	1.59
2023	11.93	12.00	102185	101618	567	9592	10159	171484	1.58
2024	12.18	12.20	108660	108453	207	10188	10395	181878	1.57
2025	12.40	12.40	115565	115595	-30	10799	10768	192646	1.57
2030	13.16	13.04	153465	154883	-1419	14131	12713	251341	1.54
2035	13.31	13.27	199233	199843	-610	18419	17809	328450	1.57
2040	13.14	13.26	255294	252969	2325	24780	27105	443421	1.67
2045	12.97	13.17	323837	318822	5015	34386	39401	615120	1.84
2050	12.97	13.11	409058	404590	4468	47807	52275	851674	2.00
2055	13.17	13.06	514173	518489	-4316	64367	60051	1138207	2.09
2060	13.34	13.05	649791	664462	-14671	82967	68296	1460545	2.09
2065	13.40	13.09	827296	846974	-19678	105044	85366	1848692	2.08
2070	13.41	13.14	1055926	1077430	-21504	133542	112038	2352740	2.08
2075	13.47	13.23	1348934	1373357	-24424	170931	146508	3013352	2.09
2100	13.95	13.73	4564574	4637132	-72558	571557	498999	10084575	2.07

MAIN TABLE 2
PROJECTION OF TOTAL EXPENDITURES
(in millions of dollars)

		Disability				Survivor						
Year	Retirement	Flat-Rate	Earnings-Related	DCC Children	Sub-Total	Flat-Rate	Earnings-Related	Sub-Total	Orphans	Death	Expenses	Grand Total
1992	8557	949	1028	146	2123	297	1485	1782	185	192	184	13024
1993	9181	967	1051	147	2165	321	1657	1978	189	206	192	13910
1994	9879	983	1076	149	2208	328	1778	2106	194	220	201	14809
1995	10589	998	1101	152	2251	336	1906	2243	201	235	213	15731
1996	11298	1015	1128	156	2300	344	2038	2381	208	250	226	16663
1997	11993	1038	1164	160	2363	351	2170	2522	216	265	235	17595
1998	12676	1066	1206	166	2437	359	2304	2663	225	282	246	18529
1999	13450	1105	1262	173	2540	368	2445	2813	235	299	258	19596
2000	14326	1156	1331	181	2668	380	2603	2984	247	320	272	20817
2001	15325	1217	1412	192	2821	395	2782	3177	261	343	287	22213
2002	16402	1287	1505	203	2994	412	2975	3387	276	368	302	23729
2003	17562	1363	1606	215	3184	429	3178	3607	290	395	319	25356
2004	18822	1446	1717	227	3390	447	3390	3837	304	424	337	27114
2005	20187	1536	1838	240	3615	466	3611	4077	318	454	355	29006
2006	21667	1633	1969	254	3856	487	3841	4328	331	486	375	31043
2007	23314	1735	2108	267	4111	507	4082	4589	343	521	394	33272
2008	25159	1840	2252	280	4372	528	4334	4862	354	558	415	35721
2009	27176	1949	2403	293	4646	551	4598	5148	364	599	437	38369
2010	29342	2067	2565	306	4938	574	4872	5446	373	641	459	41199
2011	31679	2183	2731	319	5233	598	5161	5759	381	686	484	44222
2012	34262	2284	2883	331	5498	623	5464	6087	389	734	509	47478
2013	37103	2390	3039	344	5772	647	5785	6432	395	786	534	51022
2014	40139	2506	3209	356	6071	673	6120	6793	402	840	561	54806
2015	43370	2630	3392	368	6390	699	6473	7172	408	898	589	58828
2016	46818	2758	3584	381	6723	726	6845	7571	414	960	618	63103
2017	50511	2887	3778	393	7058	754	7237	7991	420	1026	647	67652
2018	54480	3013	3971	406	7390	782	7653	8435	427	1096	678	72507
2019	58729	3138	4164	419	7721	810	8095	8905	434	1170	710	77670
2020	63263	3262	4357	432	8051	838	8564	9403	442	1251	744	83153
2021	68079	3387	4557	446	8390	866	9064	9931	451	1335	779	88965
2022	73192	3510	4756	460	8726	895	9597	10492	461	1426	814	95111
2023	78622	3631	4956	475	9061	923	10166	11088	472	1522	852	101618
2024	84334	3750	5156	490	9397	951	10772	11723	484	1625	891	108453
2025	90314	3862	5351	507	9720	978	11420	12398	497	1734	932	115595
2030	123106	4300	6251	609	11160	1109	15366	16475	580	2385	1177	154883
2035	158892	5083	7798	747	13628	1250	20651	21901	689	3231	1501	199843
2040	200045	6193	10014	917	17123	1442	27332	28774	823	4280	1925	252969
2045	250769	7737	13179	1112	22028	1713	35351	37064	979	5523	2459	318822
2050	318383	9607	17227	1334	28168	2071	44709	46781	1161	6977	3120	404590
2055	411394	11576	21813	1598	34987	2492	55599	58092	1376	8704	3937	518489
2060	532869	13628	26956	1929	42513	2949	68668	71617	1634	10850	4979	664462
2065	683889	16288	33816	2344	52448	3467	85268	88735	1943	13640	6320	846974
2070	872891	19831	43208	2844	65882	4100	106901	111001	2309	17311	8036	1077430
2075	1115260	24281	55535	3432	83248	4890	134944	139834	2741	22078	10196	1373357
2100	3837101	61945	180077	8786	250808	11564	426377	437940	6454	71583	33245	4637132

MAIN TABLE 3
PROJECTION OF TOTAL EXPENDITURES
(as a percentage of contributory earnings, i.e., pay-as-you-go rate)

		Disability				Survivor						
Year	Retirement	Flat-Rate	Earnings-Related	DCC Children	Sub-Total	Flat-Rate	Earnings-Related	Sub-Total	Orphans	Death	Expenses	Total Pay-As-You-Go Rate
1992	4.64	0.52	0.56	0.08	1.15	0.16	0.81	0.97	0.10	0.10	0.10	7.07
1993	4.79	0.50	0.55	0.08	1.13	0.17	0.86	1.03	0.10	0.11	0.10	7.25
1994	4.91	0.49	0.53	0.07	1.10	0.16	0.88	1.05	0.10	0.11	0.10	7.36
1995	4.98	0.47	0.52	0.07	1.06	0.16	0.90	1.06	0.09	0.11	0.10	7.40
1996	5.00	0.45	0.50	0.07	1.02	0.15	0.90	1.05	0.09	0.11	0.10	7.37
1997	5.10	0.44	0.49	0.07	1.00	0.15	0.92	1.07	0.09	0.11	0.10	7.48
1998	5.15	0.43	0.49	0.07	0.99	0.15	0.94	1.08	0.09	0.11	0.10	7.53
1999	5.21	0.43	0.49	0.07	0.98	0.14	0.95	1.09	0.09	0.12	0.10	7.58
2000	5.27	0.43	0.49	0.07	0.98	0.14	0.96	1.10	0.09	0.12	0.10	7.66
2001	5.35	0.42	0.49	0.07	0.98	0.14	0.97	1.11	0.09	0.12	0.10	7.75
2002	5.43	0.43	0.50	0.07	0.99	0.14	0.98	1.12	0.09	0.12	0.10	7.85
2003	5.51	0.43	0.50	0.07	1.00	0.13	1.00	1.13	0.09	0.12	0.10	7.95
2004	5.59	0.43	0.51	0.07	1.01	0.13	1.01	1.14	0.09	0.13	0.10	8.05
2005	5.68	0.43	0.52	0.07	1.02	0.13	1.02	1.15	0.09	0.13	0.10	8.16
2006	5.78	0.44	0.53	0.07	1.03	0.13	1.03	1.15	0.09	0.13	0.10	8.28
2007	5.92	0.44	0.54	0.07	1.04	0.13	1.04	1.17	0.09	0.13	0.10	8.45
2008	6.06	0.44	0.54	0.07	1.05	0.13	1.04	1.17	0.09	0.13	0.10	8.60
2009	6.22	0.45	0.55	0.07	1.06	0.13	1.05	1.18	0.08	0.14	0.10	8.78
2010	6.39	0.45	0.56	0.07	1.08	0.12	1.06	1.19	0.08	0.14	0.10	8.97
2011	6.54	0.45	0.56	0.07	1.08	0.12	1.07	1.19	0.08	0.14	0.10	9.13
2012	6.73	0.45	0.57	0.07	1.08	0.12	1.07	1.20	0.08	0.14	0.10	9.33
2013	6.95	0.45	0.57	0.06	1.08	0.12	1.08	1.20	0.07	0.15	0.10	9.56
2014	7.15	0.45	0.57	0.06	1.08	0.12	1.09	1.21	0.07	0.15	0.10	9.77
2015	7.36	0.45	0.58	0.06	1.08	0.12	1.10	1.22	0.07	0.15	0.10	9.98
2016	7.58	0.45	0.58	0.06	1.09	0.12	1.11	1.23	0.07	0.16	0.10	10.22
2017	7.81	0.45	0.58	0.06	1.09	0.12	1.12	1.24	0.06	0.16	0.10	10.46
2018	8.03	0.44	0.59	0.06	1.09	0.12	1.13	1.24	0.06	0.16	0.10	10.69
2019	8.27	0.44	0.59	0.06	1.09	0.11	1.14	1.25	0.06	0.16	0.10	10.93
2020	8.50	0.44	0.59	0.06	1.08	0.11	1.15	1.26	0.06	0.17	0.10	11.18
2021	8.74	0.43	0.59	0.06	1.08	0.11	1.16	1.28	0.06	0.17	0.10	11.42
2022	8.99	0.43	0.58	0.06	1.07	0.11	1.18	1.29	0.06	0.18	0.10	11.68
2023	9.23	0.43	0.58	0.06	1.06	0.11	1.19	1.30	0.06	0.18	0.10	11.93
2024	9.47	0.42	0.58	0.06	1.06	0.11	1.21	1.32	0.05	0.18	0.10	12.18
2025	9.69	0.41	0.57	0.05	1.04	0.10	1.23	1.33	0.05	0.19	0.10	12.40
2030	10.46	0.37	0.53	0.05	0.95	0.09	1.31	1.40	0.05	0.20	0.10	13.16
2035	10.58	0.34	0.52	0.05	0.91	0.08	1.38	1.46	0.05	0.22	0.10	13.31
2040	10.39	0.32	0.52	0.05	0.89	0.07	1.42	1.49	0.04	0.22	0.10	13.14
2045	10.20	0.31	0.54	0.05	0.90	0.07	1.44	1.51	0.04	0.22	0.10	12.97
2050	10.20	0.31	0.55	0.04	0.90	0.07	1.43	1.50	0.04	0.22	0.10	12.97
2055	10.45	0.29	0.55	0.04	0.89	0.06	1.41	1.48	0.03	0.22	0.10	13.17
2060	10.70	0.27	0.54	0.04	0.85	0.06	1.38	1.44	0.03	0.22	0.10	13.34
2065	10.82	0.26	0.54	0.04	0.83	0.05	1.35	1.40	0.03	0.22	0.10	13.40
2070	10.86	0.25	0.54	0.04	0.82	0.05	1.33	1.38	0.03	0.22	0.10	13.41
2075	10.94	0.24	0.54	0.03	0.82	0.05	1.32	1.37	0.03	0.22	0.10	13.47
2100	11.54	0.19	0.54	0.03	0.75	0.03	1.28	1.32	0.02	0.22	0.10	13.95

IV- Sensitivity of results to assumptions

The six tables of auxiliary Account projections below have been prepared to provide an indication of the degree to which the results of this report depend on each of its key assumptions. The differences between the results shown in main table 1 and in those of one or more given auxiliary Account projection tables can also serve as the basis for deriving a reasonable approximation of the projected effect of larger or smaller changes in the value specified by one or more of the key assumptions. However, one must bear in mind that any such calculation does not take into account either the extent to which the effect of changing a given assumption may not be strictly linear, or the interaction effect that may come into play when more than one assumption is changed.

Each of the six auxiliary Account projections below was developed using until 2016 the contribution rates of the existing 25-year schedule, and, thereafter, the rates generated by the *15-year formula* (see Appendix A, section 11). Each of the auxiliary Account projections is based on a set of assumptions that differs in the following respects from the set underlying main table 1:

Auxiliary table 1: 0.1 arithmetic increase in the total ultimate **fertility** rate, i.e., 1.95 for Canada and 1.90 for Quebec instead of 1.85 and 1.80, respectively).

Auxiliary table 2: 10% geometric increase in the **net immigration** to Canada (for 1986, 115,500 or 0.44% of the Canada population, instead of 105,000 or 0.4% of the Canada population).

Auxiliary table 3: **improvements in life expectancy:** 10% geometric decrease in each of the annual mortality reduction factors assumed for 1987 and later years (i.e., a reduction factor of 0.8 would be decreased to 0.72).

Auxiliary table 4: 0.25% arithmetic increase in the ultimate annual rate of increase in **earnings** (i.e., 4.75% instead of 4.5%).

Auxiliary table 5: 0.25% arithmetic decrease in the ultimate annual rate of increase in **prices** (i.e., 3.25% instead of 3.5%).

Auxiliary table 6: 1% arithmetic increase in the nominal annual rate of **interest** on new loans (annual Fund increase) to provinces (i.e., 7% instead of 6%).

AUXILIARY TABLE 1 (fertility rate: +0.1)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13026	-4183	4490	307	42350	3.04
1993	7.25	5.00	9593	13913	-4320	4492	171	42521	2.87
1994	7.36	5.20	10467	14812	-4345	4498	153	42674	2.71
1995	7.40	5.40	11476	15735	-4259	4492	232	42906	2.57
1996	7.37	5.60	12666	16669	-4003	4483	480	43386	2.46
1997	7.48	5.85	13769	17602	-3833	4475	642	44028	2.38
1998	7.53	6.10	15017	18536	-3519	4446	927	44956	2.29
1999	7.59	6.35	16409	19604	-3195	4448	1253	46208	2.22
2000	7.66	6.60	17943	20827	-2884	4444	1559	47768	2.15
2001	7.75	6.85	19635	22225	-2590	4411	1821	49589	2.09
2002	7.85	7.10	21465	23742	-2277	4320	2043	51632	2.04
2003	7.96	7.35	23440	25371	-1931	4195	2264	53896	1.99
2004	8.06	7.60	25598	27131	-1533	4206	2673	56569	1.95
2005	8.17	7.85	27899	29025	-1126	4187	3061	59630	1.92
2006	8.29	8.10	30360	31065	-705	4255	3550	63181	1.90
2007	8.45	8.30	32696	33298	-602	4354	3752	66932	1.87
2008	8.61	8.50	35298	35751	-453	4490	4037	70970	1.85
2009	8.79	8.70	38016	38403	-387	4640	4253	75223	1.82
2010	8.98	8.90	40881	41237	-356	4815	4459	79682	1.80
2011	9.14	9.10	44090	44264	-175	4968	4794	84476	1.78
2012	9.33	9.30	47381	47526	-145	5170	5024	89500	1.75
2013	9.55	9.50	50793	51075	-282	5437	5154	94654	1.73
2014	9.76	9.70	54530	54865	-335	5717	5382	100036	1.70
2015	9.97	9.90	58483	58893	-410	6011	5601	105638	1.67
2016	10.20	10.10	62581	63174	-593	6316	5723	111361	1.64
2017	10.43	10.38	67427	67730	-303	6635	6331	117692	1.62
2018	10.65	10.66	72655	72591	64	6996	7060	124752	1.60
2019	10.88	10.94	78186	77761	425	7420	7846	132598	1.59
2020	11.11	11.22	84080	83253	827	7892	8719	141317	1.59
2021	11.34	11.50	90311	89072	1239	8416	9655	150972	1.59
2022	11.58	11.69	96102	95229	873	8983	9855	160827	1.58
2023	11.82	11.88	102244	101745	499	9560	10059	170887	1.57
2024	12.05	12.07	108780	108593	187	10150	10338	181224	1.57
2025	12.26	12.26	115757	115749	8	10759	10767	191991	1.56
2030	12.93	12.81	153666	155137	-1471	14093	12622	250649	1.53
2035	13.00	12.94	199280	200275	-995	18305	17310	326207	1.55
2040	12.76	12.87	255923	253707	2216	24505	26722	438600	1.65
2045	12.50	12.73	325844	320080	5764	34091	39855	610581	1.82
2050	12.41	12.58	412236	406759	5477	47740	53217	851306	1.99
2055	12.53	12.51	521908	522593	-685	64922	64237	1150574	2.09
2060	12.66	12.46	662536	673402	-10866	85123	74258	1501039	2.12
2065	12.73	12.45	846158	865248	-19090	108811	89721	1915292	2.11
2070	12.75	12.49	1087284	1109635	-22351	138433	116082	2438456	2.09
2075	12.80	12.58	1400542	1424950	-24408	177235	152827	3125072	2.09
2100	13.24	13.08	4938322	4998610	-60288	611570	551282	10804100	2.06

AUXILIARY TABLE 2 (net immigration: +10%)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.06	4.80	8857	13031	-4174	4490	317	42359	3.04
1993	7.24	5.00	9616	13920	-4304	4493	189	42548	2.87
1994	7.34	5.20	10501	14821	-4320	4500	180	42728	2.71
1995	7.38	5.40	11522	15747	-4225	4497	272	43000	2.58
1996	7.34	5.60	12724	16683	-3959	4492	533	43533	2.47
1997	7.45	5.85	13842	17619	-3777	4487	710	44243	2.38
1998	7.49	6.10	15106	18558	-3452	4464	1011	45255	2.31
1999	7.55	6.35	16516	19630	-3114	4470	1357	46611	2.23
2000	7.62	6.60	18071	20858	-2787	4473	1686	48297	2.17
2001	7.71	6.85	19786	22262	-2476	4448	1973	50270	2.11
2002	7.80	7.10	21641	23786	-2145	4367	2222	52492	2.06
2003	7.90	7.35	23644	25423	-1779	4253	2474	54966	2.02
2004	8.00	7.60	25835	27192	-1357	4278	2920	57886	1.99
2005	8.11	7.85	28172	29096	-924	4274	3350	61236	1.97
2006	8.23	8.10	30673	31147	-474	4360	3886	65122	1.95
2007	8.39	8.30	33051	33392	-341	4480	4139	69261	1.93
2008	8.54	8.50	35700	35858	-158	4641	4483	73744	1.91
2009	8.71	8.70	38469	38525	-56	4818	4762	78506	1.90
2010	8.90	8.90	41386	41377	9	5025	5034	83540	1.88
2011	9.05	9.10	44651	44424	227	5214	5441	88981	1.87
2012	9.24	9.30	47999	47708	291	5455	5746	94727	1.85
2013	9.47	9.50	51467	51281	186	5767	5952	100680	1.83
2014	9.67	9.70	55260	55100	160	6096	6256	106936	1.81
2015	9.88	9.90	59268	59160	108	6443	6551	113488	1.79
2016	10.11	10.10	63417	63478	-61	6805	6745	120232	1.77
2017	10.34	10.37	68250	68075	175	7185	7360	127592	1.75
2018	10.57	10.64	73456	72983	473	7607	8080	135672	1.73
2019	10.81	10.91	78953	78206	747	8092	8839	144511	1.73
2020	11.04	11.18	84803	83756	1047	8622	9670	154181	1.72
2021	11.28	11.45	90980	89641	1339	9202	10541	164722	1.72
2022	11.53	11.63	96695	95869	826	9820	10646	175368	1.71
2023	11.78	11.81	102751	102466	285	10443	10727	186095	1.70
2024	12.01	11.99	109187	109402	-215	11070	10855	196950	1.69
2025	12.23	12.17	116051	116653	-602	11706	11104	208054	1.68
2030	12.97	12.75	154054	156663	-2609	15056	12446	266638	1.61
2035	13.11	13.01	201171	202715	-1544	19250	17706	342344	1.61
2040	12.94	13.01	258745	257425	1320	25586	26906	456904	1.69
2045	12.78	12.96	330204	325524	4680	35177	39856	628907	1.84
2050	12.78	12.91	418775	414435	4340	48811	53151	869461	2.00
2055	12.97	12.90	529813	532747	-2934	65823	62888	1165082	2.08
2060	13.14	12.90	672284	684889	-12605	85543	72938	1507635	2.09
2065	13.20	12.90	855963	875906	-19943	108956	89013	1917722	2.09
2070	13.21	12.94	1095048	1117964	-22916	138415	115498	2438163	2.08
2075	13.27	13.03	1403442	1429607	-26166	176892	150727	3118147	2.08
2100	13.74	13.53	4828389	4902878	-74489	589916	515427	10413850	2.02

AUXILIARY TABLE 3 (improvement in life expectancy: -10%)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13022	-4179	4490	311	42354	3.05
1993	7.25	5.00	9592	13907	-4315	4492	177	42530	2.87
1994	7.36	5.20	10466	14804	-4338	4499	161	42691	2.72
1995	7.40	5.40	11474	15723	-4249	4493	244	42935	2.58
1996	7.36	5.60	12663	16653	-3990	4486	496	43431	2.47
1997	7.47	5.85	13765	17581	-3816	4479	663	44094	2.38
1998	7.52	6.10	15012	18511	-3499	4452	953	45047	2.30
1999	7.58	6.35	16403	19573	-3170	4455	1285	46332	2.23
2000	7.65	6.60	17935	20789	-2854	4453	1599	47931	2.16
2001	7.74	6.85	19626	22179	-2553	4423	1870	49801	2.10
2002	7.84	7.10	21454	23687	-2233	4335	2101	51902	2.05
2003	7.94	7.35	23425	25306	-1881	4213	2333	54235	2.00
2004	8.04	7.60	25580	27054	-1474	4229	2755	56990	1.97
2005	8.15	7.85	27878	28935	-1057	4216	3158	60149	1.94
2006	8.27	8.10	30335	30960	-625	4290	3664	63813	1.92
2007	8.43	8.30	32666	33176	-510	4395	3886	67698	1.90
2008	8.58	8.50	35262	35610	-348	4541	4193	71891	1.88
2009	8.76	8.70	37974	38241	-267	4700	4433	76324	1.86
2010	8.95	8.90	40828	41052	-224	4886	4662	80986	1.84
2011	9.11	9.10	44020	44054	-34	5052	5018	86004	1.82
2012	9.30	9.30	47289	47289	0	5267	5267	91271	1.80
2013	9.53	9.50	50672	50808	-136	5549	5413	96683	1.77
2014	9.73	9.70	54370	54564	-194	5845	5651	102334	1.75
2015	9.95	9.90	58273	58557	-284	6155	5871	108205	1.72
2016	10.18	10.10	62308	62800	-492	6476	5984	114189	1.70
2017	10.42	10.39	67138	67314	-176	6811	6635	120824	1.68
2018	10.65	10.68	72339	72131	208	7191	7400	128224	1.66
2019	10.89	10.97	77831	77252	579	7636	8216	136440	1.65
2020	11.13	11.26	83675	82691	984	8131	9114	145554	1.65
2021	11.37	11.55	89842	88453	1389	8679	10068	155623	1.65
2022	11.62	11.74	95483	94546	937	9270	10207	165829	1.64
2023	11.88	11.93	101456	100995	461	9867	10328	176158	1.63
2024	12.12	12.12	107803	107768	35	10472	10506	186664	1.63
2025	12.34	12.31	114568	114841	-273	11089	10815	197479	1.62
2030	13.08	12.90	151579	153701	-2122	14375	12252	255025	1.57
2035	13.22	13.12	196630	198057	-1427	18472	17045	328709	1.58
2040	13.03	13.11	251895	250354	1541	24576	26117	439206	1.68
2045	12.84	13.02	319417	315111	4306	33855	38161	605226	1.83
2050	12.84	12.96	403344	399462	3882	46869	50751	834735	1.99
2055	13.03	12.91	506833	511536	-4703	62937	58234	1112775	2.07
2060	13.20	12.90	640339	655149	-14810	80953	66143	1425050	2.07
2065	13.25	12.94	815067	834549	-19482	102343	82860	1801355	2.06
2070	13.25	12.99	1040066	1060773	-20707	130068	109361	2292217	2.06
2075	13.30	13.08	1328385	1350849	-22464	166708	144243	2940372	2.07
2100	13.74	13.53	4473352	4541202	-67850	559839	491989	9880085	2.07

AUXILIARY TABLE 4 (earnings: +0.25%)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13024	-4181	4490	309	42352	3.04
1993	7.25	5.00	9593	13910	-4317	4492	174	42527	2.87
1994	7.36	5.20	10467	14809	-4342	4498	156	42683	2.71
1995	7.40	5.40	11476	15731	-4255	4492	237	42920	2.58
1996	7.37	5.60	12666	16663	-3997	4484	487	43407	2.47
1997	7.48	5.85	13769	17595	-3826	4477	650	44058	2.38
1998	7.53	6.10	15017	18529	-3512	4449	936	44994	2.30
1999	7.58	6.35	16409	19596	-3187	4451	1263	46257	2.22
2000	7.65	6.60	17966	20817	-2851	4448	1596	47854	2.15
2001	7.73	6.85	19687	22214	-2527	4418	1890	49744	2.10
2002	7.80	7.10	21608	23733	-2125	4332	2207	51951	2.05
2003	7.88	7.35	23654	25366	-1712	4219	2507	54458	2.01
2004	7.96	7.60	25893	27135	-1242	4246	3004	57462	1.98
2005	8.06	7.85	28284	29043	-759	4249	3490	60952	1.96
2006	8.18	8.10	30785	31101	-316	4343	4027	64979	1.95
2007	8.32	8.30	33262	33361	-99	4473	4374	69353	1.93
2008	8.46	8.50	36017	35851	166	4650	4816	74169	1.92
2009	8.63	8.70	38864	38549	315	4848	5163	79332	1.91
2010	8.79	8.90	41944	41442	502	5082	5584	84916	1.91
2011	8.96	9.10	45230	44538	692	5304	5996	90912	1.90
2012	9.13	9.30	48759	47887	872	5581	6452	97365	1.89
2013	9.35	9.50	52378	51540	838	5937	6775	104139	1.88
2014	9.54	9.70	56376	55451	925	6318	7243	111382	1.87
2015	9.76	9.90	60475	59617	858	6726	7584	118966	1.86
2016	9.98	10.10	64851	64057	794	7153	7947	126913	1.84
2017	10.19	10.34	69780	68795	985	7605	8590	135504	1.83
2018	10.43	10.58	74945	73864	1081	8100	9181	144684	1.83
2019	10.65	10.82	80529	79273	1256	8649	9905	154589	1.82
2020	10.89	11.06	86322	85030	1292	9239	10531	165120	1.81
2021	11.14	11.30	92482	91148	1334	9867	11200	176320	1.81
2022	11.37	11.47	98468	97639	829	10524	11353	187674	1.80
2023	11.60	11.64	104855	104529	326	11190	11516	199190	1.78
2024	11.84	11.81	111483	111787	-304	11862	11559	210748	1.77
2025	12.07	11.98	118545	119394	-849	12538	11689	222437	1.75
2030	12.77	12.55	158850	161619	-2769	16072	13303	284397	1.66
2035	12.90	12.77	208565	210627	-2062	20526	18464	364482	1.64
2040	12.71	12.76	270494	269402	1092	27131	28223	484100	1.71
2045	12.53	12.71	348345	343301	5044	37239	42284	665766	1.85
2050	12.53	12.70	446868	440817	6051	51848	57899	924558	1.99
2055	12.73	12.70	570716	571900	-1184	70515	69331	1249521	2.07
2060	12.90	12.70	730292	741872	-11580	92282	80702	1627909	2.08
2065	12.95	12.70	938316	956771	-18455	118349	99894	2085476	2.07
2070	12.95	12.74	1211021	1231150	-20130	151643	131513	2674876	2.07
2075	13.00	12.83	1566181	1587525	-21344	195837	174493	3457560	2.07
2100	13.46	13.33	5632336	5685453	-53117	694263	641146	12276045	2.05

AUXILIARY TABLE 5 (prices: -0.25%)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13024	-4181	4490	309	42352	3.04
1993	7.25	5.00	9593	13910	-4317	4492	174	42527	2.87
1994	7.36	5.20	10467	14809	-4342	4498	156	42683	2.71
1995	7.40	5.40	11476	15731	-4255	4492	237	42920	2.58
1996	7.37	5.60	12666	16663	-3997	4484	487	43407	2.47
1997	7.48	5.85	13769	17595	-3826	4477	650	44058	2.38
1998	7.53	6.10	15017	18529	-3512	4449	936	44994	2.30
1999	7.58	6.35	16409	19596	-3187	4451	1263	46257	2.22
2000	7.66	6.60	17942	20817	-2875	4447	1572	47829	2.16
2001	7.74	6.85	19634	22174	-2540	4416	1876	49705	2.10
2002	7.82	7.10	21463	23636	-2173	4329	2157	51862	2.06
2003	7.90	7.35	23437	25206	-1769	4213	2443	54305	2.02
2004	7.99	7.60	25594	26902	-1308	4236	2928	57233	1.99
2005	8.08	7.85	27894	28729	-835	4234	3399	60633	1.98
2006	8.19	8.10	30354	30698	-344	4324	3980	64612	1.97
2007	8.34	8.30	32688	32854	-166	4450	4284	68897	1.96
2008	8.49	8.50	35287	35226	61	4621	4683	73580	1.95
2009	8.65	8.70	38002	37791	211	4812	5023	78603	1.94
2010	8.83	8.90	40860	40533	327	5036	5363	83966	1.93
2011	8.98	9.10	44056	43462	594	5246	5841	89806	1.93
2012	9.16	9.30	47330	46621	709	5513	6222	96029	1.92
2013	9.38	9.50	50718	50061	657	5855	6512	102541	1.91
2014	9.58	9.70	54422	53734	688	6220	6908	109449	1.90
2015	9.78	9.90	58331	57637	694	6609	7303	116752	1.89
2016	10.01	10.10	62373	61787	586	7020	7605	124358	1.88
2017	10.23	10.34	66887	66203	684	7450	8134	132492	1.87
2018	10.46	10.58	71742	70916	826	7918	8744	141236	1.86
2019	10.69	10.82	76856	75929	927	8441	9368	150604	1.85
2020	10.92	11.06	82286	81253	1033	9001	10034	160638	1.85
2021	11.16	11.30	88006	86895	1111	9600	10710	171348	1.85
2022	11.40	11.47	93405	92863	542	10227	10770	182118	1.84
2023	11.65	11.64	99119	99179	-60	10857	10798	192915	1.82
2024	11.88	11.81	105186	105814	-628	11489	10861	203776	1.81
2025	12.10	11.98	111650	112743	-1093	12125	11032	214808	1.79
2030	12.81	12.51	147227	150786	-3559	15391	11832	271543	1.71
2035	12.93	12.72	190975	194153	-3178	19288	16111	341484	1.68
2040	12.74	12.71	244705	245339	-634	25017	24382	445101	1.73
2045	12.56	12.66	311297	308874	2423	33710	36133	601107	1.86
2050	12.56	12.65	394706	391855	2851	46143	48993	821054	2.00
2055	12.76	12.65	498031	502303	-4272	61810	57538	1093085	2.07
2060	12.93	12.65	629874	643828	-13954	79708	65754	1403508	2.08
2065	12.98	12.69	802015	820447	-18432	100997	82565	1778079	2.07
2070	12.98	12.74	1023782	1043173	-19391	128671	109280	2268091	2.07
2075	13.04	12.79	1304071	1329143	-25072	164885	139813	2905903	2.08
2100	13.49	13.28	4414971	4484067	-69097	544142	475045	9603947	2.04

AUXILIARY TABLE 6 (interest rate: +1%)
ACCOUNT PROJECTION
(in millions of dollars)

The contribution rate for 1991 was 4.60%.
Future contribution rates were determined as follows:
1. From 1992 to 2016: the existing 25-year schedule.
2. After 2016, contribution rates were generated by the *15-year formula*.

Year	Pay-as-you-go rate %	Contribution rate %	Contributions $	Expenditures $	Cash flow $	Investment earnings $	Change in Account $	Year-end Account $	Account/Expenditures ratio
1992	7.07	4.80	8843	13024	-4181	4490	309	42352	3.04
1993	7.25	5.00	9593	13910	-4317	4492	174	42527	2.87
1994	7.36	5.20	10467	14809	-4342	4498	156	42683	2.71
1995	7.40	5.40	11476	15731	-4255	4492	237	42920	2.58
1996	7.37	5.60	12666	16663	-3997	4484	487	43407	2.47
1997	7.48	5.85	13769	17595	-3826	4477	650	44058	2.38
1998	7.53	6.10	15017	18529	-3512	4496	984	45041	2.30
1999	7.58	6.35	16409	19596	-3187	4529	1341	46382	2.23
2000	7.66	6.60	17942	20817	-2875	4564	1689	48071	2.16
2001	7.75	6.85	19634	22213	-2579	4577	1998	50069	2.11
2002	7.85	7.10	21463	23729	-2266	4540	2274	52344	2.06
2003	7.95	7.35	23437	25356	-1919	4481	2562	54906	2.02
2004	8.05	7.60	25594	27114	-1520	4561	3041	57947	2.00
2005	8.16	7.85	27894	29006	-1112	4622	3510	61457	1.98
2006	8.28	8.10	30354	31043	-689	4776	4087	65544	1.97
2007	8.45	8.30	32688	33272	-584	4980	4396	69940	1.96
2008	8.60	8.50	35287	35721	-434	5226	4792	74733	1.95
2009	8.78	8.70	38002	38369	-367	5494	5127	79860	1.94
2010	8.97	8.90	40860	41199	-339	5795	5456	85315	1.93
2011	9.13	9.10	44056	44222	-166	6090	5924	91240	1.92
2012	9.33	9.30	47330	47478	-148	6442	6294	97534	1.91
2013	9.56	9.50	50718	51022	-304	6859	6555	104089	1.90
2014	9.77	9.70	54422	54806	-384	7302	6918	111007	1.89
2015	9.98	9.90	58331	58828	-497	7772	7275	118282	1.87
2016	10.22	10.10	62373	63103	-730	8267	7537	125819	1.86
2017	10.46	10.35	66952	67652	-700	8788	8088	133907	1.85
2018	10.69	10.60	71877	72507	-630	9356	8726	142633	1.84
2019	10.93	10.85	77069	77670	-601	9966	9365	151998	1.83
2020	11.18	11.10	82584	83153	-569	10621	10052	162050	1.82
2021	11.42	11.35	88395	88965	-570	11323	10753	172802	1.82
2022	11.68	11.53	93894	95111	-1217	12060	10843	183646	1.81
2023	11.93	11.71	99715	101618	-1903	12802	10900	194545	1.79
2024	12.18	11.89	105899	108453	-2554	13548	10994	205540	1.78
2025	12.40	12.07	112489	115595	-3106	14302	11196	216736	1.76
2030	13.16	12.65	148875	154883	-6008	18210	12202	274866	1.68
2035	13.31	12.87	193227	199843	-6616	22880	16265	346283	1.65
2040	13.14	12.90	248363	252969	-4606	29670	25064	451628	1.70
2045	12.97	12.86	316215	318822	-2607	40198	37591	613489	1.84
2050	12.97	12.81	399698	404590	-4892	55264	50372	841124	1.98
2055	13.17	12.80	503937	518489	-14552	74106	59554	1121265	2.06
2060	13.34	12.80	637343	664462	-27119	95891	68771	1444805	2.07
2065	13.40	12.84	811495	846974	-35479	121973	86494	1837201	2.07
2070	13.41	12.89	1035836	1077430	-41594	155848	114254	2349889	2.08
2075	13.47	12.94	1319365	1373357	-53992	200111	146119	3016440	2.09
2100	13.95	13.43	4464838	4637132	-172294	660721	488427	9968043	2.05

V- Actuarial Opinion

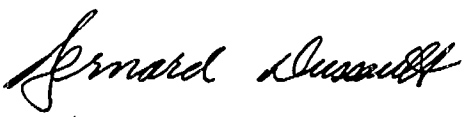
In my opinion, for the purposes of this actuarial report,

(a) the data on which the valuation is based are sufficient and reliable for the purpose of the valuation;

(b) the assumptions which have been used are adequate and appropriate; and

(c) the valuation methodology employed is consistent with sound actuarial principles.

This report has been prepared and this opinion has been given in accordance with generally accepted actuarial principles and the Recommendations of the Canadian Institute of Actuaries.



Bernard Dussault, B.Sc, F.S.A., F.C.I.A.
Acting Chief Actuary

Ottawa, Canada
30 March 1993

APPENDIX A

MAIN PROVISIONS OF THE CANADA PENSION PLAN

1. DEFINITION OF TERMS RELATING TO EARNINGS

Contributor

The Canada Pension Plan, which came into force on 1 January 1966, includes as contributors virtually all members of the labour force in Canada (both employees and self-employed persons) between the ages of 18 and 70 with employment earnings, other than persons in the province of Quebec who are covered by the Quebec Pension Plan. However, the Canada Pension Plan covers all members of the Canadian Forces and the Royal Canadian Mounted Police, including those residing in the province of Quebec. The main exceptions are persons with earnings less than the Year's Basic Exemption (YBE, defined below), persons to whom a retirement or disability pension is payable pursuant to the Act and members of certain religious groups.

Contributory Period

The contributory period corresponds to the number of months from attainment of age 18 or from January 1, 1966, if later, to the earliest of the month in which the contributor dies, the month preceding the one in which the retirement pension commences and the month preceding the one in which the contributor reaches 70 years of age, less the number of months during which the contributor received a CPP disability pension, or during which, after 1977, the contributor had at least one eligible child under 7 years of age, and had earnings less than 1/12 of the YBE.

Year's Maximum Pensionable Earnings (YMPE)

The YMPE for any calendar year means the limit above which that year's employment earnings are not subject to contributions and benefits. The YMPE for a particular calendar year is prorated in individual cases to allow for the portion of the year before age 18 or after age 70, or after death, retirement or disablement. The YMPE increases each year in accordance with the ratio of the average of the Industrial Aggregate (the measure of average wages and salaries by Statistics Canada) during the 12-month period ending 30 June of the preceding year over the average during the corresponding period one year earlier. If the amount calculated by formula is not a multiple of $100, the next lower multiple of $100 is used. However, the YMPE is not allowed to decrease from one year to the next. For 1992, the YMPE is $32,200.

Year's Basic Exemption (YBE)

The YBE for any calendar year means the lower limit below which that year's employment earnings are not subject to contributions. It is calculated as 10% of the YMPE and rounded, if necessary, to the next lower multiple of $100. The YBE is subject to adjustment, in individual cases, similar to the YMPE. For 1992, the YBE is $3,200.

Unadjusted Pensionable Earnings

Unadjusted pensionable earnings for any calendar month means all employment earnings of a contributor in the calendar month up to 1/12 of the YMPE applicable to the corresponding calendar year, provided that required contributions have been made for that month. The unadjusted pensionable earnings are zero for any month during which contributions are not required or not made. Earnings in a month in excess of one twelfth of the YMPE are applied to the extent required to maximize the unadjusted pensionable earnings in other months in the same calendar year.

Contributory Earnings

Contributory earnings for any calendar year means the unadjusted pensionable earnings on which contributions are payable; that is, employment earnings between the YBE and the YMPE for that year.

Pensionable Earnings

Pensionable earnings for a given month means the unadjusted pensionable earnings of that month multiplied by the earnings index, i.e., the ratio that the average of the YMPE for the year when a retirement pension or any earnings-related pension becomes payable under the Act, and of the YMPE for the two preceding years, bears to the YMPE for the year to which the given month belongs. Hence, the application of the earnings index escalates the earnings of a given month, in accordance with the current 3-year average YMPE, for purposes of averaging earnings over the contributory period elapsed at the time of emergence of a benefit.

2. RETIREMENT PENSION

A person aged 60 or over becomes eligible for a retirement pension, upon application, provided contributions (see section 11 below) have been made for at least one calendar year. After a retirement pension becomes payable or, in any event after age 70, a contributor may not contribute under the Plan. Thus, except for annual adjustments of the amount of pension in payment in accordance with changes in the Pension Index (see section 8 below), the amount of pension is fixed at the time the pension first becomes payable. The initial amount of retirement pension payable to a contributor is based on the whole history of pensionable earnings during the contributory period. The initial amount of annual retirement pension is equal to 25% of the average of a number of the highest pensionable earnings. This number is determined as follows:

For pensions commencing	Number of Highest Monthly Pensionable Earnings used in computing the initial retirement pension
before 1976	120 less the number of months of disability;
after 1975	the number of months in the contributory period less (a) the number of months, after 1977, during which the contributor had at least one eligible child less than 7 years of age, and had earnings greater than one-twelfth of the YBE which, if dropped out, would increase his or her average pensionable earnings, provided the remaining number of months is not thereby reduced to less than 120 months minus the months of disability, less (b) the number of months, if any, between age 65 of the contributor and the commencement of the retirement pension, if later, provided the remaining number of months is not thereby reduced to less than 120 months minus the months of disability, less (c) 15% of the number of months remaining in the contributory period, provided the remaining number of months is not thereby reduced to less than 120 months.

A certain number of months associated with the lowest recorded monthly pensionable earnings are therefore excluded, in the calculation of benefits, by reason of pensions commencing after age 65 and of the disability, the child-rearing and the 15% drop-out provisions. The resulting amount of pension is subject to an actuarial adjustment that depends on the contributor's age at commencement of the retirement pension: the initial rate of pension is accordingly decreased or increased, depending on whether the pension begins before or after age 65, by 0.5% for each month between age 65 and the age when the pension commences. An applicant for a retirement pension payable before age 65 must have ceased to be wholly or substantially engaged in paid employment or self-employment. The maximum initial monthly retirement pension for 1992 is $636.11.

3. DISABILITY PENSION

A person is considered disabled if he or she is determined in a prescribed manner to be suffering from a severe and prolonged mental or physical disability. A disability is considered severe if by reason of it the person is incapable of pursuing regularly any substantially gainful occupation; a disability is considered prolonged if it is likely to be long continuing and of indefinite duration or likely to result in death.

A person who becomes disabled while under age 65 and not receiving a CPP retirement pension is eligible for a disability pension provided that contributions have been made, at time of disablement, for at least either 5 of the last 10 calendar years, or 2 of the last 3 calendar years, irrespective of whether any of these years are included wholly or partly in the contributory period.

Disability pensions commence with the fourth month following the month of disablement and are payable until age 65 (disability pensions are automatically replaced by retirement pensions at age 65) or until death or recovery from disability at an earlier age. If an application for a disability pension is filed more than 15 months following the date at which the pension would normally have commenced, eligibility to receive a disability pension is determined as described above irrespective of the filing delay. For cases so eligible, the initial amount of the pension is then determined as if disability had commenced 15 months before the filing date, and retroactive payments are made commencing with the eleventh month prior to the filing date.

The amount of pension payable is composed of a flat-rate portion depending only on the year in which the pension is payable and an earnings-related portion depending initially only on the pensionable earnings record of the contributor as of the onset of disability. The monthly flat-rate portion is $306.81 for 1992. The initial earnings-related portion is equal to 75% of a pension calculated in the manner described earlier for retirement pensions, except that no actuarial adjustment applies and that the number of months to be taken into account in determining the Average Pensionable Earnings is subject, in connection with the child-rearing drop-out period, to a minimum of 24 (instead of 120) less months of disability. The maximum initial monthly earnings-related portion is $477.08 for 1992.

4. SURVIVOR'S PENSION

(a) Eligibility

A surviving spouse is eligible for a survivor pension if the following two conditions are met as at the date of the contributor's death:

i) the deceased contributor must have made contributions during the lesser of 10

calendar years, or one-third of the number of years included wholly or partly in his or her contributory period, but not less than three years;

ii) the surviving spouse must have dependent children, be disabled or be at least 35 years of age.

(b) Definition of Surviving spouse with dependent children

A surviving spouse with dependent children means a widow or widower who wholly or substantially maintains a child of the deceased contributor where the child is

- under age 18, or
- aged 18 or over but under age 25 and attending school full-time, or
- aged 18 or over and disabled, having been disabled without interruption since attaining age 18 or the time of the contributor's death, whichever occurred later.

(c) Amount of survivor's pension

i) **Surviving spouses aged between 45 and 65 at date of contributor's death**
The amount of pension payable until the surviving spouse attains age 65 is composed of two portions: a flat-rate portion depending only on the year in which the survivor's pension is payable, and an earnings-related portion depending initially only on the contributor's record of pensionable earnings as at the date of his or her death. The monthly flat-rate portion is $119.70 for 1992. The initial earnings-related portion is equal to 37.5% of an earnings-related pension based on the deceased contributor's pensionable earnings record. The amount of the contributor's earnings-related pension is calculated in the manner described earlier for retirement pensions (see section 3 above) except that no actuarial adjustment applies and that the number of months to be taken into account in determining the Average Pensionable Earnings may not be reduced, in respect of the months of child-rearing, to less than 36 (instead of 120) minus the months of disability. The earnings-related portion is calculated as at the date of the deceased spouse's death or commencement of his or her retirement pension, whichever is earlier, except that in the latter case the calculated pension is adjusted in accordance with the increase in the Pension Index (see 8 below) from the year in which the contributor's retirement pension became payable to the year of his or her death. The maximum initial monthly earnings-related portion in respect of surviving spouses under age 65 is $238.54 for 1992.

ii) **Surviving spouses, aged less than 45 at date of contributor's death, without dependent children and not disabled**
An eligible spouse without dependent children and not disabled who becomes widowed:

- while aged less than 35 years is not entitled to a survivor's pension;
- while between 35 and 45 years of age is entitled for an amount of pension, calculated as described in i) above, reduced by 1/120th of such amount for each month that the surviving spouse's age at onset of widowhood or widowerhood is less than 45.

iii) **Surviving spouses aged less than 45 with dependent children at date of contributor's death**

An eligible spouse who becomes widowed while aged less than 45 and with dependent children is entitled to a survivor's pension calculated as described in i) above. If a surviving spouse in receipt of a survivor's pension ceases to be a surviving spouse with dependent children before attaining age 45 and is not disabled at that time, the amount of the survivor's pension is discontinued or reduced in the manner described in ii) above in accordance with the surviving spouse's age at the time she or he ceased to be a surviving spouse with dependent children.

iv) **Disabled surviving spouses aged less than 65**

An eligible surviving spouse aged less than 65 years is entitled to a survivor's pension if she or he either is disabled at the date of death of the contributor or becomes disabled at a later date. The disabled surviving spouse's pension is payable from the month following the month in which the contributor dies or from the month following the month in which the surviving spouse becomes disabled, whichever is later. If the disabled surviving spouse recovers from disability before age 45, the amount of the survivor's pension is discontinued or reduced in the manner described in ii) above in accordance with the surviving spouse's age at the time of recovery. The initial amount of pension is calculated as described in i) above, except that, in the case where the surviving spouse becomes disabled subsequent to the death of the contributor, the pension so calculated is adjusted in accordance with changes in the Pension Index (see 8 below) from the year in which the contributor died to the year in which disability occurs.

v) **Surviving spouses aged 65 or over**

At age 65, or upon widowhood or widowerhood at a later age, an eligible surviving spouse is entitled a pension equal to 60% of an earnings-related pension based on the pensionable earnings record of the deceased spouse. This earnings-related pension is calculated as described in i) above and is adjusted, where applicable, in accordance with changes in the Pension Index (see 8 below) from the year in which the contributor died to the year in which the surviving spouse attains age 65 or the year in which a retirement pension becomes payable to her or him while in receipt of a survivor's pension. The maximum initial monthly earnings-related portion in respect of survivors aged 65 and over is $381.67 for 1992.

5. DEATH BENEFIT

A lump-sum benefit is payable to the estate of a deceased contributor if the eligibility rules described in 4(a)i) above are met. The amount of the death benefit is equal to:

(a) in respect of a contributor to whom a retirement pension was payable at the time of death, one-half of the annual amount of pension payable in the year of death, adjusted to exclude any reduction that may have arisen by reason of commencement of pension within the 10-year phase-in period ending 31 December 1975 or any actuarial adjustment applicable by reason of commencement of a retirement pension after 1986 at an age other than 65; and

(b) in respect of any other contributor, one-half of the annual amount of an earnings-related pension calculated, exclusive of the actuarial adjustment, in the manner described for retirement pensions in 2 above,

subject to the limitation that the amount of benefit cannot exceed 10% of the YMPE applicable in the year of the contributor's death. The maximum death benefit payable for deaths occurring in 1992 is $3,220.

6. CHILDREN'S BENEFITS

(a) Disabled contributor's child's (DCC) benefit
Each child of a contributor who is eligible for a CPP disability pension is entitled to a DCC benefit provided the child is under age 18, or is aged 18 or over but under 25 and is attending school full-time.

(b) Orphan's benefit
Each child of a deceased contributor is entitled an orphan's benefit if the eligibility rules described in 4(a)i) above are met and if the child is under age 18, or aged 18 or over but under age 25 and is attending school full-time.

(c) Amount of children's benefit
The amount of the monthly pension payable in respect of each eligible child is $154.70 for 1992. Two child's benefits are payable in respect of each child if both parents died while eligible for a survivor benefit or are entitled a CPP disability pension; furthermore, where applicable, a child may simultaneously receive a disabled contributor's child's benefit and an orphan's benefit.

7. COMBINED PENSIONS

Benefits payable to persons who become entitled to both a survivor pension and either a disability or a retirement pension are subject to a limit as follows:

(a) Survivor pension combined with a disability pension

i) the flat-rate portion of the combined pension is equal to the flat-rate portion of the disability pension;

ii) the earnings-related portion of the combined pension is equal to the sum of the earnings-related portions of the survivor and the disability annual pensions but cannot initially exceed the maximum retirement pension applicable for the year in which the later of the two pensions commences; in such case, the earnings-related portion of the survivor pension is reduced accordingly.

(b) Survivor pension combined with a retirement pension

i) the flat-rate portion of the combined pension is equal to the flat-rate portion of the survivor pension;

ii) the earnings-related portion of the combined pension is equal to the sum of the earnings-related portion of the survivor pension and of the survivor's actuarially adjusted retirement pension; however, the sum of the earnings-related portion of the survivor pension and of the survivor's retirement pension before application of the actuarial adjustment cannot initially exceed the maximum retirement pension applicable for the year in which the later of the two pensions commences; in such case, the earnings-related portion of the survivor pension is reduced accordingly but any actuarially reduced retirement pension (i.e., a retirement pension commencing under age 65) is increased by an amount equal to the product of the applicable actuarial reduction percentage and the absolute reduction in the earnings-related survivor pension computed as above.

8. INFLATION ADJUSTMENTS

All CPP benefits are, with the exception of the death benefit which is payable in a lump sum, payable in the form of monthly pensions over a determinate period of time. Once a CPP pension has commenced, its initial amount is adjusted thereafter in accordance with inflation. Pensions are accordingly multiplied on 1 January of each calendar year by the ratio of the Pension Index (described below) applicable for that calendar year to the Pension Index applicable for the year during which the pension commenced.

The Pension Index for a given calendar year is equal to the Consumer Price Index averages over the 12-month period ending with October of the preceding year; however, the Pension Index of a given year may not be lesser than the previous years' Pension Index.

9. SPLITTING OF EARNINGS UPON MARITAL UNION BREAKDOWN

In the event of a divorce occurring after 1976 or of a separation or the breakdown of a marital common-law union after 1982, Unadjusted Pensionable Earnings may be split equally between the two spouses of a given couple in respect of their previous cohabitation period. In case of divorce, splitting is automatic provided the Minister receives the prescribed information; in case of separation for at least 12 consecutive months or until the death of one of the former spouses during this period, splitting is mandatory, upon valid application by one spouse, provided the former spouses did cohabit for at least twelve months. Splitting can be waived by agreement between the two parties where expressly provided for by the applicable provincial law.

10. SPLITTING OF RETIREMENT PENSIONS

If one of the spouses requests it, retirement pensions may be divided, in respect of the proportionate number of years during which the spouses cohabited, during the joint lifetime of the spouses. This applies provided both spouses are at least 60 years old and have ceased contributing. On the death of the first spouse, or in the event of divorce or separation, any pension splitting previously applied is reversed. In the case of separation, the assignment ceases the twelfth month after the spouses separated.

11. CONTRIBUTION RATES AND CONTRIBUTIONS

Contributions are required during the contributory period in respect of the contributory earnings of each contributor. From 1966 to 1986, the annual rate of contribution applicable to contributory earnings was 1.8% for employees (and a like amount for their employers) and 3.6% in respect of self-employed earnings. This combined employer-employee contribution rate of 3.6% was subject, in accordance with the 25-year Schedule adopted pursuant to Bill C-116, to an annual increase of 0.2% for 1987 to 1991 and is subject, in accordance with the 25-year Schedule adopted pursuant to Bill C-39, to an annual increase of 0.2% for 1992 to 1996, 0.25% for 1997 to 2006, and 0.20% for 2007 to 2016.

However, the rates beyond 1996 will depend on the conclusions of the quinquennial federal-provincial reviews by the Ministers of Finance. The next such review is scheduled to take place prior to 1997 and, if possible, to be completed early enough to permit the Minister of Finance to make appropriate recommendations before 1 January 1996. At the conclusion of each quinquennial federal-provincial review, the rates for the last 20 years in the 25-year Schedule must be confirmed or revised and the Schedule extended for the following five years. In addition to the 25-year Schedule, the *15-year formula* (described below) prescribed by regulation would come into operation in the absence of agreement or recommendation at subsequent quinquennial federal-provincial reviews.

The *15-year formula* is designed to extend the schedule for five years by means of the

smallest constant annual rate of change, expressed as a multiple of 0.01% of contributory earnings, such that if a change of that size were in effect for a total of 15 years, the Account (see 12 below) at the end of 15 years would be at least equal to twice the expenditure in the following year (i.e., an Account/Expenditure ratio equal to 2).

12. ACCOUNT, OPERATING BALANCE AND INVESTMENT FUND

Income (contributions, and investment earnings from the Operating Balance and the Investment Fund described below) and expenditures (benefits and administrative expenses) are posted to the CPP Account in the Consolidated Revenue Fund.

At the end of each quarter, the excess of the balance to the credit of the Account over the Operating Balance (the estimated amount required in the ensuing three months to pay benefits and administrative expenses) constitutes an increase in the Investment Fund and is available for loans to the provinces in proportion to contributions made by the residents of the respective provinces. Any part of this excess not borrowed by the provinces is invested in federal securities.

The securities are non-negotiable obligations payable to the CPP Investment Fund. The term to maturity is 20 years, unless the Minister of Finance, on the recommendation of the Chief Actuary of the Office of the Superintendent of Financial Institutions, deems it appropriate to fix a lesser period to meet the projected payments. The interest applicable to the securities is payable semi-annually and is based on the average yield to maturity on all outstanding Government of Canada bonds maturing in 20 years or more.

13. AMENDMENTS

Any major amendment providing for changes in benefits or contributions cannot become effective until the first day of the third year following the year in which notice of intention to introduce such a measure was laid before Parliament. An amendment requires the consent of at least two-thirds of the provinces having in aggregate at least two-thirds of the population of Canada, excluding the Yukon and the Northwest Territories.

APPENDIX B

DATA, ASSUMPTIONS AND METHODOLOGY

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APPENDIX B

DATA, ASSUMPTIONS AND METHODOLOGY

The purpose of Appendix B is to describe the data, the assumptions and the methodology used in making the CPP financial projections that appear in the main body of this report.

-I- POPULATION

1. Data

The following data were used in performing the demographic projections:

(a) Canadian quinquennial censuses

Catalogue No. 93-101 published by Statistics Canada is the main reference used regarding the data on Canadian censuses. The calculation of future average earnings and benefits requires population and death figures not only for the projection period (1992 to 2100), but also for 1966 to 1991. Data from each of the five quinquennial censuses of 1966 to 1986 are accordingly maintained not only for the projection of average earnings and benefits of all relevant cohorts of contributors and beneficiaries, but also for methodology validation purposes as described in section 3 below. The 1986 Census data, by age and sex, for Canada and Quebec separately, serve as the starting point for the projection of the population and deaths until year 2100. The census data used for projection purposes consist primarily of the numbers of live persons and deaths by age and sex, the proportions of male to female births and the adjustments for undercount.

(b) Postcensal data

In between each Canada quinquennial census, Statistics Canada publishes annually various postcensal data. Data on actual past fertility rates and migration levels, taken from catalogues No. 82-003s14, 82-204 and 91-210, are used as a basis for determining the assumptions required for projecting the actual 1986 population by age and sex. Moreover, previously assumed fertility rates for the period 1966 to 1990 were replaced by actual values in the projection process that, in a technical sense, starts in 1966.

(c) Life Tables, Canada and the Provinces, 1985-1987

These tables, published by Statistics Canada (catalogue No. 82-003S), are used as a basis for the determination of the assumptions required for projecting the population into the future.

(d) The November 1988, 1989, 1990 and 1991 Reports of the Subcommittee on Modelling, Canadian Institute of Actuaries' (CIA) Task Force on AIDS.

These studies are the main reference used to estimate the effect of AIDS on mortality rates.

(e) Actuarial Study No. 102

This study, conducted by the Social Security Administration in the U.S.A, shows the extent to which mortality rates could be expected to decrease annually from now until year 2100. These annual rates of decrease were determined by analysing the current trends in mortality decrease separately for each of 10 broad causes of death.

2. Demographic assumptions

In accordance with the practice first adopted for the Third CPP Statutory Actuarial Report as at 31 December 1973, the Main Tables of financial projections, as shown in the main body of this report, are based on a single set of realistic demographic assumptions. This section describes the assumptions most central to the demographic projections.

As in preceding reports, various auxiliary projections (see section IV of the main body of this report) provide an appreciation of the sensitivity of the financial projections to certain variations in key assumptions.

(a) Fertility

The fertility rate for a given age corresponds to the number of live births per female at the given age. The total fertility rate corresponds to the sum of all live births per female over the entire period of reproductive ages. For convenience, such rates are multiplied by 1,000 in the table below. The actual total fertility rates for 1990 (1.826 and 1.717 for Canada and Quebec, respectively) are 9% and 17% higher than those assumed, in the preceding three CPP actuarial reports, for Canada and Quebec, respectively. Fertility rates are therefore approaching their previously assumed ultimate (2010) levels (1.85 and 1.80 for Canada and Quebec, respectively) more rapidly than anticipated. Considering the recency of these developments and the long-term period over which assumptions apply, the ultimate total fertility rates of 1.85 for Canada and 1.80 for Quebec, used in the previous three actuarial reports, have been maintained. However, the year from which these ultimate rates are assumed to apply has been changed from 2010 to 2000. For 1991 to 1999, the assumed rates were calculated by linear interpolation between the actual 1990 values of 1.826 for Canada and 1.717 for Quebec, and the assumed values of 1.85 for Canada and 1.80 for Quebec for year 2000. The distribution of assumed ultimate total fertility rates for Canada and Quebec into age-specific rates was made using the corresponding proportions of the 1990 experience for Canada and Quebec, respectively. In accordance with past experience, the assumed ratio of male to female births was taken as 1.056.

Fertility rates are used not only for the demographic projections, but also for the valuation of the child rearing drop-out provision, and for the projection of children's benefits (see section II below).

FERTILITY RATES

CANADA

Age Group	calendar year					
	1970	1975	1980	1985	1990	2000+
15-19	42.8	35.3	27.6	23.7	26.6	26.9
20-24	143.3	112.7	100.1	85.3	85.5	86.6
25-29	147.2	131.2	129.4	125.3	132.2	133.9
30-34	81.8	64.4	69.3	74.6	88.1	89.3
35-39	39.0	21.6	19.4	21.8	28.8	29.2
40-44	11.3	4.8	3.1	3.0	3.9	4.0
45-49	0.9	0.4	0.2	0.1	0.1	0.1
Total	2,331.5	1,852.0	1,745.5	1,669.0	1,826.0	1,850.0

QUEBEC

Age Group	calendar year					
	1970	1975	1980	1985	1990	2000+
15-19	20.7	19.5	16.1	14.5	19.0	19.9
20-24	113.9	96.4	92.7	73.5	84.7	88.8
25-29	131.0	136.2	137.2	116.7	134.9	141.4
30-34	77.4	69.4	70.6	62.0	78.6	82.4
35-39	39.0	23.4	19.8	17.1	23.1	24.2
40-44	11.8	5.2	3.0	2.2	3.0	3.1
45-49	1.0	0.6	0.2	0.1	0.1	0.1
Total	1,974.0	1,753.5	1,698.0	1,430.5	1,717.0	1,800.0

(b) Mortality (Canada Life Tables, mortality reductions, AIDS)

Life Tables for 1990-1992 were not yet available when this report was completed. Therefore, mortality rates shown in Life Tables, Canada and the Provinces, 1985-1987 (see section 1(c) above), assumed to be applicable for 1986, were used as the starting point for mortality assumptions. The 1985-1987 Canada Life Tables for Canada, the corresponding tables for Quebec, and the ultimate mortality tables consist of one-year probabilities of mortality for individual ages from 0 to 106.

To reflect anticipated sustained improvements in life expectancy, the 1986 mortality rates were projected to the year 2100 using, as in the Eleventh Report, the following annual rates of decrease:

i) For 1987 to 2010, the annual rates of decrease, varying by age, sex and calendar year, were determined by linear interpolation between:
   - the average reduction rates experienced in Canada between 1976 and 1986, and
   - the constant reduction rates, described in ii) below, in respect of the period running from 2011 to 2100.

ii) For 2011 and later years, the annual rates of decrease, varying by age and sex only, not by calendar year, are those identified as *Alternative II (medium)* in Actuarial Study No. 102 (see section 1(e) above).

To account for AIDS, male mortality for both Canada and Quebec was increased for the years 1989 to 2018 by the increments estimated by the Canadian Institute of Actuaries (see section 1(d) above). A constant level of new infections is assumed to hold from 1984 to 1988 and to decrease gradually from that level to 0 in 1999. Subsequent studies of the CIA's Task Force on AIDS for 1989 to 1991 have also been examined. These studies show average extra mortality lower than that of the 1988 study; however, recent trends indicate that AIDS-related extra mortality might return, after 1991, to levels previously assumed. For these reasons, the assumptions of the CPP eleventh actuarial report were maintained for this report. On the basis of the cumulative number of deaths attributable to AIDS (as reported by the Federal Centre for AIDS), female mortality was also increased, but by only 10 per cent of the above increments for males.

Life Expectancies (longevity expressed in number of years) resulting from the above mortality assumptions are shown below for Canada as a whole.

Year	At birth		At age 65		
	males	females	males	females	calculation basis
1986	73.0	79.7	14.9	19.1	without improvements in life expectancy
1986	77.8	84.6	15.7	20.4	with improvements in life expectancy
2100	80.3	86.9	19.3	24.5	without improvements in life expectancy

The first table below sets out sample values of the ultimate mortality rates as well as sample values of mortality rates of the 1985-87 Canada Life Tables, all before AIDS adjustments. The second table shows sample values of the extra mortality assumed to apply in connection with AIDS.

MORTALITY RATES
(before AIDS adjustments)
(number of annual deaths per 1,000 persons)

	MALES			
	1985-87 Canada Life Tables		Rates Assumed for Year 2100	
Age	Quebec	Canada	Quebec	Canada
0	8.02	8.58	2.10	2.24
1	0.62	0.67	0.25	0.27
5	0.27	0.30	0.11	0.12
10	0.22	0.18	0.10	0.08
20	1.36	1.30	0.67	0.64
30	1.39	1.30	0.89	0.83
40	2.12	1.97	1.02	0.95
50	5.81	5.32	2.73	2.50
60	16.59	14.68	8.75	7.75
70	42.05	36.73	24.28	21.21
80	94.08	86.65	57.10	52.59
90	198.73	191.97	118.52	114.49
95	271.71	276.51	159.44	162.25
100	322.70	359.43	182.46	203.23
105	777.72	796.02	500.49	512.26

	FEMALES			
	1985-87 Canada Life Tables		Rates Assumed for Year 2100	
Age	Quebec	Canada	Quebec	Canada
0	6.22	6.78	1.48	1.61
1	0.58	0.62	0.22	0.24
5	0.26	0.22	0.09	0.07
10	0.16	0.14	0.06	0.05
20	0.37	0.42	0.18	0.20
30	0.54	0.51	0.28	0.26
40	1.09	1.12	0.52	0.53
50	3.21	3.12	1.73	1.68
60	7.67	7.51	4.32	4.23
70	19.49	18.67	10.68	10.23
80	55.09	51.73	28.96	27.19
90	150.37	144.15	75.74	72.61
95	235.05	230.03	119.72	117.16
100	322.27	322.72	163.29	163.52
105	784.40	785.62	454.20	454.91

EXTRA MORTALITY RATES IN RESPECT OF AIDS (*)
(number of annual deaths per 1,000 persons)

	CALENDAR YEAR				
Age	1995	2000	2005	2010	2015
25	0.33	0.38	-	-	-
30	0.80	0.90	0.62	-	-
35	0.60	0.86	0.59	0.29	-
40	0.46	0.50	0.44	0.21	0.07
45	0.34	0.35	0.23	0.14	0.05
50	0.23	0.25	0.16	0.08	0.03
55	0.19	0.17	0.12	0.05	0.02
60	0.16	0.15	0.08	0.04	0.01

(*) 100% of these increases apply to male mortality rates; only 10% apply to female rates.

(c) Migration

Immigration and emigration are generally recognized to be volatile parameters of future population growth, since they are subject to a variety of demographic, economic, social and political factors; immigration, especially, is subject to government control. During the period from 1 June 1973 to 31 May 1990, for example, annual immigration to Canada varied from 83,000 to 214,000, and annual emigration out of Canada is estimated to have fluctuated between 37,000 and 84,000. Net annual Canadian immigration during the most recent 10-year period averaged 82,947.

For purposes of this report it was decided to assume, for 1986, 155,000 immigrants to Canada and 50,000 emigrants leaving Canada. Both these figures were increased with time so as to maintain a constant ratio of net immigration to total current Canadian population of 0.4%.

For purposes of projecting the population of Quebec, it was assumed that 17% of the immigrants, and 14% of the emigrants assumed for Canada would be attributable to that province; Statistics Canada data for the last 10 years showed 17.3% of immigrants and 14.1% of emigrants to be attributable to Quebec. In addition it was assumed that Quebec would experience net interprovincial emigration of 10,000 in 1986, decreasing uniformly to zero by the year 2010, based on the trends observed over the 1979 to 1989 period.

The distributions of immigrants and emigrants by age group and sex used for purposes of the projections in the previous report were based on Statistics Canada data for 1983-1988. The corresponding distributions averaged over the period 1986 to 1990, used for purposes of this report, and shown below separately for Canada and Quebec, also indicate average ages somewhat higher for immigrants than for emigrants.

DISTRIBUTIONS OF IMMIGRANTS AND EMIGRANTS
(1986-1990 average)

	Age group	Immigrants males (%)	Immigrants females (%)	Emigrants males (%)	Emigrants females (%)
Canada	0- 4	3.640	3.448	3.500	3.512
	5- 9	4.043	3.774	4.355	4.209
	10-14	3.936	3.648	3.982	3.618
	15-19	4.509	4.432	3.783	3.689
	20-24	5.965	6.688	4.426	5.714
	25-29	7.536	7.302	7.186	7.557
	30-34	6.226	5.904	6.725	6.504
	35-39	4.160	3.919	6.162	4.993
	40-44	2.378	2.201	4.247	3.509
	45-49	1.509	1.632	2.164	1.845
	50-54	1.200	1.658	1.394	1.188
	55-59	1.254	1.749	0.980	0.852
	60-64	1.284	1.613	0.536	0.705
	65-69	0.890	1.069	0.555	0.696
	70+	0.984	1.449	0.543	0.872
	TOTAL	49.514	50.486	50.537	49.463
Quebec	0- 4	3.778	3.424	3.426	3.436
	5- 9	4.280	4.239	4.337	4.143
	10-14	4.422	3.973	3.929	3.645
	15-19	4.771	4.283	3.779	3.705
	20-24	6.720	5.975	4.382	5.751
	25-29	7.979	6.617	7.170	7.514
	30-34	6.270	5.511	6.717	6.503
	35-39	4.332	3.851	6.224	4.969
	40-44	2.707	2.414	4.337	3.585
	45-49	1.839	1.734	2.191	1.872
	50-54	1.381	1.373	1.409	1.200
	55-59	0.988	1.271	0.976	0.846
	60-64	0.944	1.294	0.523	0.682
	65-69	0.682	0.796	0.568	0.712
	70+	0.816	1.338	0.568	0.901
	TOTAL	51.909	48.091	50.535	49.465

3. Methodology

In 1991, for the first time, the census of population included both permanent and non-permanent residents of Canada. Using this new definition of population for demographic projections purposes, without introducing appropriate methodological adjustments, would introduce non-negligible structural inconsistencies into the CPP actuarial valuation methodology. Unfortunately, the timing for the release of the 1991 census population data precluded the implementation of such methodological adjustments within the time frame for the preparation of this report. Consequently, this report uses the 1986 census as the starting point for its demographic projections.

More specifically, however, the starting point for demographic projections purposes is 1 July 1986. However, population data for 1966 to 1985 are required for the calculation of future benefits of some relevant cohorts of contributors and beneficiaries. For this latter purpose, use is made of data from each of the quinquennial censuses from 1966 to 1986, and the values projected in previous CPP actuarial reports for the intercensal years (1967-1970, 1972-1975, 1977-1980, and 1982-1985), but adjusted to account for the actual experience regarding fertility and migration. For methodology validation purposes, the postcensal data taken from Statistics Canada (catalogue No. 91-210), regarding total populations by age and sex for each year from 1987 to 1990, were compared with the demographic projections of the previous report, but with those projections revised for the actual fertility rates for these years. The projections so revised closely match actual experience. Across all of the age-sex-year cells, actual/expected ratios range from 0.997 to 1.003. These small discrepancies are caused primarily by minor differences between actual and expected mortality and migration for 1987 to 1990.

The 1986 census data for Canada and Quebec are available by individual ages up to 89, but the data for ages 90 and over are grouped. Therefore, the latter data were dis-aggregated for individual ages 90 to 106 by surviving the population data at age 89, using the 1985-1987 Life Tables, up to age 106. A constant proportional adjustment was made to the population so survived for each age from 90 to 106 to match its total with the census aggregate value for this age group.

To compensate for the census undercount, adjustment factors developed by Statistics Canada were applied to the 1986 census population data. These factors vary by age, sex and area, i.e., Canada and Quebec separately. The population, by age and sex, was then projected from one year to the next, by age and sex, by adding births and immigrants, subtracting deaths and emigrants, and adjusting for net migration between Quebec and the rest of Canada. The annual numbers of births, deaths, immigrants and emigrants were developed by applying the fertility, mortality and migration assumptions for 1987 to 2100 to the mid-year population. However, actual fertility rates were used for 1987 to 1990. The projections carry forward to 2100.

The populations covered by the CPP pertain to Canada excluding Quebec, but include all members of the Canadian Forces and the Royal Canadian Mounted Police. The population and deaths projections used for purposes of the financial projections were

obtained by simple subtraction of the projected figures for Quebec from the projected figures for Canada. Consequently, the projected populations do not make explicit allowance for members of the Canadian Forces and Royal Canadian Mounted Police who reside in Quebec or outside Canada. However, provision for this group was made implicitly through the development of the proportions of contributors described in Section II3(d) of this appendix.

4. Population Tables

The first two tables below show, for Canada excluding Quebec, the projected mid-year populations for 1991, 1995, 2000, 2025, 2050, 2075 and 2100. The populations shown are distributed by sex and broad age groups. The third table shows corresponding dependency ratios.

POPULATION (in thousands)
CANADA excluding QUEBEC
BOTH SEXES

	Age Group	1991	1995	2000	2025	2050	2075	2100
	0- 4	1567	1602	1531	1662	1780	1914	2071
	5- 9	1448	1564	1636	1677	1782	1923	2089
	10-14	1386	1463	1599	1652	1778	1939	2112
	15-19	1412	1412	1501	1624	1795	1970	2141
Total	0-19	5813	6041	6267	6615	7135	7746	8413
	20-24	1562	1497	1469	1667	1867	2033	2197
	25-29	1901	1640	1562	1790	1957	2100	2262
	30-34	1859	1975	1700	1926	2009	2142	2315
	35-39	1720	1861	2008	1889	1986	2142	2335
	40-44	1537	1680	1872	1763	1929	2127	2333
	45-49	1190	1480	1677	1665	1901	2122	2314
	50-54	977	1137	1470	1675	1931	2115	2277
	55-59	904	943	1123	1721	1967	2065	2213
	60-64	875	881	922	1926	1847	1957	2124
Total	20-64	12525	13094	13803	16022	17394	18803	20370
	65-69	797	814	829	1688	1625	1797	2001
	70-74	618	704	729	1375	1401	1626	1844
	75-79	469	495	590	1034	1216	1445	1629
	80-84	291	343	374	623	998	1201	1322
	85-89	149	177	221	350	798	832	950
	90+	73	89	116	257	627	738	984
Total	65+	2397	2622	2859	5327	6665	7639	8730
Grand total		20735	21757	22929	27964	31194	34188	37513

POPULATION (in thousands)
CANADA excluding QUEBEC

Age Group	1991	1995	2000	2025	2050	2075	2100
				males			
0- 4	809	819	782	853	915	984	1065
5- 9	740	808	836	863	917	989	1074
10-14	710	748	826	852	915	997	1086
15-19	724	723	767	836	922	1012	1100
0-19	2983	3098	3211	3404	3669	3982	4325
20-24	800	765	749	851	954	1040	1125
25-29	967	836	794	907	996	1071	1154
30-34	933	999	864	976	1024	1092	1180
35-39	859	931	1012	963	1011	1089	1187
40-44	774	838	933	889	979	1078	1183
45-49	603	744	834	838	959	1072	1171
50-54	490	572	734	838	967	1064	1148
55-59	452	468	559	855	978	1033	1108
60-64	428	434	451	942	915	969	1052
20-64	6306	6587	6930	8059	8783	9508	10308
65-69	367	386	399	802	783	874	974
70-74	271	310	333	631	654	765	873
75-79	195	204	244	453	538	646	738
80-84	110	129	139	251	407	498	559
85-89	49	58	72	122	286	311	362
90+	19	23	30	69	174	213	294
65+	1011	1110	1217	2328	2842	3307	3800
Total males	10300	10795	11358	13791	15294	16797	18433
				females			
0- 4	758	783	749	809	865	930	1006
5- 9	708	756	800	814	865	934	1015
10-14	676	715	773	800	863	942	1026
15-19	688	689	734	788	873	958	1041
0-19	2830	2943	3056	3211	3466	3764	4088
20-24	762	732	720	816	913	993	1072
25-29	934	804	768	883	961	1029	1108
30-34	926	976	836	950	985	1050	1135
35-39	861	930	996	926	975	1053	1148
40-44	763	842	939	874	950	1049	1150
45-49	587	736	843	827	942	1050	1143
50-54	487	565	736	837	964	1051	1129
55-59	452	475	564	866	989	1032	1105
60-64	447	447	471	984	932	988	1072
20-64	6219	6507	6873	7963	8611	9295	10062
65-69	430	428	430	886	842	923	1027
70-74	347	394	396	744	747	861	971
75-79	274	291	346	581	678	799	891
80-84	181	214	235	372	591	703	763
85-89	100	119	149	228	512	521	588
90+	54	66	86	188	453	525	690
65+	1386	1512	1642	2999	3823	4332	4930
Total females	10435	10962	11571	14173	15900	17391	19080

DEPENDENCY RATIOS (%)
Canada excluding Quebec

Year	Both Sexes		
	Children[1]	Seniors[2]	Total[3]
1991	46.4	19.1	65.6
2000	45.4	20.7	66.1
2025	41.3	33.3	74.5
2050	41.0	38.3	79.3
2075	41.2	40.6	81.8
2100	41.3	42.9	84.2

Year	Males		
	Children[1]	Seniors[2]	Total[3]
1991	47.3	16.0	63.4
2000	46.3	17.4	63.9
2025	42.2	28.3	71.1
2050	41.8	32.6	74.1
2075	41.9	34.8	76.6
2100	42.0	36.9	78.8

Year	Females		
	Children[1]	Seniors[2]	Total[3]
1991	45.5	22.3	67.8
2000	44.5	23.9	68.4
2025	40.3	37.7	78.0
2050	40.2	44.4	84.7
2075	40.5	46.6	87.1
2100	40.6	49.0	89.6

1 Population aged 19 years and under as a percentage of population aged 20 to 64 years.
2 Population aged 65 years and over as a percentage of population aged 20 to 64 years.
3 Population aged 19 years and under, plus population aged 65 years and over, as a percentage of population aged 20 to 64 years.

-II- CONTRIBUTORY EARNINGS AND BENEFITS

1. Data

(a) Demographic

Historical (1966-1986) and projected (1987-2100) populations and deaths, the output of section I above, are used for various computational purposes in the economic projections. For example,

- ratios of the actual number of earners to the population correspond to the proportions of earners;
- the relevant population times the benefit eligibility rate, and times the computed average benefit factor for each age-sex cohort, produces the amount of projected benefits;
- numbers of deaths by age, sex and year are used in computing death, survivor and orphan benefits.

(b) Economic indices

The Consumer Price Index (CPI) and the Average Industrial Aggregate Wages statistic (AIAW, the current measure of the average rate of weekly wages and salaries) are produced by Statistics Canada (catalogues 72-002 and 11-010, respectively). The observed (1966 to 1992) annual increases in the CPI and the AIAW replace, for methodology validation purposes, values assumed in previous actuarial reports; they are also used as a basis for the determination of corresponding assumptions for the future. Rates of interest, which come into play only in the Account projections, are discussed in section III below.

(c) Earnings statistics

Statistics on the average employment earnings, by sex and age-group, of all workers covered by the CPP are prepared annually and transmitted as machine readable files, via magnetic tapes, by officials of Health and Welfare Canada (HWC) and Supply and Services Canada (SSC) involved in the administration of the CPP. These data originate from Revenue Canada, which is responsible for the processing of CPP contributions through salary deductions. The employment earnings data pertaining to a given calendar year normally become available in the second year (about mid-year) following that given year. This normal delay is due to the contribution adjustments resulting from tax returns filed after the given year. In summary, these earnings statistics include the number of earners, average annual employment earnings of these earners and the distributions, over 78 earnings categories, of earners and of their average employment earnings by quinquennial age-groups and sex. For example, the distributions of earners and of their average employment earnings could indicate that 60% of earners (distribution of earners) for a particular age-sex cell earn less than 120% of average earnings for the cell and

account for 40% of total earnings (distribution of average employment earnings) for the cell. By linear interpolation between the relevant points of the distributions, it is possible to determine, for a given percentage of average earnings in any age-sex cell, what percentage of earners earn less than that given percentage of average earnings, and what percentage of the total earnings for the cell is earned by such earners.

One might expect that earnings statistics would include few, if any, earners earning less than the Year's Basic Exemption (YBE), since, except in unusual circumstances, the CPP employee contributions are refundable in such cases and earnings are not counted for purposes of calculating pensionable earnings. However, each year's data reveal a large number of earners earning less than the YBE, a number as large or almost as large as one might expect if there were no YBE. The likely reason for this is that most contributors who earn less than the YBE during the course of a year have low annual earnings because they work for only a small fraction of the year, but during that fraction they have monthly earnings in excess of 1/12 of the YBE. Employer and employee contributions must be deducted at source for any month during which individual earnings exceed 1/12 of the YBE (unless the year's maximum has already been deducted). Although the employee contributions may be refundable if the employee earns less than the YBE during the year, the employer contributions are not. Hence, most earners earning less than the YBE in any year would have employer contributions to their credit. They would therefore have records of their employment earnings for that year maintained on the CPP Record of Earnings, even though those earnings are not counted for pensionable earnings purposes. For this reason, it appeared reasonable to consider the cumulative distributions of earners and of their average earnings as being generally representative of cumulative distributions for all covered earners and of their average employment earnings.

Officials responsible for earnings statistics in HWC and SSC also report annually on the cumulative number of records of earnings as at 1 July of the year by individual age and sex. These numbers are intended to be used for the calculation and validation of the benefit eligibility rates (see section 3(g) below).

The aggregate amount of annual employment earnings of all Canadian workers is transmitted by the actuarial branch in Employment and Immigration Canada. This data originates, as does that for CPP records of earnings purposes, from Revenue Canada Taxation. With respect to Quebec earnings, the annual aggregate values, by sex, of the number of earners and their average employment earnings, stemming from income tax returns data, are transmitted by the actuarial branch of the Quebec Pension Plan. The difference in aggregate employment earnings between Canada and Quebec was compared for 1989 with the aggregate of employment earnings, for both sexes over all age-groups, prepared for CPP purposes (i.e., Canada less Quebec). The small discrepancy of 0.4% so obtained reflects generally a high degree of dependability of the earnings statistics used for CPP actuarial valuation purposes.

(d) Monthly Information Reports

Monthly Information Reports, flowing from the administration of the CPP by HWC, provide aggregate financial data (e.g., total contributions for the year, total benefits, administrative expenses) that serve as a basis for the CPP annual accounting report of the Comptroller General. These reports are prepared on a cash, as opposed to accrual, basis.

In the actuarial valuation process, including the methodology validation process mentioned in section (e) below, the total amounts of actual benefits obtained from the benefits statistics described in section (e) below, are adjusted in line with the aggregate cash-basis results shown in the monthly information reports since they form the basis of the formal accounting reports on the CPP.

Aggregate data from Monthly Information Reports are also compiled over each calendar year after the preparation of an actuarial report and compared with corresponding aggregate projected values of that report for further methodology validation purposes until the next report comes due.

(e) Benefits Statistics

Benefits statistics correspond to extracts from individual records in the Master Benefit File administered by officials in HWC and SSC. These include primarily, but not exclusively, for each past and existing beneficiary, separately for each type of benefit, the date (month and year) of emergence of the benefit, the age and sex of the beneficiary at emergence, the initial monthly amount of the benefit, and, when applicable, the date of, and reason for, benefit termination. Actual past values of the YMPE, the YBE, the amount of the various monthly flat-rate benefits, and the distribution of retirement pensions, over six categories expressed as a percentage of the YMPE, constitute other benefits-related statistics used in the actuarial valuation process.

Extracts as at 31 December 1991 from each individual record in the CPP Master Benefit file play an important role in the actuarial valuation process since they are used for three distinct reasons:

i) The number and amount of benefits by type, both emerging and in force, can be obtained by age, by sex and by calendar year. This information is used in a methodology validation algorithm integrated into the computer actuarial valuation system. The various values computed in this valuation system for years preceding 1992 are accordingly compared with actual values to validate the valuation methodology or to detect areas where it should be improved, and to ensure that benefits statistics are correctly interpreted. It must be pointed out that this validation process looks only at methodology, not assumptions; accordingly, in the methodology validation process, the assumptions made in

previous reports are replaced by actual values. The results of the methodology validation process are favourable taking into account the adjustment of benefits statistics to match in aggregate the official CPP cash-basis reports (see section (d) above), while actuarial valuation results data are computed on an accrual basis. However, the effect of this inconsistency is practically negligible as regards benefits because, in contrast to contributions, cash benefits are, as a general rule, nearly the same as accrued benefits due to the relatively fast handling of most CPP claims. Some disability benefit cases do, however, constitute exceptions to this rule.

ii) The benefits, underlying these extracts, paid during 1991, are converted into benefits in pay as at the valuation date (31 December 1991) and used as the starting point for the projections. This is achieved by computing experience factors (i.e., ratios of actual to evaluated benefits for 1991) and by multiplying these experience factors by the evaluated benefits.

iii) Various secondary demographic and economic assumptions, required in projecting future benefits, are selected relying on past experience. These assumptions relate, for example, to the age at which contributors elect to start receiving the retirement pension, the proportions of contributors married at death, and distribution of spouses by age, disability incidence and termination (death and recovery) rates. Benefits statistics can also, and will eventually, be used to measure the mortality rates of the respective beneficiaries of retirement and survivor pensions.

(f) Monthly Statistics

Statistics published monthly by HWC are similar to benefits statistics (see section (e) above), but are generally combined for some age-groups, and are less detailed (e.g., no information on terminations). Since the more detailed benefits statistics are not produced as frequently as monthly statistics, these monthly statistics are used for various preliminary valuation studies in between two valuation dates.

2. Assumptions (other than interest)

In accordance with the practice first adopted for the Third Statutory Actuarial Report as at 31 December 1973, the Main Tables of financial projections shown in the main body of this report are based on a single set of realistic economic and demographic assumptions. The economic assumptions described below relate to these Main Tables, but not to the Auxiliary Tables.

(a) Key assumptions

The key economic assumptions involved in the projection of earnings and benefits are the annual rates of increase in average employment earnings and in the CPI.

Rates of interest, which come into play only in the Account projections, are discussed in section III below.

The assumptions used in the 25 February 1992 federal budget constitute the main reference used for the selection of short-term assumptions. Consequently, for the years 1993 to 1997 for prices and earnings, the key economic assumptions are those included in this budget. For 1998 and 1999, the assumptions were derived to fall between the budget projections and the ultimate (2000 and later years) assumptions described below.

Since the financial projections of this report cover a long period, long-term key economic assumptions were chosen on the basis of:

i) The average long-term (about 50 years) past experience and the observed trends over the past short (about 15 years) and medium (about 25 years) terms.

ii) Judgmental opinion as to the outlook of the overall economy over the future long term.

It was accordingly decided to maintain the ultimate assumption for the annual increase in prices at 3.5% as for the sixth through thirteenth CPP actuarial reports. However, the ultimate annual rate of increase in average employment earnings is assumed to be 4.5%, as compared to 4.8% for the eleventh through thirteenth reports. This corresponds to a reduction from 1.3% to 1% in the productivity rate, i.e., the assumed ultimate gap between the annual rates of increase in earnings and prices. The possibility and appropriateness of such a reduction was discussed in the eleventh report. It was decided to apply it for this report considering, among other things, that:

i) The actual gap between the annual rates of increase in average employment earnings and prices, each measured using ratios of the relevant yearly average index over that of the previous year, has been equal on average over the last 5, 10, 15, 20 and 25 years, to –0.26%, –0.16%, –0.30%, +0.36% and +1.02%, respectively. The average gap over the last 50 years, measured as the ratio of the year-end relevant index to that of the previous year, is +2.77%. The assumed gap of 1% therefore corresponds closely to the actual recent 25-year average.

ii) It is generally believed that, in this post-industrialized era where the economy is more and more service-oriented, the productivity rate should not, in the long-term, be as high as during the industrialized era.

The table below shows the short-term and ultimate assumptions adopted for this report regarding the annual increases in earnings and prices.

ANNUAL RATE OF INCREASE IN PRICES AND AVERAGE EMPLOYMENT EARNINGS

YEAR	PRICES (%)	EARNINGS (%)	earnings-prices GAP (***) (%)
1985 (*)	3.9	3.5	(0.4)
1986 (*)	4.2	3.0	(1.2)
1987 (*)	4.4	3.8	(0.6)
1988 (*)	4.0	4.4	0.4
1989 (*)	5.0	5.2	0.2
1990 (*)	4.8	4.5	(0.3)
1991 (*)	5.6	4.6	(1.0)
1992 (*)	1.5	3.4	1.9
1993	2.2 (**)	2.8 (**)	0.6
1994	2.1 (**)	2.9 (**)	0.8
1995	2.0 (**)	2.8 (**)	0.8
1996	1.9 (**)	2.9 (**)	1.0
1997	1.8 (**)	2.8 (**)	1.0
1998	2.5	3.5	1.0
1999	3.0	4.0	1.0
2000 (ultimate)	3.5	4.5	1.0

(*) Rates for these years are actual experience rates.
(**) Rates for these years are taken from the February 1992 budget.
(***) Brackets mean that these rates are negative.

(b) Secondary (other than key) assumptions

The exhaustive list of secondary assumptions is quite extensive. The following thirteen sections cover the majority of these assumptions. For example, a fourteenth secondary assumption, flowing implicitly from the valuation methodology, is described in the methodology section 3(a)i) below (i.e., earnings of contributors dying before retirement are assumed to be the same, on average each year until death, as those of all other contributors).

i) Proportions of earners

In respect of each past year since 1966, proportions of earners are computed, by age and sex, as the ratio of the number of earners (from earnings statistics) to the corresponding population (from demographic computations). In addition to being used for the computation of the past and future benefits of the relevant cohorts of contributors, these historical values constitute an important reference for the selection of assumed future proportions of earners.

These proportions for the future were accordingly determined taking partly into account the trends in their counterpart actual, adjusted (see section 3(c) below) values for 1966 to 1990. These trends reveal quite stable proportions for males and significant year to year increases for females.

Male proportions of earners are assumed to reach by year 2000 the levels at which they were on average from 1975 to 1980, before the 1982-1984 recession. However, such proportions assumed for rnales were multiplied, on the basis of past experience, by 0.975 for 1991, 1992 and 1993, and by 0.98 and 0.99 for 1994 and 1995, respectively, to account for the effects of the early 1990's recession on earnings.

Since 1985, female proportions have increased much more rapidly than anticipated, and in 1990 have already, on average, reached the levels assumed in previous actuarial reports for 2050. It was nonetheless decided for the period 1992 to 2100 to maintain the previous assumptions for females. This approach implicitly produces, for the 1991 to 1994 period, female proportions geometrically decreasing by about 5% on average, in line with the expected effect of the early 1990s recession on earnings.

Selected values of the adjusted past actual and future assumed proportions of earners is shown by age, sex and calendar year in section 3(c) below.

ii) Average employment earnings

In respect of a cohort of earners of a given age and sex, the average employment earnings for a given calendar year correspond to the ratio of the sum of individual employment earnings earned during the year to the number of earners in the cohort. Average employment earnings for each such age-sex cohort are assumed to increase from one year to the next at the same rate as the AIAW. The AIAW, compiled by Statistics Canada, corresponds to the weekly rate of pay, at a particular point in time, averaged over all industries. However, this rate of earnings increase assumption is subject to the following two adjustments:

- The preceding statement of the above assumption implies that the effect, on average employment earnings, of unemployment levels prevailing on average during the base year (1990) of earnings projections, will remain constant each year in the future. Whenever the actual level of average unemployment during the base year of earnings projections is not deemed representative of the expected future average level of unemployment, average earnings of the base year are adjusted over the next 5 to 10 years to bring them in line with the expected average unemployment level. On the basis of the average level of unemployment prevailing during 1990, it was decided, for this report, that no such adjustment was required. On the other hand, the anticipated temporary reduction effect of the early 1990s recession on average employment earnings was taken into account by multiplying male and female assumed average employment earnings by 0.945 (determined on the basis of past experience) for 1991, 1992 and 1993, and by 0.955 and 0.975 for 1994 and 1995, respectively.

- The assumed annual rate of increase in the AIAW was not implemented uniformly by sex since it was further assumed that an annual geometrical narrowing of 1% in the gap between male and female average employment earnings would apply. Hence, rates of increase in average employment earnings were developed by age and by sex so as to produce:
  - an aggregate rate of increase equal to that assumed for the AIAW;
  - rates of increase for each age, both sexes combined, that would be the same for all ages; and
  - separate rates of increase for male and female average earnings for each age such that the ratio of female to male average earnings would move 1% of the way to unity each year.

iii) Distributions of earners and earnings over 78 earnings categories

The distributions of earners and earnings relative to average earnings (see section 1(c) above) have actually been quite stable since 1966, both by age and sex. It was therefore decided that for the future they would be assumed constantly equal to their actual adjusted five-year (1986-1990) average described and shown in section 3(c) below).

iv) Credit-splitting on marital union breakdown

The effect (not more than 0.02% of contributory earnings) of the equal apportionment, between spouses, of unadjusted pensionable earnings in event of marital union breakdown, is accounted for by adjusting appropriately the projected proportions of contributors and average (unadjusted) pensionable earnings of the respective spouses. These adjustments were achieved by assuming the following:

- On the basis of past medium-term average experience, the annual incidence rate of divorce is assumed at 1% for any age-sex-year cell. Divorce rates show increasing patterns, but these aspects were ignored because of their recency and of their negligible effect on financial estimates.
- The proportions of contributors (see section 3(d) below) do not vary by marital status for males, and the corresponding proportions for single females are the same as those for males having the same age. Assumed proportions for married females are then obtained as the weighted differences between overall female proportions and single female proportions assumed as above.
- The distribution of average employment earnings (see section 1(c) above) of the cohort of spouses (sorted by age in accordance with the distribution of surviving spouses, described in section xi) below) of a cohort of contributors of a given age is assumed to apply uniformly to each of the 78 earnings categories of the given cohort of contributors.
- The proportions of married live persons (as opposed to proportions of contributors married at death) were taken from data of the Canada 1986 census, and are assumed constant over time.

v) **Employment Mobility Rate**

In respect of a cohort of persons born in a given calendar year, the employment mobility rate corresponds to the proportion, assumed to never contribute to CPP, of those persons not contributing to CPP in respect of the calendar year associated with this cohort's highest annual proportion of contributors over its entire contributory period. For actuarial valuation purposes, the remainder of persons, i.e., those deemed to contribute for at least one year during the contributory period, is assumed to contribute randomly during the contributory period.

The employment mobility rate, which is required for the estimate of eligibility rates (see section 3(g) below), and of the effect of the drop-out provisions (see section 3(h) below), is assumed to be constantly equal to 50%.

For example, if the highest proportion of contributors of a cohort of persons over its entire contributory period is 80%, then 10% (i.e., half of the proportion not contributing for that year) are assumed to never contribute and 90% (i.e., the difference between 100% and 10%) are assumed to contribute randomly, if ever possible (e.g., if the contributory period was limited to one year in the above case, the percentage never contributing would be 20% instead of 10%).

vi) **Drop-out period**

Assumptions must be made regarding the child-rearing period and the years for which contributions are made over age 65:

- **Period during which the contributor had at least one dependent child under 7 years of age**

  Because the actual proportions of males benefiting from the child-rearing drop-out provision are very small, it was assumed that all years of child-rearing would relate to female contributors. In any event, this alternative approach has no significant effect on financial projections. For a female born in a given calendar year, the cumulative number of years to be dropped on account of the child-rearing drop-out provision was computed for each year during her contributory period. The calculation uses actual past and future assumed fertility rates (adjusted, to correspond to Canada less Quebec, by weighting them by the population for the appropriate age, and calendar year and residence) to yield the number of children born so far to the female. Assuming a uniform age difference of exactly two years between any two consecutive births, the child-rearing period could then be computed taking into account the limit of seven years per child. Further, since years of child-rearing are not necessarily the years of lowest earnings, only half of the computed period was taken into account.

- **Years for which contributions are made over age 65**

  The provision for the replacement of earnings under age 65, by any higher earnings beyond age 65, is assumed to have a nil effect on retirement benefits.

vii) Retirement election proportions

The assumed proportions, by age, sex and calendar year, of contributors electing to start receiving the retirement pension at a given age (last birthday) were determined by extrapolating the corresponding CPP experience (see section 1(d) above) for 1987 to 1991. These proportions correspond to the ratio of the number of emerging retirement beneficiaries to the product of the population times the retirement benefit eligibility rate ELIRET (described in section 3(g) below).

Given the negligible proportion of contributors actually electing to start receiving the retirement pension after age 65, it was decided to assume that all contributors would be retired by age 65. For each year after 1991, the retirement election proportion for age 65 was taken as 100% minus the sum of proportions experienced by, or assumed for, the underlying cohort (of contributors reaching age 65 in the given year) for ages 60 to age 64. With this approach, it is implicitly assumed that all eligible contributors will have applied for the retirement pension by age 65.

The retirement election proportions, and the underlying prevalence rates of retirement, are used for the following five estimates:

- the emergence of retirement benefits (using election proportions) described in section 3(i)i) below
- the adjustment (using prevalence rates), for benefits computation purposes, of proportions of contributors at ages 60 to 70 (described in section 3(d) below)
- the adjustment (using election proportions), for benefits computation purposes, of average pensionable earnings at ages 60 to 70 (described in section 3(e) below)
- the reduction (using prevalence rates) effect of early retirement on disability incidence rates (described in section viii) below)
- the limit (using prevalence rates) on combined survivor-retirement pensions (described in section 3(i)iii) below)

A sample of some past actual and future assumed retirement election proportions is shown below by age, by sex and by calendar year.

RETIREMENT ELECTION PROPORTIONS

		Age at Retirement					
	Year	60	61	62	63	64	65
Males	1987*	.261	.209	.236	.250	.305	.741
	1988*	.242	.093	.104	.101	.172	.625
	1989*	.243	.074	.076	.074	.127	.550
	1990*	.258	.071	.071	.068	.109	.529
	1991*	.282	.080	.078	.071	.100	.499
	1992	.310	.080	.080	.070	.100	.402
	1993	.310	.080	.080	.070	.100	.442
	1994	.310	.080	.080	.070	.100	.438
	1995	.310	.080	.080	.070	.100	.412
	1996	.310	.080	.080	.070	.100	.388
	1997	.310	.080	.080	.070	.100	.360
	1998	.310	.080	.080	.070	.100	.360
	1999+	.310	.080	.080	.070	.100	.360
Females	1987*	.315	.223	.241	.242	.319	.523
	1988*	.289	.092	.095	.094	.192	.419
	1989*	.296	.073	.066	.067	.143	.358
	1990*	.309	.068	.061	.054	.116	.337
	1991*	.316	.071	.060	.054	.102	.317
	1992	.350	.075	.065	.060	.100	.371
	1993	.350	.075	.065	.060	.100	.423
	1994	.350	.075	.065	.060	.100	.416
	1995	.350	.075	.065	.060	.100	.395
	1996	.350	.075	.065	.060	.100	.384
	1997	.350	.075	.065	.060	.100	.350
	1998	.350	.075	.065	.060	.100	.350
	1999+	.350	.075	.065	.060	.100	.350

* Proportions for these years are actual experience proportions

viii) Disability incidence and termination rates

Disability incidence and termination rates used in the previous four reports are based on the actual CPP disability experience (re: benefits statistics in section 1(e) above) for 1976 to 1984. Additional experience data has since become available, during 1989 in respect of the 1985-1988 period, and in the fall of 1992 in respect of the 1989-1991 period.

Actual disability incidence rates by age and sex for each year of the study period (1976-1988) were developed as the ratio of the number of emerging disability beneficiaries to the product of the population and the disability flat-rate benefit eligibility rate (described in section 3(g) below). Actual disability death and recovery rates were obtained by age, sex, duration, for each year from 1976 to 1988, as the ratio of the number of cases dying of, and recovering from, disability, respectively, at a particular duration (i.e., disability year) to the corresponding number of original emergences. In respect of any individual case exposed to risk (death and recovery) only partially during any year of disability due to occurrence of the risk or to the starting or termination of the study period, the denominator (number of original emergences) was adjusted in accordance with the Balducci formula (i.e., ${}_{1-t|}q_{x+t} = (1-t)*q_x$). The total (death and recovery) disability termination rate for each age-sex cell was obtained as the sum of the death and recovery rates minus the product of the two same rates.

For purposes of this report, it was decided to assume that future disability incidence and termination rates would correspond to the arithmetic mean of the average experience for 1976 to 1981 and that for 1982 to 1987. It is thereby implicitly assumed that the total period of economic downturns, which tend to be related to increased disability benefits, will in the future be about the same on average as it has been from 1976 to 1988.

In determining assumed disability incidence rates for ages 60 to 64, the above averaging process was applied ignoring results for 1987 and 1988 since they reflects the reduction effect of the flexible retirement age provision (implemented 1 January 1987) on disability benefits. To account for such effect for 1987 and later years, assumed incidence rates were multiplied by the complement of retirement prevalence rates determined yearly in accordance with the retirement election proportions mentioned in section vii) above. Pursuant to this adjustment, disability incidence rates become ultimate in 1999 given that it is the year during which retirement prevalence rates become ultimate.

The additional benefit statistics for 1989 to 1991 were received too late for a revision of the assumed incidence rates described above, but sufficiently early to replace the incidence rates assumed in the previous CPP actuarial report for 1988 to 1991 by the actual ones. The examination of these recent actual incidence rates indicates a decreasing pattern and argues that the actual rates should eventually blend gradually into the assumed rates. It was therefore decided, taking also into account the normally expected increasing effect of the early 1990s recession on the incidence of disability, to increase the assumed incidence rates by 12.2%, 10% and 3% for 1991, 1992 and 1993, respectively for males, and by 44.5%, 25% and 10% for 1991, 1992 and 1993, respectively for females, and to use the table without adjustment for years after 1993.

A sample of the assumed ultimate disability incidence and termination rates is shown in the following tables.

ULTIMATE DISABILITY INCIDENCE RATES
(assumed for 2000 and later years)
1,000 PERSONS

Age	Males	Females
25	0.374	0.180
30	0.715	0.383
35	1.154	0.632
40	1.782	1.075
45	2.855	1.842
50	5.434	3.385
55	11.185	6.241
60	21.644	11.220

DISABILITY TERMINATION RATES PER 1,000 BENEFICIARIES

Age at disablement		Year of Disability 1	2	3	4	5	Ultimate	Attained Age
Males	20	182.099	228.349	178.481	132.604	85.969	42.186	25
	25	159.475	184.093	161.025	132.031	76.063	42.114	30
	30	143.281	176.507	119.222	94.169	66.041	33.859	35
	35	142.588	151.963	101.159	57.327	58.089	35.221	40
	40	145.662	132.281	82.989	61.943	51.408	38.910	45
	45	146.984	118.735	71.318	58.805	52.363	37.823	50
	50	146.497	101.596	65.325	53.265	54.746	44.705	55
	55	124.682	88.400	56.335	53.437	55.226	55.750	60
	60	98.264	78.783	56.923	52.652	55.221	-	65
Females	20	134.693	154.729	116.361	87.672	66.276	37.335	25
	25	137.370	139.869	105.118	81.230	65.078	37.996	30
	30	145.457	143.831	107.733	79.976	58.801	29.265	35
	35	172.931	135.403	92.622	63.130	45.263	24.345	40
	40	171.650	114.388	75.224	51.833	41.576	24.370	45
	45	156.950	92.031	60.505	44.002	38.823	29.561	50
	50	128.685	77.961	52.972	39.963	35.983	28.493	55
	55	90.963	60.971	43.469	35.722	34.899	30.330	60
	60	65.181	43.614	35.420	32.365	33.913	-	65

ix) Proportions of contributors married at death

The assumed proportions of contributors married at time of their death were determined from benefits statistics as at 31 December 1991 (see section 1(e) above). The number of emerging surviving spouse benefits, sorted according to the age and sex of the deceasing contributing spouse, was divided by the number of all emerging death benefits relating to the same age and sex. This measure corresponds exactly to the proportion required for the valuation of survivor benefits since eligibility for survivor benefits is the same as for death benefits. For each age-sex cell, the resulting actual proportions, averaged over 1982 to 1990, were:

- Smoothed; with only a few slight adjustments required for this purpose.
- Further adjusted, for each age, so that the overall average over all ages combined, separately for each sex, equals the actual average for 1990.

The resulting adjusted proportions are deemed to correspond to 1990. On the basis of the trends shown by past experience, the proportions assumed for the projection period were obtained by decreasing geometrically the average adjusted rates for 1990 by 1% and 4% for males and females, respectively, each year for 1991 to 1995. Proportions are assumed to remain constant (ultimate) after 1995. Sample ultimate values are shown below.

ASSUMED ULTIMATE PROPORTIONS OF CONTRIBUTORS MARRIED AT DEATH

Age	Males	Females
20	.0537	.0286
25	.1970	.1842
30	.3959	.3488
35	.5473	.5036
40	.6479	.5396
45	.6972	.5507
50	.7233	.5407
55	.7320	.5168
60	.7406	.4569
65	.7320	.3694
70	.7243	.2857
75	.6814	.1864
80	.6338	.1075
85	.5475	.0497
90	.4373	.0295

x) Proportion of survivors emerging under age 45 with reduced benefits

Surviving spouses emerging under age 45, if then not disabled and in the absence of any eligible children under their care, are only entitled to reduced survivor benefits. To account for this provision, it was assumed that 75% of all surviving spouses emerging under age 45 would then be disabled or have at least one eligible dependent child.

xi) Distributions of spouses by age

The distributions of spouses by age are required in the valuation process for:

- The survivorship of survivor benefits.
- The estimate of the effect of limits applying to combined pensions.
- The estimates of orphan's benefits, regarding the numbers of children born to the female spouses of deceased male contributors.

For a cohort of married contributors of a given age and sex at time of death, the distribution of their spouses by age is assumed, on the basis of past experience, to be constantly equal, over the projection period, to the actual distribution, averaged over the 1982 to 1991 observation period, derived from benefits statistics (see section 1(e) above).

The assumed distributions of spouses by age are fully shown on the following page.

ASSUMED DISTRIBUTIONS OF SPOUSES BY AGE

Age of wife at her death	Age of widower at wife's death															
	15-19 %	20-24 %	25-29 %	30-34 %	35-39 %	40-44 %	45-49 %	50-54 %	55-59 %	60-64 %	65-69 %	70-74 %	75-79 %	80-84 %	85-89 %	90+ %
15-19	0.0	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24	0.0	21.4	56.5	15.3	5.3	0.8	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-29	0.0	2.2	34.4	40.4	17.4	3.8	1.4	0.0	0.2	0.0	0.0	0.0	0.1	0.0	0.1	0.0
30-34	0.0	0.3	3.9	37.1	41.7	12.3	2.1	1.7	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.1
35-39	0.0	0.0	0.5	5.4	42.0	38.7	9.4	2.8	0.9	0.2	0.1	0.0	0.0	0.0	0.0	0.0
40-44	0.0	0.0	0.1	1.1	7.1	39.0	36.2	11.8	3.2	1.1	0.3	0.1	0.0	0.0	0.0	0.0
45-49	0.0	0.0	0.1	0.1	1.7	7.1	36.1	37.6	12.9	3.3	0.8	0.2	0.1	0.0	0.0	0.0
50-54	0.0	0.0	0.0	0.0	0.4	1.4	6.8	34.8	39.9	12.5	3.1	0.7	0.2	0.1	0.0	0.0
55-59	0.0	0.0	0.0	0.0	0.1	0.5	1.8	8.1	37.4	36.9	11.3	3.1	0.7	0.1	0.0	0.0
60-64	0.0	0.0	0.0	0.0	0.0	0.2	0.7	2.0	9.7	37.8	34.1	11.7	2.9	0.6	0.1	0.0
65-69	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8	3.1	11.9	38.0	32.2	10.5	2.6	0.5	0.1
70-74	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	1.2	4.7	13.7	37.7	31.0	9.3	1.8	0.1
75-79	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.6	2.2	5.0	17.5	42.1	25.4	6.0	1.0
80-84	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.3	1.0	2.3	7.2	22.2	42.4	20.8	3.6
85-89	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	2.4	3.9	12.3	29.2	38.0	13.9
90+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.1	7.1	0.0	7.1	14.3	28.6	35.7

Age of husband at his death	Age of widow at husband's death															
	15-19 %	20-24 %	25-29 %	30-34 %	35-39 %	40-44 %	45-49 %	50-54 %	55-59 %	60-64 %	65-69 %	70-74 %	75-79 %	80-84 %	85-89 %	90+ %
15-19	50.0	50.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20-24	9.0	65.8	21.8	2.4	0.7	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25-29	1.0	27.8	55.0	12.3	2.7	0.8	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30-34	0.1	4.1	31.9	49.3	11.2	2.5	0.5	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35-39	0.0	0.8	7.1	32.1	48.0	9.2	1.9	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0
40-44	0.0	0.3	1.9	8.5	35.7	42.3	8.7	1.6	0.6	0.2	0.1	0.0	0.0	0.0	0.0	0.0
45-49	0.0	0.1	0.5	2.3	10.5	36.2	39.4	8.5	1.8	0.5	0.2	0.0	0.0	0.0	0.0	0.0
50-54	0.0	0.1	0.2	0.7	3.2	11.1	33.9	38.6	9.2	2.3	0.6	0.2	0.0	0.0	0.0	0.0
55-59	0.0	0.0	0.1	0.3	1.2	3.4	10.6	33.4	38.4	9.9	2.0	0.6	0.1	0.0	0.0	0.0
60-64	0.0	0.0	0.0	0.1	0.5	1.2	3.4	11.0	33.9	38.1	9.5	1.9	0.5	0.1	0.0	0.0
65-69	0.0	0.0	0.0	0.0	0.2	0.5	1.1	3.4	12.7	36.3	35.7	8.3	1.4	0.3	0.0	0.0
70-74	0.0	0.0	0.0	0.0	0.1	0.2	0.4	1.2	4.6	16.1	37.4	31.8	7.0	1.0	0.1	0.0
75-79	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.5	1.8	6.4	18.9	37.3	28.7	5.5	0.6	0.1
80-84	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3	0.8	2.8	8.8	21.8	38.0	23.7	3.3	0.3
85-89	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.2	0.4	1.1	4.5	11.5	26.7	37.3	16.3	1.7
90+	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	3.2	8.9	16.8	32.2	28.7	9.4

xii) Proportions of children at school in age-range 18-25

Assumed proportions of children at school in age group 18-25 are required for the valuation of children's benefits (Disabled Contributor's Child and Orphan). They were taken from Statistics Canada publication *Education in Canada* (catalogue 81-229 for 1988-1989) and are assumed to be constant over the projection period.

PROPORTIONS OF CHILDREN AT SCHOOL

Age	Proportion at school
18	0.57
19	0.44
20	0.33
21	0.25
22	0.18
23	0.12
24	0.08
25	0.08

xiii) Distribution, by amount, of average retirement pensions

Since earnings-related benefits are computed for age-sex cohorts of persons as opposed to individual persons, a distribution of average retirement pensions by amount is required for estimating the effect of limits applying to the earnings-related portion of combined survivor-retirement and survivor-disability pensions, and to the death benefit.

Distributions, expressed as a percentage of the CPP maximum annual retirement pension and available (see benefits statistics in section 1(e) above) for six categories of amount (0-20%, 20-40%, 40-60%, 60-80%, 80-99% and 100%), of past actual emerging retirement pensions, grouped by age, sex and calendar year, were used as a basis for developing a mathematical formula reproducing closely these actual distributions.

This formula produces a continuous distribution which varies according to the ratio of the average retirement pension over the maximum retirement pension. Distributions were then retained only for each of the one hundred integer values of the ratio equal to 1%, 2%, and so on up to 100%. For each of these one hundred values of the ratio, the average retirement pension continuous distribution, expressed as a proportion of the maximum retirement pension, was aggregated within each of twenty equal groups of persons in the cohort. For this purpose, persons in the cohort are sorted by order of magnitude of their earnings.

A sample of the resulting model distribution is shown below for 21 values selected from the retained 100 values of the ratio.

The distribution of the average retirement pension, as defined above, is assumed to be static over the years. However, it is nonetheless effectively dynamic since it is properly designed to apply to the average retirement benefit factor computed, as described in section 3(h) below, on a dynamic basis, i.e., varying by age and sex and year of emergence of the retirement pension. If, for example, the average retirement pension of a cohort of contributors retiring in a given year is equal to 70% of the maximum retirement pension applicable to cases emerging during that year, the table below indicates that 5% of the cohort have a retirement pension averaging 6.8% of the maximum retirement pension, the next 5% have a retirement pension averaging 15.6% of the maximum retirement pension, and so on, with the twentieth (as well as the previous one)) 5% sub-group of the cohort having a retirement pension averaging 100% of the maximum retirement pension. Summing these 20 average percentages and dividing by 20 accordingly equals the underlying ratio of 70%. For any value of the ratio falling in between two consecutive values of the 100 model values, linear interpolation is used to determine the desired distribution of the average retirement pension.

DISTRIBUTION OF THE AVERAGE RETIREMENT PENSION AS A PROPORTION OF THE MAXIMUM PENSION

	rank of each of the twenty 5%-categories of persons in the cohort																			
ratio	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0.01	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.010	0.011	0.013
0.05	0.014	0.019	0.021	0.023	0.025	0.026	0.027	0.028	0.029	0.030	0.032	0.034	0.037	0.041	0.047	0.057	0.072	0.097	0.134	0.208
0.10	0.020	0.030	0.036	0.040	0.043	0.046	0.048	0.050	0.052	0.055	0.059	0.064	0.070	0.080	0.095	0.116	0.150	0.206	0.288	0.452
0.15	0.026	0.041	0.051	0.057	0.062	0.066	0.069	0.072	0.076	0.080	0.086	0.094	0.104	0.119	0.142	0.175	0.228	0.315	0.442	0.695
0.20	0.031	0.051	0.064	0.074	0.082	0.089	0.095	0.101	0.108	0.115	0.125	0.137	0.154	0.176	0.207	0.252	0.319	0.422	0.560	0.837
0.25	0.037	0.061	0.078	0.091	0.102	0.111	0.120	0.129	0.139	0.151	0.164	0.181	0.203	0.233	0.273	0.329	0.409	0.530	0.679	0.979
0.30	0.039	0.068	0.090	0.110	0.128	0.145	0.161	0.177	0.194	0.213	0.234	0.257	0.285	0.318	0.361	0.416	0.492	0.599	0.731	0.983
0.35	0.042	0.074	0.103	0.129	0.154	0.178	0.201	0.225	0.250	0.275	0.303	0.333	0.366	0.404	0.449	0.504	0.574	0.669	0.782	0.987
0.40	0.044	0.081	0.116	0.148	0.180	0.211	0.242	0.273	0.305	0.338	0.372	0.408	0.447	0.489	0.536	0.591	0.656	0.738	0.833	0.992
0.45	0.046	0.088	0.128	0.167	0.206	0.244	0.282	0.321	0.360	0.400	0.441	0.484	0.528	0.575	0.624	0.678	0.738	0.808	0.885	0.996
0.50	0.048	0.095	0.141	0.186	0.232	0.277	0.323	0.369	0.415	0.463	0.510	0.559	0.609	0.660	0.712	0.766	0.821	0.877	0.936	1.000
0.55	0.053	0.110	0.169	0.228	0.285	0.341	0.395	0.446	0.496	0.544	0.591	0.636	0.681	0.725	0.769	0.813	0.858	0.906	0.952	1.000
0.60	0.058	0.126	0.197	0.269	0.339	0.405	0.467	0.524	0.577	0.626	0.671	0.713	0.753	0.790	0.826	0.861	0.895	0.936	0.968	1.000
0.65	0.063	0.141	0.226	0.311	0.393	0.469	0.539	0.601	0.657	0.707	0.751	0.790	0.824	0.855	0.883	0.909	0.932	0.965	0.984	1.000
0.70	0.068	0.156	0.254	0.352	0.446	0.533	0.611	0.679	0.738	0.789	0.831	0.867	0.896	0.920	0.940	0.956	0.969	0.994	1.000	1.000
0.75	0.080	0.193	0.316	0.435	0.541	0.632	0.708	0.771	0.821	0.862	0.894	0.920	0.941	0.957	0.970	0.978	0.985	0.997	1.000	1.000
0.80	0.091	0.229	0.379	0.518	0.636	0.732	0.806	0.862	0.904	0.935	0.957	0.974	0.985	0.993	0.999	1.000	1.000	1.000	1.000	1.000
0.85	0.157	0.383	0.556	0.677	0.764	0.828	0.876	0.915	0.941	0.960	0.974	0.984	0.991	0.996	0.999	1.000	1.000	1.000	1.000	1.000
0.90	0.223	0.537	0.733	0.836	0.892	0.925	0.946	0.967	0.978	0.985	0.990	0.994	0.997	0.998	1.000	1.000	1.000	1.000	1.000	1.000
0.95	0.473	0.735	0.885	0.951	0.977	0.988	0.991	0.999	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000
1.00	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

3. Methodology

(a) General Approach

Given the inherent complexity of the valuation methodology and the intent here to facilitate its comprehension as much as possible, it is appropriate at this stage to point out two significant characteristics of the general approach underlying the valuation methodology.

i) The actuarial approach used for projections is macro-simulated as opposed to micro-simulated. One of the important characteristics of such macro-simulation is that projections are made relying on grouped, as opposed to individual, data (mainly numbers of persons and earnings). This results in the need for a considerably smaller volume of data to be processed. Using micro-simulation, individual benefits can be easily determined via calculations involving individual data. Using macro-simulation, only aggregate benefits (i.e., combined by age and sex separately for each year of benefit emergence) can be obtained directly, since the data used in the computational processes are aggregate values. Through macro-simulation, the average initial annual retirement pension of all persons (as opposed to all contributors) born in a given calendar of birth, split by sex is obtained, generally speaking (i.e., ignoring the 25% benefit proportion and the wage escalation provision), by summing, over the contributory period of this cohort, the annual products of the proportion of contributors by the average pensionable earnings deemed to apply to the given cohort, and by dividing this sum by the number of years included in the contributory period. Ignoring the four drop-out provisions and credit-splitting on marital union breakdown, the preceding formula reproduces correctly the average retirement pension of the cohort, except that it implicitly assumes that the average annual earnings of those who die before retirement is exactly the same as all other persons of the underlying age-sex cohort for each calendar year until the year of death. This formula was retained given that this implicit assumption is generally reasonable. A minor exception occurs in respect of the year in which a contributor dies, when, on average, employment earnings would be earned for only half of a year. However, given the low proportions of deaths before retirement, such part-year earnings have a negligible effect on the financial projections.

ii) All projections are made using 1966 as the starting point of projections instead of the beginning (1992) of the statutory valuation period. This is done for the following three reasons:

- The valuation methodology can be validated for the pre-valuation years (1966 to 1991) by comparing the values (benefits, contributions, numbers of beneficiaries, of contributors, etc.) computed for these years with actual

results. The computerized valuation system incorporates an extensive methodology validation process that examines the numbers and amounts of all past benefits by age (both at emergence and attained), by sex and by calendar year. Other information on the methodology validation process is provided in section 1(e)i) above.

- The projection of those benefits already in pay on the valuation date (31 December 1991) is fully integrated with that of benefits emerging after this date, thus ensuring full consistency of the various valuation processes used for these two series of beneficiaries.

- Certain amendments to the plan, e.g., the one underlying Bill C-57, which is the subject of the CPP thirteenth statutory actuarial report, instate beneficiaries rejected before the effective date of the amendment. Though such instatements are made without retroactive payments, their proper evaluation can be made only by hypothetically instating them at the prior rejection date.

(b) Projection of Economic Indices

i) Consumer Price Index (CPI)

The CPI is projected for each calendar year of the valuation period by increasing geometrically its most recent average, over the 12-month period ending in December, in accordance with the assumed annual increase in prices. Designating this assumed rate of increase in prices as "c" (e.g., 0.035 in respect of a 3.5% assumption), the CPI for a given calendar year is accordingly obtained by multiplying the previous year's CPI by "1+c".

ii) Pension Index (PI)

The PI for a given calendar year corresponds to the CPI averaged over the 12-month period ending in October of the previous year. It is therefore computed simply as the sum of 5/6 of the previous year's CPI plus 1/6 of the CPI for the year preceding that previous year. PI values are used for the price escalation of benefits.

iii) Average Industrial Aggregate Wage (AIAW)

The most current (1992) value for the AIAW is projected into the future using the assumed annual rate of increase in earnings (see section 2(a) above) in a manner exactly parallel to that for the CPI projections. Values of the AIAW are used in projecting future values of the YMPE.

iv) Year's Maximum Pensionable Earnings (YMPE)
Year's Basic Exemption (YBE)

The YMPE is projected for each calendar year of the valuation period by increasing its most recent unrounded value in accordance with the applicable increase in the AIAW computed as above. This AIAW increase applicable to the YMPE of a given year, to produce the YMPE for the following year, is the one experienced on average during the 12-month period ending with 30 June of the given year. Therefore, the increase factor corresponds on average to the ratio of the AIAW as at 1 January of the given year to that as at 1 January of the preceding year. Since AIAWs computed as described in paragraph iii) above correspond to 1 July as opposed to 1 January, the YMPE for a given calendar year is accordingly obtained by multiplying the previous year's unrounded YMPE by the square root of the ratio of the AIAW for the previous year to the AIAW for the third year preceding the given year, and by rounding the result to the next lower multiple of $100. The calculation of the unrounded YMPE for a given calendar year N can therefore be expressed as:

$$YMPE_N = YMPE_{N-1} * \sqrt{\frac{AIAW_{N-1}}{AIAW_{N-3}}}$$

The unrounded value of the YMPE is $33,493.49 for 1993. The first year for which YMPE's were projected is therefore 1994.

For any year, the YBE is obtained by taking 10% of the rounded value of the YMPE computed for that year and by rounding the result to the next lower multiple of $100.

v) Earnings Index

In the computation of actual CPP earnings-related benefits, each year's earnings are escalated in line with the average of the YMPE over the 3-year period ending with the year of benefit emergence. To reflect this plan provision, an Earnings Index is computed for each year as the ratio of the YMPE averaged over the last three years to the year's Pension Index. Because

the price indexation of CPP pensions involves the ratio of the PI (Pension Index) for the year of payment to the PI for the year of the pension emergence, it is more convenient and efficient for computational purposes to include the year-of-emergence PI in the denominator of the Earnings Index. Then, ignoring survivorship considerations, the computation of benefits for any year following emergence can simply multiply the emergence year's benefits by the PI for the payment year.

vi) Maximum Retirement Pension

With the exception of the actuarial adjustment in connection with the variable retirement age provision, the maximum annual pension payable in respect of a retirement benefit emerging in a given year is equal to 25% of the year's three-year average YMPE. Then, for computational efficiency as well as consistency with the structure and usage of the Earnings Index described above, it is convenient to divide the 25% of the 3-year average YMPE by the year's PI. The maximum pension is used to:

- identify the limit, incidentally equal to the maximum retirement pension, applying to combined survivor-retirement and survivor-disability pensions;
- compute the ratio (see section 2(b)xiii) above) used for the distribution of average retirement pensions involved in estimating the effect of the limits on combined earnings-related survivor-retirement and survivor-disability pensions as well as on the death benefit (see sections (i)iii) & (i)iv) below);
- adjust benefit eligibility rates (see section 3(g) below) whenever required for consistency purposes.

(c) Proportions of Earners, Average Employment Earnings and Distributions of Earners and Earnings

As mentioned in section 1(c) above, earnings statistics are combined into quinquennial age groups. Since the valuation process works on an individual age basis, actual past (1966-1990) Proportions of Earners, Average Employment Earnings and Distributions of Earners and Earnings are dis-aggregated to an individual age basis using appropriate interpolation formulae.

They are also adjusted so that the age corresponds to 1 July instead of 31 December of the relevant calendar year. This is required because the valuation methodology is designed on an average mid-year basis. For this purpose, specific 4-pivotal point actuarial interpolation formulae were developed.

A sample of past actual and future assumed proportions of earners and average employment earnings, and of the assumed (constant over the years) distributions of earners and of their average employment earnings over 78 earnings categories is shown in the tables below.

PROPORTIONS OF EARNERS
(past actual adjusted and future assumed)

		calendar year					
	Age	1980	1990	2000	2025	2050	2100
males							
	20	0.9057	0.7719	0.8839	0.8839	0.8839	0.8839
	25	0.9390	0.9653	0.9819	0.9819	0.9819	0.9819
	30	0.9839	0.9591	1.0056*	1.0056*	1.0056*	1.0056*
	35	0.9823	0.9632	0.9952	0.9952	0.9952	0.9952
	40	0.9691	0.9856	0.9774	0.9774	0.9774	0.9774
	45	0.9509	0.9797	0.9632	0.9632	0.9632	0.9632
	50	0.9143	0.9391	0.9167	0.9167	0.9167	0.9167
	55	0.8833	0.8765	0.8904	0.8904	0.8904	0.8904
	60	0.7683	0.7003	0.7345	0.7345	0.7345	0.7345
	65	0.4763	0.3178	0.3636	0.3636	0.3636	0.3636
females							
	20	0.8123	0.7429	0.8539	0.8945	0.8934	0.8934
	25	0.7564	0.8888	0.8242	0.8422	0.8464	0.8464
	30	0.7008	0.8216	0.7736	0.7999	0.8128	0.8128
	35	0.6838	0.8303	0.7823	0.8277	0.8485	0.8485
	40	0.6904	0.8752	0.8022	0.8274	0.8560	0.8562
	45	0.6550	0.8583	0.7710	0.8058	0.8434	0.8426
	50	0.5752	0.7619	0.7204	0.7534	0.7913	0.7946
	55	0.4926	0.6295	0.6670	0.7351	0.7800	0.7965
	60	0.3569	0.4215	0.4250	0.4541	0.4691	0.4758
	65	0.1879	0.1645	0.1400	0.1206	0.1106	0.1061

* Rates higher than one in the above table may be explained as follows:

1. Earners include all persons who ever had earnings during the year, whereas the population count is taken as at mid-year and does not record the number of all persons who ever lived in Canada during the year.
2. The undercount adjustments made to the census populations may be underestimated for certain ages.
3. The possession of more than one Social Insurance number by some individuals and the consequent overcount of earners.
4. The presence of individuals who have employment earnings, but are not included in the population count, such as students with working permits but no landed immigrant status, and persons with business visas.
5. The presence of dual earners, who would be included both as CPP contributors and Quebec Pension Plan contributors.
6. The fact that the Armed Forces personnel and the members of the RCMP who are employed in Quebec or outside Canada, contribute to the Canada Pension Plan. They are therefore included in the numerator (numbers of earners) of the proportions

AVERAGE EMPLOYMENT EARNINGS
(past actual adjusted and future assumed)

	Age	calendar year 1980	1990	2000	2025	2050	2100
Males	20	8283	9977	13505	40477	119528	1057832
	25	13866	20637	27679	82509	242704	2137051
	30	17601	27863	36857	108942	317841	2767191
	35	20189	32505	42880	125930	366633	3173819
	40	21041	36213	47951	140060	406724	3512372
	45	21020	38104	50520	147245	427172	3676207
	50	20685	37477	49801	145225	420757	3611601
	55	19549	33916	45450	133431	386930	3317593
	60	17452	30359	40523	119390	347145	3010779
	65	10044	17194	22271	65472	191537	1686632
Females	20	5831	8228	11364	35485	108063	996442
	25	9009	15754	21756	68776	211282	1969663
	30	9701	18058	25128	81975	256645	2444852
	35	9782	19721	27628	91091	287738	2760620
	40	9909	21466	30292	99939	316100	3038892
	45	9889	21654	30795	102528	326267	3150830
	50	9837	20536	29442	99046	316691	3071172
	55	9485	18343	26577	90335	289723	2813342
	60	9277	16909	24286	82181	262991	2569208
	65	6046	9993	13835	46183	147644	1452790

ASSUMED DISTRIBUTIONS OF EARNERS (*)
(actual adjusted distributions averaged over 1986 to 1990)

	Earnings category (*)	age group 18-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
	5	0.0321	0.0279	0.0273	0.0258	0.0248	0.0238	0.0240	0.0257	0.0358	0.0647	0.1477
	10	0.0673	0.0532	0.0502	0.0472	0.0449	0.0432	0.0434	0.0462	0.0604	0.0974	0.2176
	20	0.1365	0.1081	0.0989	0.0925	0.0896	0.0879	0.0901	0.0952	0.1147	0.1563	0.3115
	30	0.2087	0.1714	0.1527	0.1408	0.1352	0.1322	0.1357	0.1433	0.1677	0.2134	0.3767
	40	0.2826	0.2399	0.2036	0.1867	0.1793	0.1753	0.1803	0.1905	0.2195	0.2655	0.4313
	50	0.3523	0.3091	0.2525	0.2322	0.2229	0.2182	0.2243	0.2365	0.2680	0.3158	0.4784
Males	60	0.4178	0.3728	0.3017	0.2786	0.2688	0.2649	0.2718	0.2847	0.3161	0.3643	0.5203
	70	0.4781	0.4305	0.3519	0.3287	0.3203	0.3187	0.3276	0.3393	0.3666	0.4117	0.5584
	80	0.5334	0.4831	0.4047	0.3838	0.3800	0.3844	0.3954	0.4065	0.4240	0.4594	0.5940
	90	0.5837	0.5314	0.4605	0.4445	0.4498	0.4568	0.4676	0.4786	0.4914	0.5105	0.6275
	100	0.6287	0.5769	0.5174	0.5111	0.5232	0.5309	0.5401	0.5493	0.5594	0.5681	0.6582
	200	0.8784	0.8928	0.9438	0.9509	0.9461	0.9406	0.9355	0.9308	0.9205	0.9044	0.8550
	500	0.9944	0.9992	0.9998	0.9997	0.9996	0.9995	0.9992	0.9990	0.9984	0.9973	0.9763
	1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	5	0.0268	0.0299	0.0417	0.0466	0.0424	0.0374	0.0365	0.0393	0.0472	0.0666	0.1205
	10	0.0577	0.0574	0.0745	0.0815	0.0747	0.0664	0.0641	0.0682	0.0791	0.1056	0.1911
	20	0.1195	0.1145	0.1353	0.1451	0.1344	0.1218	0.1182	0.1232	0.1373	0.1673	0.2846
	30	0.1858	0.1796	0.1918	0.2028	0.1914	0.1777	0.1746	0.1803	0.1954	0.2232	0.3567
	40	0.2550	0.2470	0.2460	0.2600	0.2483	0.2346	0.2331	0.2420	0.2590	0.2820	0.4121
	50	0.3244	0.3129	0.2970	0.3123	0.3023	0.2901	0.2898	0.2992	0.3172	0.3386	0.4590
Females	60	0.3908	0.3753	0.3452	0.3619	0.3552	0.3453	0.3465	0.3565	0.3726	0.3903	0.5027
	70	0.4545	0.4329	0.3925	0.4100	0.4058	0.3989	0.4013	0.4116	0.4271	0.4406	0.5436
	80	0.5140	0.4850	0.4390	0.4563	0.4550	0.4508	0.4540	0.4635	0.4770	0.4895	0.5817
	90	0.5689	0.5324	0.4848	0.5010	0.5037	0.5035	0.5057	0.5128	0.5238	0.5340	0.6147
	100	0.6189	0.5766	0.5306	0.5459	0.5538	0.5577	0.5595	0.5611	0.5672	0.5750	0.6451
	200	0.8860	0.8945	0.9120	0.9012	0.9020	0.9053	0.9054	0.9027	0.9006	0.8978	0.8492
	500	0.9972	0.9996	0.9994	0.9982	0.9983	0.9981	0.9980	0.9973	0.9962	0.9950	0.9865
	1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* Percentage of earners earning less than the *earnings category* percentage of the average earnings of the age-sex cell

ASSUMED DISTRIBUTIONS OF EMPLOYMENT EARNINGS (*)
(actual adjusted distributions averaged over 1986 to 1990)

	Earnings category (*)	age group										
		18-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69
	5	0.0008	0.0007	0.0006	0.0006	0.0006	0.0005	0.0005	0.0006	0.0008	0.0014	0.0030
	10	0.0035	0.0026	0.0024	0.0022	0.0021	0.0020	0.0020	0.0021	0.0026	0.0038	0.0081
	20	0.0139	0.0109	0.0097	0.0091	0.0089	0.0088	0.0091	0.0096	0.0109	0.0127	0.0219
	30	0.0320	0.0268	0.0232	0.0211	0.0202	0.0199	0.0205	0.0216	0.0241	0.0268	0.0381
	40	0.0578	0.0508	0.0410	0.0372	0.0357	0.0349	0.0360	0.0381	0.0422	0.0450	0.0572
	50	0.0892	0.0819	0.0630	0.0576	0.0553	0.0542	0.0559	0.0588	0.0640	0.0676	0.0783
Males	60	0.1252	0.1169	0.0900	0.0832	0.0806	0.0800	0.0820	0.0853	0.0904	0.0943	0.1014
	70	0.1643	0.1543	0.1227	0.1158	0.1141	0.1150	0.1184	0.1209	0.1232	0.1251	0.1262
	80	0.2058	0.1937	0.1623	0.1571	0.1589	0.1643	0.1692	0.1714	0.1664	0.1609	0.1528
	90	0.2484	0.2348	0.2097	0.2088	0.2182	0.2259	0.2306	0.2327	0.2236	0.2044	0.1812
	100	0.2911	0.2779	0.2638	0.2721	0.2881	0.2963	0.2994	0.3000	0.2882	0.2592	0.2104
	200	0.6412	0.7278	0.8623	0.8733	0.8589	0.8461	0.8323	0.8169	0.7808	0.7213	0.4920
	500	0.9652	0.9950	0.9986	0.9981	0.9976	0.9969	0.9954	0.9939	0.9896	0.9820	0.8429
	1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
	5	0.0007	0.0007	0.0010	0.0011	0.0010	0.0009	0.0008	0.0009	0.0011	0.0014	0.0024
	10	0.0030	0.0028	0.0034	0.0037	0.0034	0.0030	0.0029	0.0031	0.0034	0.0043	0.0076
	20	0.0123	0.0114	0.0125	0.0132	0.0123	0.0113	0.0110	0.0113	0.0121	0.0135	0.0213
	30	0.0289	0.0278	0.0266	0.0276	0.0266	0.0253	0.0252	0.0256	0.0267	0.0275	0.0392
	40	0.0532	0.0514	0.0456	0.0476	0.0465	0.0453	0.0456	0.0472	0.0489	0.0481	0.0585
	50	0.0844	0.0810	0.0685	0.0711	0.0708	0.0702	0.0712	0.0729	0.0751	0.0734	0.0795
Females	60	0.1209	0.1153	0.0950	0.0983	0.0999	0.1006	0.1023	0.1044	0.1055	0.1018	0.1036
	70	0.1623	0.1527	0.1258	0.1296	0.1328	0.1354	0.1380	0.1403	0.1409	0.1345	0.1300
	80	0.2068	0.1917	0.1606	0.1643	0.1697	0.1744	0.1775	0.1792	0.1783	0.1710	0.1586
	90	0.2535	0.2319	0.1996	0.2023	0.2110	0.2191	0.2214	0.2211	0.2180	0.2088	0.1867
	100	0.3010	0.2740	0.2431	0.2449	0.2587	0.2707	0.2725	0.2670	0.2592	0.2477	0.2155
	200	0.6736	0.7345	0.7873	0.7496	0.7468	0.7545	0.7526	0.7419	0.7282	0.7102	0.5078
	500	0.9823	0.9973	0.9961	0.9893	0.9899	0.9892	0.9884	0.9840	0.9769	0.9680	0.8985
	1000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000

* Percentage of average employment earnings earned by earners earning less than the *earnings category* percentage of the average earnings of the age-sex cell

(d) Proportions of Contributors

In respect of a given calendar year, one of the conditions to be a CPP individual contributor is to have employment earnings over the YBE. Proportions of contributors are therefore determined by multiplying proportions of earners by the complement of the fraction of earners earning less than the YBE. This fraction was determined for each age, sex and calendar year by expressing the YBE as a percentage of average employment earnings and using the distribution of earners described above. The resulting proportions of contributors are those used for the calculation of average contributory earnings.

Sample values of these proportions of contributors are shown below.

PROPORTIONS OF CONTRIBUTORS
(used for contributory earnings computation purposes)

		Year				
	Age	1990	2000	2020	2050	2100
Males	18	0.338	0.475	0.473	0.463	0.453
	20	0.641	0.720	0.721	0.716	0.711
	25	0.900	0.909	0.909	0.907	0.905
	30	0.913	0.952	0.951	0.950	0.947
	35	0.925	0.952	0.951	0.949	0.947
	40	0.952	0.940	0.940	0.938	0.937
	45	0.947	0.929	0.928	0.926	0.925
	50	0.907	0.883	0.882	0.881	0.879
	55	0.836	0.846	0.845	0.843	0.841
	60	0.634	0.656	0.656	0.653	0.650
	65	0.112	0.082	0.081	0.080	0.079
Females	18	0.275	0.398	0.422	0.433	0.444
	20	0.589	0.664	0.698	0.706	0.710
	25	0.786	0.724	0.736	0.750	0.752
	30	0.725	0.679	0.700	0.722	0.726
	35	0.744	0.698	0.738	0.767	0.771
	40	0.800	0.731	0.753	0.789	0.793
	45	0.790	0.708	0.737	0.783	0.786
	50	0.696	0.657	0.686	0.731	0.738
	55	0.563	0.596	0.655	0.709	0.728
	60	0.348	0.347	0.375	0.394	0.404
	65	0.050	0.024	0.023	0.021	0.021

Proportions of contributors from the above table, used for contributory earnings computation purposes, were then adjusted, for benefit computation purposes, to reflect the effect of:

i) **Retirements occurring below age 65**
Retirement pensions commencing below age 65 have the effect of reducing the amount of contributions that would otherwise have been made to CPP. Such effect is already accounted for in the proportions of contributors described and shown above. For benefit computation purposes, however, such effect must be removed in respect of contributors having not yet retired at a given age below 65. This was done by dividing the above proportions of contributors by the complement of the CPP retirement prevalence rates (see section 2(b)vii) above).

ii) **Credit-splitting on marital union breakdown**
The provision for the equal apportionment, between spouses, of unadjusted pensionable earnings upon marital union breakdown is designed to affect benefits but not contributions. For benefit purposes, the effect of this provision on proportions of contributors was accordingly accounted for using appropriate mathematical formulae, on the basis of the assumptions described in section 2(b)iv) above.

Sample values of proportions of contributors adjusted for benefit computation purposes are shown in the table below.

PROPORTIONS OF CONTRIBUTORS
(adjusted for benefit computation purposes)

		Year				
	Age	1990	2000	2020	2050	2100
Males	18	0.339	0.476	0.474	0.464	0.454
	20	0.658	0.733	0.734	0.730	0.726
	25	0.915	0.921	0.921	0.920	0.918
	30	0.927	0.959	0.959	0.958	0.956
	35	0.937	0.959	0.959	0.958	0.956
	40	0.959	0.948	0.948	0.947	0.946
	45	0.954	0.936	0.936	0.935	0.934
	50	0.914	0.891	0.891	0.891	0.889
	55	0.842	0.853	0.853	0.852	0.850
	60	0.658	0.685	0.686	0.685	0.683
	65	0.249	0.279	0.278	0.276	0.275
Females	18	0.281	0.404	0.428	0.439	0.449
	20	0.626	0.703	0.731	0.736	0.738
	25	0.842	0.799	0.808	0.817	0.818
	30	0.795	0.767	0.782	0.798	0.800
	35	0.803	0.771	0.801	0.823	0.825
	40	0.841	0.785	0.803	0.831	0.834
	45	0.824	0.755	0.780	0.818	0.820
	50	0.733	0.697	0.722	0.762	0.768
	55	0.595	0.626	0.680	0.729	0.747
	60	0.406	0.414	0.439	0.456	0.464
	65	0.118	0.099	0.088	0.081	0.079

(e) Average Pensionable Earnings

Average pensionable earnings by age, sex and calendar year, unadjusted for the Earnings Index (i.e., the wage escalation factor), correspond, for a given cohort, to the average portion of individual employment earnings below the YMPE for this cohort's earners earning more than the YBE. Average pensionable earnings are computed by removing from average employment earnings the effect of earners earning less than the YBE and of earnings in excess of the YMPE. Since earnings statistics are aggregate (by age and sex) as opposed to individual, such removal is made using the distributions of earners and earnings (see section (c) above). The formula below used for the computation of average pensionable earnings (used for the later calculation of contributory earnings purposes, but before the adjustments later required for benefits calculation purposes) applies for each age, sex and calendar year:

$$\text{PENEAR} = \frac{\text{EMPEAR}*(\text{EU} - \text{EL}) + \text{YMPE}*(1 - \text{CU})}{1 - \text{CL}}$$

where:

PENEAR = Average Pensionable Earnings
EMPEAR = Average Employment Earnings
CL = Proportion of earners earning less than the YBE (computed using the distribution of earners)
CU = Proportion of earners earning less than the YMPE (computed using the distribution of earners)
EL = Proportion of employment earnings in the age-sex cell attributable to earners earning less than the YBE (computed using the distribution of earnings)
EU = Proportion of employment earnings in the age-sex cell attributable to earners earning less than the YMPE (computed using the distribution of earnings)

Sample values of unadjusted Average Pensionable Earnings, which are the earnings used for calculating contributory earnings, are shown below. For comparisons purposes, the YMPE is also shown, for the selected years, at the end of the table.

AVERAGE PENSIONABLE EARNINGS
(used for contributory earnings computation purposes)

		Year				
	Age	1990 $	2000 $	2020 $	2050 $	2100 $
Males	18	7126	9942	23920	88241	784988
	20	11479	15826	38236	140920	1254240
	25	19469	26917	64789	238925	2125340
	30	22690	31566	75744	279669	2485797
	35	23860	33363	80081	295861	2631970
	40	24557	34499	82727	306149	2728044
	45	24718	34772	83366	308632	2749963
	50	24498	34441	82508	305316	2716279
	55	23509	33035	79312	292744	2597405
	60	20209	27647	66406	244928	2178099
	65	13514	20003	47874	176121	1569855
Females	18	5864	8356	20632	78471	720827
	20	9934	13912	34475	130720	1199528
	25	16693	23381	58086	221339	2038657
	30	18149	25609	64169	246802	2285677
	35	18717	26531	66640	256515	2377022
	40	19440	27658	69301	266811	2470194
	45	19448	27769	69849	269599	2499361
	50	18887	27082	68494	265544	2466402
	55	17692	25531	65210	253610	2361599
	60	15023	21177	54201	210997	1973948
	65	10896	15236	38963	153208	1457709
	YMPE ==>	28900	41300	99500	372600	3366000

Average pensionable earnings from the above table, used for average contributory earnings computation purposes, were then adjusted, similar to proportions of contributors, for benefit computation purposes, to reflect the effect of:

i) **Retirements occurring below age 65**

Retirement pensions commencing below age 65 have the effect of reducing the amount of contributions that would otherwise have been made to CPP. Such effect is already accounted for in the average pensionable earnings described and shown above. For benefit computation purposes, however, such effect must be removed in respect of contributors having not yet retired at a given age below 65. This was done by dividing the above average pensionable earnings by the difference between unity and 40% (assuming retirements are taking place mid-year, and taking into account the fact that higher paid earners will have made more than 50% of their normal contributions by mid-year) of the appropriate retirement election proportion (see section 2(b)vii) above).

ii) Credit-splitting on marital union breakdown

The equal apportionment, between spouses, of unadjusted pensionable earnings upon marital union breakdown is designed to affect benefits but not contributions. For benefit purposes, the effect of this provision on average pensionable earnings was accordingly accounted for using appropriate mathematical formulae, on the basis of the assumptions described in section 2(b)iv) above.

Sample values of average pensionable earnings, adjusted for benefit computation purposes are shown below. For comparisons purposes, the YMPE is also shown, for the selected years, at the end of the table.

AVERAGE PENSIONABLE EARNINGS
(adjusted for benefit computation purposes)

		Year				
	Age	1990 $	2000 $	2020 $	2050 $	2100 $
Males	18	7099	9912	23849	87981	782672
	20	11106	15407	37295	137617	1226271
	25	18578	25561	61749	228566	2038830
	30	21269	29560	71323	264853	2362663
	35	22506	31422	75970	282406	2521158
	40	23523	32844	79122	294550	2632547
	45	23832	33318	80238	298723	2668187
	50	23643	33161	79706	296192	2640823
	55	22776	32061	77228	285963	2542575
	60	21984	30827	74042	273101	2429316
	65	17142	23368	55928	205749	1833942
Femmes	18	5777	8261	20405	77592	712635
	20	9513	13435	33355	126357	1157701
	25	16322	22551	55895	212510	1948497
	30	17816	24910	62190	238578	2196182
	35	18544	26077	65447	251541	2318471
	40	19433	27335	68281	262817	2422957
	45	19428	27420	68833	265871	2455709
	50	18727	26687	67346	261200	2419427
	55	17432	25175	64323	250312	2328021
	60	15839	22501	57975	226763	2125146
	65	12594	17716	45305	178149	1695010
	MGAP ==>	28900	41300	99500	372600	3366000

(f) Average and Total Contributory Earnings

Average contributory earnings were computed in respect of any given age-sex-year cell of contributors by subtracting the YBE from the average Pensionable Earnings computed for contributory earnings purposes (as opposed to benefits computation purposes).

AVERAGE CONTRIBUTORY EARNINGS

		YEAR				
		1990	2000	2020	2050	2100
	Age	$	$	$	$	$
Males	18	4326	5842	14020	51041	448388
	20	8679	11726	28336	103720	917640
	25	16669	22817	54889	201725	1788740
	30	19890	27466	65844	242469	2149197
	35	21060	29263	70181	258661	2295370
	40	21757	30399	72827	268949	2391444
	45	21918	30672	73466	271432	2413363
	50	21698	30341	72608	268116	2379679
	55	20709	28935	69412	255544	2260805
	60	17409	23547	56506	207728	1841499
	65	10714	15903	37974	138921	1233255
Females	18	3064	4256	10732	41271	384227
	20	7134	9812	24575	93520	862928
	25	13893	19281	48186	184139	1702057
	30	15349	21509	54269	209602	1949077
	35	15917	22431	56740	219315	2040422
	40	16640	23558	59401	229611	2133594
	45	16648	23669	59949	232399	2162761
	50	16087	22982	58594	228344	2129802
	55	14892	21431	55310	216410	2024999
	60	12223	17077	44301	173797	1637348
	65	8096	11136	29063	116008	1121108
	YMPE ==>	28900	41300	99500	372600	3366000
	YBE ==>	2800	4100	9900	37200	336600

In respect of a given age-sex cell, total contributory earnings for a given year were calculated as the product of:

- the proportion of contributors computed for contributory earnings purposes (as opposed to benefits computation purposes),
- the average contributory earnings computed as above, and
- the population number.

Total contributory earnings for the given year were obtained by summing contributory earnings computed for each age-sex cell. Total annual contributions for each past year (1966 to 1990), obtained as the product of the total contributory earnings computed as above and the actual contribution rate, are very close to those taken from earnings statistics, which validates average contributory earnings used for benefit computation purposes. Indeed, the deviation is 0.3% on average for 1983 to 1990, and 1.2% for 1971 to 1990. However, computed contributions are 2.2% (1983-1990) and 3.8% (1971-1990) lower than corresponding actual contributions as taken from monthly information reports. Total future contributory earnings computed as above were accordingly increased by 3.0% which accounts for the un-refundable portion of employers' contributions corresponding to contributions in excess of the maximum contribution (arising generally to employees with multiple employers during a year) or to contributions made in respect of employees earning less than the YBE during a given year.

(g) Benefit Eligibility Rates

i) Introduction

As mentioned in appendix A (plan provisions) of this report, the eligibility for CPP benefits varies according to the type of benefit involved. Although the eligibility rules themselves do not vary as between the flat-rate and the earnings-related portions of a given type of benefit, it will be seen below that each portion requires a distinct eligibility factor for valuation purposes.

ii) Usage

Benefit eligibility rates are used in the valuation process for the computation of historical retirement election proportions (see section 2(b)vii) above) and of benefits of all types except retirement.

iii) General approach

Benefit eligibility rates are computed using mathematical formulae which were developed so as to closely reproduce the outcome of a distinct earnings micro-simulation model. That model takes into account the applicable eligibility rules for each type of benefit, the assumed proportions of contributors and average employment earnings for all existing and future cohorts of earners, and the proportions, determined in accordance with the assumed 50% employment mobility rate (see 2(b)v) above), of persons who never contribute and of persons who contribute randomly.

Observed data on benefit eligibility rates show some unexplained inconsistencies. It was therefore not possible to use them for either computing the eligibility rates required for the valuation, or validating the eligibility rates derived for the valuation process.

iv) Retirement benefits

To be eligible for a retirement pension, a person must have made contributions, i.e., have had employment earnings in excess of the YBE, for at least one calendar year over his/her contributory period. In accordance with the assumed 50% employment mobility rate, the micro-simulation model produces retirement benefit eligibility rates corresponding closely in most cases to the value half way between the highest annual proportion of contributors over the contributory period of a cohort and unity. Therefore,

$$\mathbf{ELIRET = 0.5*(MAXPRC + 1)}$$

where ELIRET = retirement benefit eligibility rate
MAXPRC = highest annual proportion of contributors over the contributory period of a given sex, birth-year cohort.

v) **Flat-rate benefits**

Given the relative complexity of the eligibility rules in respect of other types of benefits (disability and survivor), more complex mathematical formulae had to be developed reflecting the results from the micro-simulation model.

Mathematical formulae, relying exclusively on the relevant proportions of contributors for all age-sex cohorts involved over the years in the valuation process, were therefore developed for the determination of all past and future eligibility rates separately for disability (ELIDFR) and survivor (ELIWFR) flat-rate benefits.

vi) **Earnings-related benefits**

The average earnings-related benefit factors (see section (h) below), to which benefit disability and survivor eligibility rates described above should normally apply, already implicitly incorporate the value of ELIRET, the retirement benefit eligibility rate. Therefore, the disability and survivor benefit eligibility rates ELIDFR and ELIWFR developed for flat-rate benefit purposes must be divided by the retirement benefit eligibility rate ELIRET for purposes of computing the earnings-related portion of these two types of benefit. Such operation converts these eligibility rates into gross proportions of earnings eligible for the earnings-related portion of the disability or survivor benefit:

disability gross eligible earnings proportion = ELIDFR/ELIRET
survivor gross eligible earnings proportion = ELIWFR/ELIRET

Moreover, since the eligibility rules for disability and survivor benefits are more stringent that for retirement pensions, contributors eligible for either a disability or survivor benefit have on average a lesser number of years of nil earnings than contributors solely eligible for a retirement benefit. They consequently have higher aggregate earnings than contributors solely eligible for a retirement pension. In accordance with the outcome of the micro-simulated earnings model, the above ratios were consequently adjusted accordingly as follows:

ELIDER = {ELIDFR/ELIRET}*(2/3) + 1/3
ELIWER = {ELIWFR/ELIRET}*(2/3) + 1/3

where ELIDER and ELIWER are the net proportions of earnings eligible for disability and survivor earnings-related benefits, respectively.

vii) Consistency tests

Extensive testing was made thereafter to ensure that the results from the application of all these formulae are consistent. For example,

- disability and survivor benefit eligibility rates ELIDFR and ELIWFR should, for any age-sex-year cell, be lower than the retirement benefit eligibility rates ELIRET given that eligibility for retirement benefits is in all cases less stringent than for disability or survivor benefits.

- the average retirement pension, converted from a *per population* basis (i.e., averaged over total population at the given age and sex) to a *per beneficiary* (i.e., averaged over the number of retirement pension beneficiaries) by dividing it by the retirement benefit eligibility rate ELIRET, should correspond to statistics on the actual average retirement pension.

Retirement benefit eligibility rates are computed for ages below the minimum retirement age (60) because they are required in the computation of eligibility rates for the earnings-related portion of the disability and the survivor benefits.

The following five tables show samples of these benefit eligibility rates.

PROBABILITY OF BEING ELIGIBLE FOR RETIREMENT BENEFITS (ELIRET)

		Retirement Age							
	Year	20	25	30	40	50	55	60	65
Males	2000	0.867	0.961	0.980	0.976	0.995	0.995	0.995	0.984
	2050	0.865	0.960	0.979	0.979	0.979	0.979	0.979	0.980
	2100	0.863	0.959	0.978	0.978	0.978	0.978	0.978	0.978
Females	2000	0.851	0.900	0.895	0.903	0.920	0.913	0.871	0.842
	2050	0.868	0.910	0.910	0.916	0.914	0.910	0.907	0.904
	2100	0.869	0.910	0.910	0.917	0.917	0.917	0.917	0.917

PROBABILITY OF BEING ELIGIBLE FOR FLAT-RATE DISABILITY BENEFITS (ELIDFR)

		Age at Disablement							
	Year	20	25	30	35	40	50	55	60
Males	2000	0.807	0.954	0.978	0.979	0.975	0.965	0.951	0.924
	2050	0.810	0.953	0.978	0.978	0.976	0.966	0.957	0.921
	2100	0.808	0.952	0.977	0.977	0.975	0.965	0.956	0.920
Females	2000	0.784	0.885	0.881	0.883	0.882	0.896	0.881	0.831
	2050	0.808	0.899	0.898	0.900	0.906	0.900	0.885	0.846
	2100	0.810	0.900	0.899	0.902	0.908	0.904	0.893	0.857

PROPORTION OF EARNINGS ELIGIBLE FOR DISABILITY EARNINGS-RELATED BENEFITS (ELIDER)

		Age at Disablement							
	Year	20	25	30	35	40	50	55	60
Males	2000	0.954	0.996	0.999	0.999	0.999	0.980	0.970	0.952
	2050	0.958	0.995	0.999	0.999	0.998	0.991	0.985	0.960
	2100	0.958	0.995	0.999	0.999	0.998	0.991	0.985	0.960
Females	2000	0.947	0.989	0.989	0.973	0.984	0.982	0.976	0.970
	2050	0.954	0.992	0.992	0.992	0.993	0.990	0.981	0.955
	2100	0.955	0.992	0.992	0.992	0.993	0.990	0.983	0.957

PROBABILITY OF BEING ELIGIBLE FOR FLAT-RATE SURVIVOR BENEFITS (ELIWFR)

		Age at Widow/er/hood							
	Year	20	25	30	40	50	55	60	65
Widows	2000	0.701	0.952	0.975	0.974	0.994	0.994	0.993	0.978
	2050	0.708	0.954	0.974	0.976	0.977	0.977	0.976	0.974
	2100	0.701	0.953	0.973	0.975	0.975	0.975	0.975	0.973
Widowers	2000	0.686	0.890	0.889	0.899	0.915	0.909	0.854	0.807
	2050	0.700	0.903	0.904	0.910	0.908	0.905	0.901	0.891
	2100	0.701	0.904	0.904	0.912	0.912	0.911	0.911	0.904

PROPORTION OF EARNINGS ELIGIBLE FOR SURVIVOR EARNINGS-RELATED BENEFITS (ELIWER)

		Age at Widow/er/hood							
	Year	20	25	30	40	50	55	60	65
Widows	2000	0.873	0.994	0.997	0.999	0.999	1.000	0.999	0.996
	2050	0.879	0.996	0.997	0.998	0.998	0.998	0.998	0.996
	2100	0.874	0.996	0.997	0.998	0.998	0.998	0.998	0.996
Widowers	2000	0.870	0.993	0.995	0.997	0.996	0.997	0.987	0.973
	2050	0.871	0.995	0.996	0.996	0.996	0.996	0.995	0.990
	2100	0.876	0.995	0.996	0.996	0.996	0.996	0.996	0.991

(h) Average Earnings-Related Benefit Factor

The average earnings-related benefit factor is designed to produce, when multiplied by the population and the Pension Index of a given calendar year successively for both sexes and all relevant ages, the total annual earnings-related benefit expenditure for that year.

i) Gross factor

In respect of a given cohort of contributors, the gross (i.e., before accounting for the drop-out provisions and the Earnings Index) average earnings-related benefit factor was determined by sex and calendar year for each (attained) age from 18 to 70, as the product of 0.25 (the retirement pension benefit proportion) and the ratio of:

- the sum, over the elapsed contributory period (i.e., from age 18 to the attained age), of the ratios of:
  - the product of the year's proportion of contributors (adjusted for benefit computation purposes) times the year's average pensionable earnings (adjusted for benefit computation purposes), to
  - the YMPE, to
- the elapsed contributory period at the attained age.

$$BENFAC = 0.25 * \frac{\sum_{I=18}^{attained\ age} \left(\frac{PROCON_I * PENEAR_I}{YMPE_{N+I-18}} \right)}{CONPER_{attained\ age}}$$

where

I = age
N = year during which the contributor attains age 18
BENFAC = gross average earnings-related benefit factor
PROCON = proportion of contributors (adjusted for benefit purposes)
PENEAR = average wage-unescalated pensionable earnings (adjusted for benefit purposes)
CONPER = elapsed contributory period

ii) Accounting for the drop-out provisions

- **Amount of lowest earnings to be dropped-out**
  The earnings/YMPE ratios that have to be dropped out from the numerator of the gross average benefit factor described above, in respect of an individual, are the lowest annual earnings/YMPE ratios for a number of years equal to half (see assumption described in section 2(b)vi) above) of the child-rearing

period plus 15% of the residual contributory period. Since the general valuation approach is based on macro-simulation (aggregate), there is no explicit way of determining the lowest earnings/YMPE ratios of each individual that would have to be dropped out from the denominator above to account for these two drop-out provisions.
Consequently, on the basis of the outcome of the micro-simulation model described in section (g) above, the following formula was developed for determining the multiplying factor DROFAC.

Range of PRCFAC	Multiplying factor DROFAC
0.0 to 0.5	PRCFAC /10.
0.5 to 1.0	PRCFAC - 0.45
1.0 to MAXFAC	$0.55 + 0.45 * \frac{(PRCFAC-1)}{(MAXFAC-1)}$

where:
PRCFAC = Average contributing proportion factor = DROPRO/(1-AVRPRC)
DROPRO = Drop-out proportion (i.e., 15% + child rearing percentage period)
AVRPRC = Average proportion of contributors over the elapsed contributory period
MAXFAC = Maximum average contributing proportion factor = 1/(1-AVRPRC)

It can thus be seen that the multiplying factor DROFAC varies according to the total drop-out percentage (15% plus the child-rearing period as a percentage of the elapsed contributory period) and the average proportion of contributors over the elapsed contributory period.

The multiplying factor DROFAC is designed so that when multiplied by the sum, for a number of years equal to the total drop-out period, of the products of the successive lowest proportions of contributors and the lowest successive average earnings, it gives the amount of earnings deemed to be dropped from the numerator above in connection with the drop-out provisions.

Period to be dropped-out

The average period that has to be dropped from the contributory period (i.e., the denominator of the gross average benefit factor described above), is computed as the sum of the three periods determined as follows in respect of the disability, the child-rearing and the 15% drop-out provisions.

The disability period was determined, by age, sex and calendar year, using the assumed disability incidence and termination rates, the disability benefit eligibility rates and the appropriate actuarial formula (i.e., for a given attained age, the sum of the products, in respect of each age from 18 to the one preceding the attained age, of the disability incidence rate by the elapsed duration of disability, such duration being computed relying on disability termination rates).

In accordance with:
- the prescribed limit of 7 years per child,
- the assumed age difference of 2 between any two consecutive children,
- and the assumed effect of 50% in connection with employment earnings during the child rearing period not all being lowest earnings,

the child-rearing drop-out period was determined, for females, as 50% of:

{7*(NUMCHI)}, if NUMCHI < 1,
and
{7*(1)} + {2*(NUMCHI-1)}, if NUMCHI >or= 1

where NUMCHI, not necessarily an integer, is the average number of children (born so far to a female contributor) computed using the Canada and Quebec fertility rates adjusted, to correspond to Canada less Quebec, by taking as weights the relevant populations. In accordance with the assumption described in section 2(b)vi) above, the child-rearing period was uniformly set equal to zero in respect of male contributors.

The drop-out period in respect of the 15% provision was determined as 15% of the difference between the elapsed contributory period and the disability and child-rearing periods computed as above at the contributor's attained age.

iii) Accounting for the Earnings Index (i.e., the wage escalation provision)
The average earnings-related benefit factor, was finally determined by multiplying the gross factor (see section i) above), adjusted for the drop-out provisions (see section ii) above), by the Earnings Index which accounts for the wage escalation provision underlying the calculation of the initial rate of a benefit when it emerges.

(i) Annual Expenditures

i) Retirement Pensions

In accordance with the eligibility rules, CPP retirement pensions became payable for the first time in 1967.

Hence, for each cohort of contributors reaching a given retirement age from 60 to 70 in each of the calendar years from 1967 to 2100, an average retirement benefit factor was computed, by age, sex and calendar year of emergence of the pension, as the product of:

- the assumed proportion of contributors electing to retire,
- the actuarial adjustment factor in connection with the flexible retirement age provision, and
- the average earnings-related benefit factor (see section (h) above).

These benefit factors correspond to the annualized average rate of retirement pension payable during the year of emergence of the pension.

It was assumed that retirements occur mid-year on average. Therefore, the retirement pension expenditure for the year of emergence was taken as 50% of the annualized rate of pension multiplied by the population for the appropriate age (60 to 70), sex and calendar year.

The retirement pension expenditure for each year following the year of retirement of a given age-sex-year population cohort, until the year during which the cohort attains age 106, was computed as the product of:

- The relevant annualized average rate of retirement pension payable during the year of emergence (described above).
- The population for the appropriate attained age (61 and over), sex and calendar year (which implicitly accounts for the survivorship of the cohort).
- The Pension Index (which accounts for the CPI escalation of a pension each year after its emergence).

The retirement pension expenditure for the beneficiary's year of death is assumed to be 50% of the annualized pension. This is implicitly accounted for in the approach described above, since the population is computed as at mid-year.

The amount of total retirement pensions payable for any given past or future calendar year were obtained by simply summing the annual expenditure, applying for the given calendar year as described above, in respect of all age-sex cohorts having emerged in the given and each of the previous calendar years.

As part of the methodology validation process, the amounts of total annual retirement pensions computed as above were compared to their CPP historical data counterparts for 1966 through 1991. The comparisons revealed that the actual retirement benefits tend to be about 101% of the corresponding projected benefits. Presumably, the 1% deviation arises primarily from differences in mortality rates between the general population and persons receiving a CPP retirement pension. Given the consistency of the 1% deviation over time, and the unavailability at this time of mortality rates specific to the CPP retirement pension beneficiaries, a constant experience adjustment factor of 1.01 was applied to all of the past and future retirement pensions calculated using the methodology described above.

However, in order to account for the exact distribution by age and sex of retirement pensions already in pay at the end of 1991, computed retirement pensions deemed to be payable during 1991 were replaced, by age and sex, by benefits actually paid during that year (see, in section 1(e) above, benefits statistics adjusted to match results shown in monthly information reports) and projected until death of the last survivor using the methodology described above for the survival of the computed emerging retirement pensions.

ii) Disability Pensions

In accordance with the eligibility rules, CPP disability pensions became payable for the first time in 1970. Hence, the general approach used to estimate disability pensions was to:

- Compute the initial value of flat-rate benefits emerging by age and sex each year after 1969 as the product of:
  - the actual or assumed disability incidence rate;
  - the probability (ELIDFR) of being eligible for disability benefits;
  - the annual amount of the disability flat-rate benefit (projected using the PI);
  - the population.

- Compute the initial value of earnings-related benefits emerging by age and sex each year after 1969 as the product of:
  - the actual or assumed disability incidence rates;
  - the proportion (ELIDER) of earnings eligible for disability benefits;
  - 0.1875, corresponding to the applicable earnings-related disability benefit proportion, i.e., 75% of the retirement pension proportion of 25%;
  - the average earnings-related benefit factor (see section (h) above);
  - the population.

- Project by age and sex initial flat-rate and earnings-related benefits to each future year until termination (due to recovery, death, or attaining age 65) using year after year actuarial formulae incorporating the disability termination rates for the appropriate duration and the Pension Index.

Total disability benefits for any particular year are equal to 100% of the sum of the annualized disability pensions projected to that year in respect of all age-sex cohorts having emerged so far. However, assuming that emergences and terminations occur on average at mid-year, 50% was used instead of 100% in respect of cases having either emerged or terminated during the given year.

Through the methodology validation process, emerging disability benefits and disability benefits in pay computed as above by age, sex and type of benefit (flat-rate, earnings-related) for each past applicable year (1970 to 1991) were compared with actual data. The outcome of this process shows actual over expected experience ratios generally very close to 100%. For this reason, no experience adjustment factor was applied in projecting future disability benefits using the above methodology.

However, in order to account for the exact distribution of disability benefits already in pay at the end of 1991 by age, sex and year of emergence, computed disability benefits deemed to be payable during 1991 were replaced, separately by age, sex and year of emergence, by benefits actually paid during that year (see, in section 1(e) above, benefits statistics adjusted to match results shown in monthly information reports) and projected until termination (due to recovery, death, or attaining age 65) using the disability termination rates and the Pension Index.

iii) Survivor Pensions

In accordance with the eligibility rules, CPP survivor pensions became payable for the first time in 1968. Hence, for each year after 1967, the numbers of male and female deaths, taken from demographic projections for each individual age 18 and over, were multiplied by proportions of contributors married at death (see section 2(b)ix) above) to produce all the numbers of deaths of married persons emerging by age, sex and calendar year.

For purposes of the flat-rate portion of survivor pensions, the numbers of married deaths, by sex and by calendar year, were categorized by age of the surviving spouses using the age distributions described in section 2(b)xi) above, and each resulting number was multiplied by:

- The annual flat-rate benefit amount (projected using the PI).
- The probability (ELIWFR), for the deceased spouse, of being eligible for survivor benefit.
- The appropriate factor accounting for the reductions of survivor pensions in respect of survivors emerging under age 45 without dependent children and not disabled (see section 2(b)x) above).
- The appropriate factor accounting for the limit applying to combined survivor-disability pensions. This factor is equal to the difference between unity and the disability prevalence rate described in section 2(b)viii) above.

For purposes of the earnings-related portion of the survivor pensions, the numbers of married deaths, by sex and calendar year, were categorized by age of the surviving spouses using the age distributions described in section 2(b)xi) above, and each resulting number was multiplied by:

- The average earnings-related benefit factor for the deceased spouse (see section (h) above).
- The proportion ELIWER of the deceased spouse's earnings eligible for a survivor benefit.
- The appropriate factor accounting for the reductions of survivor pensions in respect of survivors emerging under age 45 without dependent children and not disabled (see section 2(b)x) above).
- The appropriate factor accounting for the limit applying to combined survivor-retirement and survivor-disability pensions. This factor was computed using the maximum retirement pension, the assumed distribution of average retirement pensions and the retirement and disability prevalence rates described in sections 2(b)vii) and 2(b)viii) above.

The annual initial amount of all survivor pensions emerging by year as well as by age and sex of the surviving spouse, computed as described above, was then projected to each subsequent year:

- Applying actuarial formulae incorporating actual or assumed mortality rates (see section I2(b) above), adjusted to correspond to Canada less Quebec by taking as weights the population for the appropriate age, sex, year and geographic component (i.e., Canada or Quebec).

- Making allowance for the Pension Index (CPI) escalation.
- Multiplying by 0.375 for ages under 65, and by 0.60 for ages 65 and over of the surviving spouse, to account for the applicable survivor earnings-related benefit proportion.

Total survivor benefits for any particular year are equal to 100% of the sum of the annualized survivor pensions projected to that year in respect of all age-sex cohorts of survivors having emerged so far. However, assuming that emergences and terminations occur mid-year on average, 50% is used instead of 100% in respect of cases having either emerged or terminated during the given year.

Through the methodology validation process, emerging survivor benefits and survivor benefits in pay computed as above by age, sex and type of benefit (flat-rate, earnings-related) for each past year (1968 to 1991) were compared with actual data. Irrespective of the various methodology improvements made since the completion of the eleventh report, the outcome of this process still shows significant differences between actual and expected values. The relatively low level of past actual widowers benefits as compared to those computed could be due to a significant proportion of widowers' benefits not being applied for in the case of death of eligible female contributors, or to an overestimate of the proportion ELIWFR of females giving entitlement at death to a widower's benefit, or to a combination of both. The differences between experience ratios for emerging benefits and benefits in pay, especially large for widowers, seem to indicate that mortality rates used to survive these benefits are too low. All of this will be the subject of further research for purposes of the next report. In any event, due to these significant differences, it was decided to adjust estimates of all future survivor benefits, determined using the above methodology, by applying the following experience factors varying by sex and by type of benefit:

EXPERIENCE ADJUSTMENT FACTORS FOR SURVIVOR BENEFITS

Widows		Widowers	
Flat-Rate	Earnings-Related	Flat-Rate	Earnings-Related
0.90	0.94	0.50	0.55

Moreover, in order to account for the exact distribution of survivor benefits already in pay at the end of 1991 by age, sex and year of emergence, computed benefits deemed to be payable during 1991 were replaced by benefits actually paid during that year (re: benefits statistics, section 1(e) above, adjusted to match results shown in monthly information reports, section 1(d) above) and projected until death of the last survivor using the methodology described above for the survival of the computed emerging survivor pensions.

iv) Death Benefits

In accordance with the eligibility rules, CPP death benefits became payable for the first time in 1968. Hence, the amount of lump sum death benefits payable each year after 1967 was determined by age and sex as the product of:

- the number of deaths, derived by sex for each individual age 18 and over consistent with the population data and projections;
- 50% of the average earnings-related benefit factor (the lump sum death benefit is equivalent to six months of a retirement pension) reduced, using the maximum retirement pension and the assumed distribution of average retirement pensions (see section 2(b)xiii) above), to allow for the provision limiting the death benefit to 10% of the YMPE for the year of death.
- the proportion (ELIWER) of the deceased contributor's earnings eligible for survivor benefits (the eligibility for death benefits is the same as for survivor benefits).

Through the methodology validation process, death benefits so computed for males and females were multiplied by experience adjustment factors of 0.90 and 0.70, respectively, to account for the difference between actual results of recent years and those computed as above. The relatively low level of past actual female death benefits as compared to those computed could be due to a significant proportion of CPP death benefits not being applied for in the case of death of eligible female contributors, or to an overestimate of the proportion ELIWFR of females eligible for the death benefit, or to a combination of both. These significant differences will be the subject of further research for purposes of the next report.

v) Children's Benefits

In accordance with the eligibility rules, Disabled Contributor's Child's (DCC) and Orphan benefits became payable for the first time in 1970 and 1968, respectively. Hence, the numbers of DCC and Orphan benefits emerging each year after 1969 and 1967, respectively, were determined, as described below, so as to correspond to the number of children born, up to the date of emergence, to the previously computed number, emerging during the given year, of beneficiaries of disability and/or survivor pensions.

For this purpose, the numbers of emerging disabled contributors and surviving spouses were first split by age, sex and calendar year. Canada fertility rates, adjusted to correspond to Canada less Quebec, by taking as weights the population for the appropriate age, sex, year and geographic component (i.e., Canada or Quebec), were then applied appropriately to these numbers, i.e., to

- the female disabled contributors and the spouses of male disabled contributors, and to
- the widows and the deceased spouses of widowers,

for the appropriate age of the female. For this purpose, the age of spouses of male disabled contributors were distributed in accordance with the assumed

distribution of spouses by age. As for the demographic projections (see section I above), the constant proportion of male births was assumed to be 1.056 of female births.

The resulting emerging numbers of children by age, sex and calendar year were thereafter survived, from one year to the next, incorporating the following reasons for termination of benefits:

- Attainment of age 25 by the child. For this purpose, use was made of mortality rates determined by age as the yearly ratios of the number of deaths to the population, both taken from demographic projections (see section I above).

- Stopping full attendance at school while over age 18. For this purpose, the assumptions described in section 2(b)xii) above were used.

- Regarding DCC benefits only, termination (recovery, death or attainment of age 65) of the parent's disability benefits. For this purpose, the assumed disability termination rates (see section 2(b)viii) above) were used.

Total children's benefits were then obtained for any given calendar year as the product of:

- the sum of all child beneficiaries having emerged so far, and having survived until that date, and.

- the applicable annualized amount of the child flat-rate benefit obtained by adjusting the actual 1992 rate in accordance with the Pension Index. However, assuming that emergences and terminations occur mid-year on average, 50% instead of 100% of the annualized amount was used in respect of cases emerging or terminating during the year.

The actual DCC and Orphan benefits paid each year form 1966 to 1991 were compared by age with the corresponding benefits computed by age for each of these years using the above approach. They correspond very steadily by age, by calendar year and by type of benefit (DCC, orphan) to about 85% of benefits computed as above. Accordingly, DCC and Orphan benefits projected for all years after 1991 were reduced by 15%. The relatively low level of past actual children benefits (DCC and orphan) as compared to those computed could be due to an overestimate of the number of children born to contributors before disability or death. These significant differences will be the subject of further research for purposes of the next report.

vi) Administrative Expenses

On the basis of past average experience, CPP annual administrative expenses were assumed constant at 0.1% of total annual contributory earnings.

-III- PAY-AS-YOU-GO AND CONTRIBUTION RATES, CONTRIBUTIONS, ACCOUNT

1. Data (year-end amounts)

(a) Historical (1966 to 1991)

i) taken from HWC Monthly Information Reports:
- the Account
- the Operating balance
- the amount of investment earnings from the Operating Balance
- total expenditures

ii) taken from CPP Investment Fund Reports prepared by the Department of Finance:
- the Fund (i.e., loans made to provinces each month)
- the average nominal annual interest rate, compounded semi-annually, applying to loans made during the year

iii) taken from the CPP Act
- the annual contribution rates

iv) taken from section II3(f) above
- contributory earnings

(b) Projection period (1992 to 2100)

- the annual contribution rates for the remainder of the 25-year period of the Schedule to the Act
- the projected contributory earnings (from section II3(f) above)
- the projected total expenditures (from section II3(i) above)

2. Assumptions (including interest)

(a) Interest rate applying to the CPP Fund (loans to provinces)

On the basis of
- the average long-term, medium-term and short-term past experiences of the annual yield on long-term investments, and
- the current outlook of the economy,

it was decided to maintain at 6%, as in the most recent four CPP actuarial reports, the assumed ultimate (i.e., for 1998 and later years) annual nominal rate of interest applying to new loans made to provinces during the year. For the period 1993 to 1997, the assumed rates are taken from the 25 February 1992 federal budget assumptions. The following table shows the actual interest rate on 1992 loans and the rates assumed for subsequent years.

ANNUAL NOMINAL RATES OF INTEREST APPLYING TO NEW LOANS

year						
1992	1993	1994	1995	1996	1997	1998+
9.4%	8.3%	7.9%	7.6%	7.3%	6.9%	6.0%

This ultimate assumption of 6%, coupled with the ultimate assumption of 3.5% for increases in the CPI, implies an assumed real rate of investment earnings of 2.415% (i.e., 1.06/1.035 - 1). For a fund invested entirely at rates reflecting long-term Government of Canada bond rates, this real rate is deemed to be close to the rate that might be expected to be earned over long periods on the basis of past experience. In any event, it must be recognized that although rates of interest may have a significant effect on the ratio of the Account to expenditures, they do not have a significant effect on contribution rates, unless a relatively high degree of funding is contemplated. In this latter context, the assumed rate of interest is highly significant in calculating both the contribution rate on an actuarially funded basis and the related unfunded actuarial liability (see Appendix C to this report).

(b) Interest rate applying to the CPP Operating Balance

Since the Operating Balance is generally invested in very short term securities, it is assumed to be totally reinvested yearly and to earn the assumed rate of interest on new loans (i.e., on 20-year securities) less 1%. This assumed difference of 1% very closely corresponds to the actual average interest rate differential experienced from 1966 to 1991. By using a lower assumed interest rate for the Operating Balance, the assumed ultimate combined (i.e., Fund and Operating Balance) yield on the Account is accordingly less than 6%. For example, this combined ultimate yield would be 5.875% if one assumed that the year-end Account is exactly equal to twice the expenditure of the ensuing year and the year-end Operating Balance is exactly equal to 1/4 of this expenditure.

(c) Timing of new loans made during the calendar year

Of all new loans to provinces during any calendar year, 60% are assumed to be made during the first half of the year. This percentage reflects the timing of contributions received during the year; indeed, earners with earnings above the YMPE would normally complete the full payment of their contributions once they have earned the YMPE during the year. This 60% assumption corresponds to the underlying actual average experience for 1966 to 1991. It is used, for a given calendar year, in connection with the new loans arising out of the first semi-annual coupon payable from the new loans made in the first six months of that calendar year.

3. Methodology

(a) Pay-as-you-go Rates

The pay-as-you go rate for a given year corresponds to the ratio of the year's total expenditures to the year's total contributory earnings.

(b) Contribution Rates

Annual Contribution rates for the 25-year period (1992-2016) of the schedule in force as at the valuation date are stipulated in the Act. Rates projected for 2017 to 2021 are computed in accordance with the prescribed *15-year formula*. This is done through an iteration process whereby the Account is projected, as described in section (d) below, using successive multiples of 0.01% of constant annual change (positive or negative) from the contribution rate for 2016, and retaining the lowest multiple which produces an Account/Expenditure ratio of at least 2 at the end of 2031. This iteration process is then similarly repeated, in accordance with the prescribed timing for quinquennial reviews of the schedule of contribution rates, for each subsequent 5-year period, i.e., 2022 to 2026, 2027 to 2031, and so on until the 2087-2091 period.

(c) Contributions

The amount of total annual contributions corresponds, for a given year, to the product of the year's contribution rate and the year's total contributory earnings.

(d) Account

As for the projection of contributory earnings and expenditures, Account calculations are made using 1966 as the starting point of the projections, rather than the beginning (1992) of the valuation period. This is done for the following three objectives:

- The reproduction, for methodology validation purposes, of the past values of the Account, the Fund and the Operating Balance.

- The availability of a reliable set of 1991 values for the proper projection of the Account to 1992 and later years. The projection of the Account is accordingly started accurately by using the actual important components of the Account, e.g., the amount, the yield and the 20-year renewal date of each loan made each year from 1966 to 1991.

- This approach facilitates the integration of the existing components of the Account with those emerging after the valuation date, thus ensuring full consistency of the valuation process as it applies to past and future values.

i) Annual increase in the Account

The Account at the end of a given year is obtained by adding to the previous year-end Account the year's increase in the Account. This increase corresponds to the sum of the cash flow (year's excess of contributions over expenditures) and the investment earnings. Due to the distinctive investment peculiarities of the two main components of the Account (the Operating Balance and the Fund), the annual increase in the Account is computed as the sum of the respective annual increases in the Operating Balance and the Fund.

Account INCREASE = OPERATING BALANCE INCREASE + FUND INCREASE

These two main components of the annual increase in the Account were computed as follows:

ii) Annual increase in the Operating Balance

The Operating Balance at the end of a given year, deemed to correspond to the expenditures of the first three months of the ensuing year, is first computed as follows:

YEAR-END OPERATING BALANCE =
3/32 of year's expenditure + 5/32 of ensuing year's expenditure

The annual increase in the Operating Balance (DELOPE) for a given year is then easily obtained by taking the difference between the year-end Operating Balance and the corresponding amount for the previous year.

It is important to note at this point that the increase in the Operating Balance (DELOPE) originates from the investment earnings from the Operating Balance (INVOPE) and the residual amount (DELOPE-INVOPE), positive or negative, corresponding to an amount otherwise available for loans to provinces (i.e., an increase in the Fund). To compute this residual amount, required for the computation of the yearly fund increase described below, DELOPE is obtained as described above and INVOPE is obtained using the following approximation formula for the internal rate of return on the Operating Balance:

$$INTOPE_N = 2*INVOPE_N / \{OPEBAL_{N-1} + OPEBAL_N - INVOPE_N\}$$

where INTOPE corresponds to the actual or assumed annual rate of return on the Operating Balance as described in section 2(b) above, and $OPEBAL_{N-1}$ and $OPEBAL_N$ corresponds the Operating Balance at the end of years N-1 and N, respectively.

iii) Annual increase in the Fund

The annual increase in the Fund (DELFUN) is computed by relying on the following relationship:

DELFUN = {CASHF - (DELOPE-INVOPE) + CUMINVDELFUN}*{1+0.5*0.6*INTFUN}

where **CASHF** = the year's cash flow (i.e., contributions minus expenditures)

DELOPE-INVOPE = the year's residual amount described above

CUMINVDELFUN = the year's investment earnings from all loans made in previous years (in other words from all previous annual Fund increases). In respect of each such previous year, the component of CUMINVDELFUN is equal to that year's Fund increase (DELFUN) times that year's actual or assumed interest rate (INTFUN) on new loans made during the year. These calculations were made taking into account the renewal new money interest rate applying (actual or assumed) every 20 years after a loan is originally made. If the amount to be invested in any year (DELFUN) should turn out to be negative, investment maturities (additional to normal 20-year renewals) are assumed for that year, sufficient to provide a positive investment, and to release sufficient cash in that year to meet all expected expenditures. These additional maturities are assumed to be implemented on the first-in, first-out basis as stated in the Act.

1 + 0.5*0.6*INTFUN = the factor, which increases the yearly gross amounts available for loans, i.e.,
CASHF - DELOPE + INVOPE + CUMINVDELFUN,
in accordance with the additional availabilities arising out of the first semi-annual interest coupon earned on loans made during the first six months of the given year (INTFUN and 0.6 are assumptions described in sections 2(a) and 2(c) above).

Once the Account has been so computed in respect of any year prior to the projection period (1966 to 1991), it is re-computed by adjusting the 0.6 factor (in connection with the timing of investments) so that the computed Account is equal to its actual known value. Each of the annual adjusted timing of investment factors is very close to the actual ones for 1966 to 1991, indicating that the methodology used for account projections is acceptable. For methodology validation purposes, the annual increase in the Fund (loans to provinces), computed as described above, was compared with actual data; *actual over expected* ratios obtained in this manner are equal to 1 (to three decimal points) for most years. The greatest deviation is +.025 for 1988 followed by a deviation of -.015 for 1989; these largely counterbalancing deviations are due to the fact that the amounts made available loaned to provinces in a given year are determined on the basis of short term forecasts of expected cash flows.

APPENDIX C

ACTUARIAL FUNDING AND UNFUNDED ACTUARIAL LIABILITY

1. Discussion on actuarial funding

The CPP is funded on a pay-as-you-go basis slightly modified for the provision of a relatively small fund (i.e., the Account) targeted to correspond, at the end of any year, to twice the total expenditure of the ensuing year. Thus, like comparable social insurance programs of other countries, the CPP is not actuarially funded. On the other hand, in the field of private pensions, normal actuarial funding is the standard practice and serves three main purposes:

(a) It recognizes and aims to meet the estimated real cost of pension obligations at the time the benefits are deemed to be earned. Thus it prevents inappropriate deferment of costs.

(b) The plan sponsor transfers the accrued pension obligations to trustees or an insurance company. Thus the security of the pensions is not tied to the fortunes of the sponsor (normally the employer).

(c) Costs tend to be stable and are conducive to the orderly conduct of the sponsor's business.

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.

Nevertheless, it is interesting and informative to calculate the level of the contribution rate that might be considered appropriate, if the benefits provided by the Canada Pension Plan were to be funded by means of a normal pension trust. Moreover, the Auditor General of Canada suggested in 1977 that information based on principles of actuarial funding be made public. Accordingly, this information was included for the first time with the Sixth Statutory Actuarial Report.

2. Key Assumptions

The unfunded actuarial liability is calculated as the amount that theoretically would be required to be invested on the valuation date. It is therefore extremely sensitive to the rate of interest assumed applicable at that date. For example, if there is a drop in interest rates, all other things being equal, the unfunded liability would appear to have increased very substantially in the following year, merely because the amount of the unfunded liability was not invested during a year of high interest rates. To avoid these somewhat artificial fluctuations, the calculations of the entry age normal cost and the unfunded liability were based only on the ultimate economic assumptions described in Appendix B of this report. Two sets of ultimate key assumptions were used: the one underlying this report and the one underlying the previous report.

3. Variations in assumptions

Each of the key assumptions has, on the pay-as-you-go rate, an effect possibly different from that on the entry-age normal contribution rate. The table below summarizes these differences.

Assumption changed	Effect on CPP contribution rate	
	Pay-as-you-go	Entry-age normal
(a) Interest rate	independent	varies inversely, other things being equal.
(b) Rate of increase in earnings	varies inversely	varies directly.
(c) Rate of increase in prices	varies directly	varies directly.
(d) Real rate of increase in earnings (i.e., differential between earnings and prices increases)	varies inversely	may vary directly or inversely depending on the net effect of change in both: . the real interest rate (interest rate less rate of price increases), . the difference between the rate of interest and the rate of increase in earnings.
(e) Fertility	varies inversely	negligible (affects only volume of children's benefits).
(f) Immigration	varies inversely	varies directly.

4. Methodology

The concept of actuarial funding carries with it the concept of an unfunded actuarial liability arising from the lack of contributions prior to the inception of the Plan and the collection of contributions since the inception of the Plan at a rate below the entry-age normal rate. The contribution rates quoted in this appendix, as well as the related unfunded liability, were developed by the entry-age normal actuarial cost method. This method aims at a level percentage of contributory earnings to be contributed during the active lifetime of a normal cohort of entrants sufficient to support all benefits payable to them and their beneficiaries.

(a) Entry-age normal actuarial cost

The entry-age normal cost was determined, using the methodology described in section II of Appendix B (projection of contributory earnings and expenditures), as the ratio, in respect of the cohort of people aged 18 on average on their nearest birthday on 31 December 1991, of:

- the present value of all future annual expenditures, to
- the present value of all future annual contributory earnings.

These present values were determined using the assumed ultimate rate of interest but not the rates of increase in average earnings and prices which are already accounted for in the calculation of expenditures and contributory earnings.

(b) Unfunded actuarial liability

An amount, hypothetically invested in mid-1992, was determined, using the methodology described in section III of Appendix B (Account projection), by an iteration process such that together with:

- the Account as at 31 December 1991,
- future (post-1991) contributions at the entry-age (18) normal actuarial cost rate collected in respect of the cohort of eligible (earnings higher than the Year's Basic Exemption) people aged 18 and over on 31 December 1991, and
- total investment earnings from the Fund and the Operating Balance,

it would be just sufficient to pay all future benefits and administrative expenses in respect of those eligible persons aged 18 and over on 31 December 1991. The unfunded actuarial liability as at 31 December 1991 was taken as the amount so obtained but further discounted for one-half year's interest.

5. Results

If the CPP were actuarially funded, the Account at the end of 1991 would be equal, on the basis of the ultimate main assumptions of this report, to $462.4 billion, i.e., is the sum of the actual value of the CPP Account at the end of 1991 ($42.0 billion) and the unfunded liability shown above ($420.4 billion).

Economic Assumptions			Entry Age Normal Actuarial Cost	1991 Year-End Unfunded Actuarial Liability
Increase in CPI (%)	Increase in Earnings (%)	Interest on New Loans (%)	(%)	($ billions)
3.5	4.5	6.0	9.62	420.4
3.5	4.8	6.0	10.16	427.4

The unfunded actuarial liability may be expected to grow each year in the future by:

- the amount of interest accruing thereon at the assumed rate; and by
- the difference between contributions at the hypothetical entry-age normal actuarial cost rate and contributions actually collected, plus the interest accruing on this difference. These increases in the unfunded actuarial liability are offset to some extent by the difference between interest at the actual and assumed rates (and there may be other sources of gains and losses).

APPENDIX D

INDEX OF KEYWORDS AND ACRONYMS