CHANGES IN THE CANADIAN POPULATION AND LABOUR FORCE: PROSPECTS AND IMPLICATIONS

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Résumé — Cette étude fournit des projections de la population et de la main-d'oeuvre canadiennes, et place ces projections dans un contexte historique. Les conséquences des changements démographiques futurs sur la main-d'oeuvre, la macroéconomie, des industries et professions particulières font l'objet d'une attention spéiale.

Abstract — This paper provides projections of the Canadian population and labour force, and places the projections in historical context. The implications of future demographic changes for the labour force, the macro-economy, and particular industries and occupations are given special attention.

Key Words — **population, labour force, projections, macroeconomic effects, occupations and industries**

Introduction

The population of Canada has been growing for as long as records have been kept, as has the labour force. However, the pace of growth has been very uneven, ranging from rapid in some decades to much slower in others. As is well known, the rate of population growth has slowed considerably in recent years, largely because of the dramatic decline in the birth rate, and the rate of labour force growth is now slowing also. Most observers expect birth

rates to remain low, in which case low rates of population and labour force growth will persist. If so, the demographic future will be unlike the past. This paper provides some projections, places them in historical context, and discusses implications of the changes that are in prospect.

Historical Aspects

The top panel of Table 1 provides summary information relating to the size and age distribution of the population of Canada for each census year from 1951 to 1981. (This section and the following one draw, in part, on Denton *et al*, 1986.) Among the main features, we note the following: *(a)* the population grew from 14 million in 1951 to 24.3 million in 1981; *(b)* the growth during the 1950s was especially rapid, these being the peak years of the "baby-boom"; *(c)* the growth rate has declined subsequently; and *(d)* the age distribution of the population has changed markedly: the proportion under 20 had declined to 32 per cent by 1981, from a peak of more than 42 per cent in 1966; most of the corresponding gain occurred in the age group 20-64, but the proportion over 65 also increased by two percentage points.

Three ratios based on various population measures are displayed in the second panel. The first, a "young dependency ratio," is the ratio of those under 20 to those in the main "providing" years, 20-64. The second, an "old dependency ratio," is the ratio of the population 65 and over to the population aged 20-64. The third is the ratio of females to males in the 65-and-over age group. We note that *(a)* the young dependency ratio fell sharply with the "baby bust," from 0.84 in 1966 to 0.55 in 1981 — the lowest level by far in the 30-year period for which figures are shown; *(b)* the old dependency ratio increased somewhat over the 30-year period, reaching 0.17 by 1981; *(c)* the overall dependency ratio (the sum of the young and old ratios) was only 0.72 in 1981, its lowest level in the entire period, and down sharply from 0.99 only 15 years earlier; and *(d)* the ratio of older women to older men, which had been below 1.0 until 1956, has increased remarkably since that time, such that by 1981 there were 134 older women for every 100 older men. This latter change is the direct consequence of reduction in the numbers of deaths in childbirth and the largely unexplained reduction in female mortality at older ages, relative to the corresponding male rates.

Labour force information is contained in the third panel. Since the measured labour force is drawn from the population 15 and over, its growth reflects population growth, but with a lag of 15 to 20 years. Of course, labour force growth also reflects changes in participation rates. Since female rates, in par-

TABLE 1. THE POPULATION AND LABOUR FORCE OF CANADA, CENSUS YEARS, 1951-1981

	1951	1956	1961	1966	1971	1976	1981
Population							
Total ('000)	14,009	16,081	18,238	20,015	21,568	22,993	24,342
0 - 19 (%)	37.9	39.7	41.8	42.1	39.4	35.8	32.0
20 - 64 (%)	54.4	52.5	50.6	50.2	52.5	55.5	58.3
65+ (%)	7.8	7.7	7.6	7.7	8.1	8.7	9.7
Population Ratios							
0-19 / 20-64	0.70	0.76	0.83	0.84	0.75	0.65	0.55
65+ / 20-64-	0.14	0.15	0.15	0.15	0.15	0.16	0.17
Females/Males, 65+	0.97	1.00	1.06	1.15	1.23	1.29	1.34
Labour Force ('000)	5,274	5,826	6,556	7,503	8,649	10,203	11,904
15 - 24 (%)	24.6	22.7	21.9	24.1	25.8	26.9	25.8
25 - 44 (%)	44.9	46.2	45.4	43.0	42.6	44.7	47.6
45 - 64 (%)	25.9	26.9	28.9	29.5	29.2	26.7	24.9
65+ (%)	4.6	4.3	3.8	3.3	2.5	1.7	1.6
Labour Force Ratios							
Pop. 0-19 / LF	1.01	1.10	1.16	1.12	0.98	0.81	0.66
Pop. 65+ / LF	0.21	0.21	0.21	0.21	0.20	0.20	0.20
Total Pop./ LF	2.68	2.78	2.80	2.69	2.49	2.23	2.03
Females/Males	0.30	0.32	0.39	0.45	0.52	0.60	0.69
		-- Regions, as Percent of Canada Total --					
Population							
Atlantic	11.5	11.0	10.4	9.9	9.5	9.5	9.2
Quebec	29.0	28.8	28.8	28.9	27.9	27.1	26.4
Ontario	32.8	33.6	34.2	34.8	35.7	35.9	35.4
Prairies	18.2	17.7	17.4	16.9	16.4	16.4	17.4
B.C.	8.3	8.7	8.9	9.4	10.1	10.7	11.3
Labour Force							
Atlantic	9.6	8.7	8.5	8.2	7.8	7.9	7.6
Quebec	27.7	27.6	27.6	28.2	27.2	26.4	25.5
Ontario	36.3	37.7	37.4	37.2	38.1	38.0	37.5
Prairies	18.2	17.3	17.7	16.8	16.6	16.8	17.9
B.C.	8.2	8.7	8.8	9.6	10.4	10.9	11.4

NOTE: The population figures relate to June 1 of each census year, while the labour force figures are annual averages. The labour force figures from 1951 to 1981 are based on estimates from the Statistics Canada Labour Force Survey. All labour force estimates prior to 1976 have been adjusted by the authors to make them consistent with new definitions introduced into the Labour Force Survey in the latter year. Components may not add precisely to totals because of rounding.

ticular, have increased greatly, the rates of labour force growth have exceeded by a considerable margin the corresponding rates of population growth two decades earlier. In fact, the labour force grew by almost one-quarter during the 1950s, by more than 30 per cent during the 1960s, and by almost 38 per cent during the 1970s. This growth is reflected in changes in the age distribu-

tion of the working population — the relative increase in the youngest group between 1961 and 1976 being especially noteworthy.

Dependency measures based on ratios of population to labour force, have the advantage of identifying as the "providers" only those in the labour force. Whichever measure is used, however, the message is similar: the young dependency ratio has decreased sharply since 1961, while the old dependency ratio has not. By 1981 their sum was at its lowest level in the entire 30-year period — 0.86 — as compared to a peak of 1.37 only 20 years earlier. An alternative dependency measure is based on the ratio of the overall population to the labour force. In 1981 this ratio was 2.03, by far the lowest level recorded over the entire period.

We note also the substantial increase in the ratio of women to men in the labour force — from 30 women per 100 men in 1951, to 39 by 1961, and to 69 by 1981.

Finally, we note the regional distribution of the population and labour force. Since 1951 both the population and the labour force of the Atlantic region have declined more or less steadily as a proportion of the Canada total, while the shares of British Columbia have increased. Quebec, which held roughly constant in relative terms until the latter part of the 1960s, has seen both its population and its labour force grow more slowly than the Canadian average since that time. In the case of the Prairies, the long-term reduction in both population and labour force (in relative terms) was reversed, at least temporarily, starting in the 1970s. Ontario's share of both population and labour force increased generally over the 30-year period, although there were some reductions at the very end.

Projections of the Future Population and Labour Force

The course of population change in Canada has not been smooth, as is clear from the preceding comments. It has been the result of largely unanticipated fluctuations in rates of fertility and immigration, combined with generally downward movements in mortality rates. The future course of the population will no doubt also be subject to shocks, and therefore forecasts cannot be made with great confidence. Nonetheless, we can explore the implications of alternative plausible assumptions about the future time paths of key demographic rates.

Standard Assumptions for Population Projection

A population projection for Canada for the period from 1986 to 2036 under what we term "standard" assumptions is provided in Table 2. These assumptions are as follows: the total fertility rate remains at its recent level of 1.7 births per woman; age-sex specific mortality rates continue to fall for a further 50 years after 1981 in accordance with recent trends, but the pace of decline gradually slows; and net immigration into Canada is 50,000 per year, consisting of 100,000 immigrants and 50,000 emigrants — levels roughly consistent with the experience of the last few years. A full statement of assumptions underlying the projections is provided in Denton and Spencer (1987b).

The main implications of these assumptions may be summarized as follows:

— the overall size of the population increases until 2026, at which time it is 19 per cent larger than in 1986;

— the pace of growth is very much slower than in recent decades, and growth turns to decline by the end of the projection period;

— with the fall in the rate of growth there is a sharp increase in the median age of the population, from 31.5 in 1986 to 37.7 by the year 2001, and then to 45.2 by 2036;

— largely in consequence of the assumed total fertility rate of 1.7 (well below the long-run natural replacement rate of 2.1), the proportion of young people falls steadily; those 19 and under account for only 20 per cent of the population in 2036, compared to 29 per cent in 1986;

— the population 20-64 years of age accounts for 60.5 per cent of the total in 1986, a record high proportion historically, but this proportion increases further, until 2011, before falling back to levels similar to those of the 1970s;

— the elderly population increases very rapidly: by the year 2001, there are 43 per cent more people 65 and over than there are today, and by 2036 there is a further increase of 96 per cent;

— those 65 and over account for more than 13 per cent of the population by the year 2001 and some 25 per cent by 2036, compared to less than 11 per cent in 1986;

— persons 65 and over constitute the most rapidly growing segment of the population and, within this group, the numbers over the age of 75 increase especially rapidly;

— among the elderly the ratio of women to men continues to increase, the increases being greater the older the age; this suggests large future increases in the number of elderly widows.

TABLE 2. PROJECTED POPULATION AND LABOUR FORCE OF CANADA
UNDER STANDARD ASSUMPTIONS, 1986 TO 2036

Age Groups	1986	1991	1996	2001	2006	2011	2016	2021	2026	2031	2036
Population											
Total('000)	25,591	26,783	27,766	28,524	29,131	29,648	30,063	30,318	30,367	30,219	29,909
Median Age	31.5	33.4	35.5	37.7	39.6	40.9	41.9	42.7	43.5	44.4	45.2
Percent of Total											
0–19	28.9	27.6	26.6	25.5	24.0	22.7	21.8	21.4	21.1	20.7	20.3
20–64	60.5	60.6	60.6	61.1	61.8	61.9	60.6	58.7	56.5	54.8	54.6
65–74	6.4	6.9	7.3	7.2	7.3	8.2	10.0	11.4	12.3	12.9	12.0
75+	4.1	4.8	5.4	6.3	6.8	7.2	7.6	8.4	10.0	11.6	13.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Female/Male Ratio											
0–19	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
20–64	1.01	1.00	1.00	1.01	1.01	1.01	1.01	1.00	1.00	1.00	1.00
65–74	2.47	2.51	2.47	2.41	2.42	2.44	2.44	2.48	2.49	2.44	2.40
75+	3.36	3.48	3.61	3.73	3.74	3.75	3.79	3.81	3.80	3.81	3.84
Total	1.02	1.03	1.04	1.04	1.05	1.06	1.06	1.07	1.08	1.09	1.10
Labour Force											
Total('000)	12,898	13,767	14,494	15,090	15,364	15,418	15,163	14,770	14,408	14,083	13,862
Median Age	34.7	35.9	37.4	38.8	39.9	40.1	39.9	39.7	39.8	40.0	40.2
Percent of Total											
15–24	21.9	18.1	16.7	16.6	16.9	16.6	15.8	15.3	15.5	16.0	16.2
25–44	52.3	55.2	53.6	50.5	47.0	44.5	45.3	46.5	47.0	46.3	45.4
45–64	24.3	25.2	28.4	31.6	34.8	37.4	37.1	36.0	35.2	35.0	36.0
65+	1.4	1.4	1.4	1.3	1.3	1.5	1.8	2.1	2.4	2.6	2.5
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Female/Male Ratio											
15–24	0.89	0.90	0.91	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
25–44	0.76	0.81	0.84	0.87	0.86	0.86	0.86	0.86	0.86	0.86	0.86
45–64	0.62	0.66	0.71	0.75	0.75	0.73	0.72	0.70	0.70	0.71	0.71
65+	0.42	0.42	0.41	0.40	0.41	0.40	0.41	0.41	0.41	0.41	0.42
Total	0.74	0.78	0.81	0.83	0.82	0.81	0.80	0.80	0.80	0.80	0.80
Population/LF	1.98	1.95	1.92	1.89	1.90	1.92	1.98	2.05	2.11	2.15	2.16

NOTE: Components may not add precisely to totals because of rounding.

The labour force can be projected by combining assumptions about future labour force participation rates with the population projection. The assumptions regarding participation rates are, roughly speaking, that the recent trends observed for particular age-sex groups will continue for some years into the future. More specifically, we assume further declines in the participation rates for men 55 and over, and especially 65 and over, and continued increases for women at most ages. (The labour force projections incorporate Statistics Canada estimates of 1985 participation rates for each age-sex group; the 1986 rates are preliminary estimates by the authors.)

The labour force projections are also provided in Table 2. The total labour force continues to grow until 2011, but the rate of growth is cut by approximately half in each successive decade after the 1970s, and eventually slow growth turns to decline.

The baby-boom generation reached working age between the late 1960s and the early 1980s. During this period, the labour force grew rapidly and its average age decreased. As the baby-boom generation moves along the age path, it will be followed by cohorts of considerably smaller size. For the next decade we can expect a continuing decrease in the age group 15-24, but an increase in the group 25-44; thereafter, we can anticipate a substantial increase in the group 45-64.

These changes are reflected in the median age of the labour force. At 34.7 in 1986, the median age was already up from recent years. By the year 2001 it will be 38.8 and still rising, according to the projection.

Alternative Assumptions for Population Projections

The population projection that we have called "standard" is, of course, just one possible statement of the demographic future. The assumptions that underlie it could be quite wrong. To gain some idea of how much difference alternative assumptions would make we report, in Table 3, projections under alternative assumptions about fertility, mortality, and immigration rates. We also repeat the standard projection and the 1986 population, for ease of reference.

The assumptions underlying the alternative projections, insofar as they differ from the standard one, can be summarized as follows:

High Fertility: The total fertility rate rises in equal annual increments from 1.7 to 3.0 by 1996, and remains at that level thereafter.

Low Fertility: The total fertility rate falls in equal decrements from 1.7 to 1.4 by 1996, and remains at that level thereafter.

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TABLE 3. PROJECTED POPULATION OF CANADA UNDER ALTERNATIVE ASSUMPTIONS, 1986 TO 2036

Year	Total Population thousands	index	Percentage Distribution by Age 0-19	20-64	65-74	75+
1986	25,591	100.0	28.9	60.5	6.5	4.2
- Standard Assumptions -						
1996	27,765	108.5	26.6	60.6	7.3	5.5
2006	29,131	113.8	24.0	61.8	7.3	6.8
2016	30,063	117.5	21.8	60.6	10.0	7.6
2026	30,367	118.7	21.1	56.5	12.3	10.0
2036	29,909	116.9	20.3	54.6	12.0	13.1
- High Fertility -						
1996	29,136	113.9	30.1	57.8	6.9	5.2
2006	32,980	128.9	32.9	54.6	6.5	6.0
2016	36,939	144.3	32.7	53.0	8.1	6.2
2026	42,131	164.6	34.2	49.8	8.9	7.2
2036	47,533	185.7	35.6	48.6	7.6	8.3
- Low Fertility -						
1996	27,449	107.3	25.8	61.3	7.4	5.5
2006	28,244	110.4	21.6	63.8	7.5	7.1
2016	28,548	111.6	18.8	62.7	10.5	8.0
2026	28,039	109.6	17.7	58.1	13.3	10.8
2036	26,700	104.3	16.3	55.5	13.4	14.7
- High Mortality -						
1996	27,750	108.4	26.6	60.6	7.3	5.4
2006	29,058	113.5	24.0	61.9	7.3	6.7
2016	29,869	116.7	22.0	60.8	9.9	7.3
2026	30,007	117.3	21.3	57.0	12.2	9.4
2036	29,394	114.9	20.6	55.3	11.9	12.2
- Low Mortality -						
1996	27,778	108.5	26.6	60.6	7.3	5.5
2006	29,186	114.0	24.0	61.7	7.3	6.9
2016	30,208	118.0	21.8	60.4	10.0	7.9
2026	30,668	119.8	21.0	56.1	12.4	10.5
2036	30,462	119.0	20.0	53.8	12.1	14.1
- High Immigration -						
1996	28,312	110.6	26.7	60.6	7.2	5.4
2006	30,287	118.4	24.2	61.8	7.2	6.7
2016	31,859	124.5	22.2	60.7	9.7	7.4
2026	32,830	128.3	21.5	57.0	11.9	9.6
2036	33,042	129.1	20.8	55.2	11.7	12.4
- Low Immigration -						
1996	27,219	106.4	26.6	60.6	7.3	5.5
2006	27,975	109.3	23.8	61.8	7.4	7.0
2016	28,268	110.5	21.4	60.4	10.3	7.8
2036	27,903	109.0	20.7	56.0	12.8	10.5
2036	26,777	104.6	19.8	53.8	12.4	14.0

Note: Components may not add precisely to 100.0 because of rounding.

High Mortality: Age-sex-specific mortality rates continue to decline until 2011 instead of 2031.

Low Mortality: Age-sex-specific mortality rates continue to decline until 2081 instead of 2031.

High Immigration: Annual gross immigration is 150,000 instead of 100,000.

Low Immigration: Annual gross immigration is 50,000 instead of 100,000.

For each projection, the overall population size is recorded in Table 3, along with an index of size relative to 1986 and some measures of the age distribution.

It is clear that both population size and age distribution depend very much on the underlying assumptions, and that the differences are greater the further into the future one looks. With high fertility, for example, there is a return to rapid growth, and by the year 2006 the population exceeds that projected under the standard assumptions for the year 2036. The growth between 1986 and 2036 is more than five times as much with "high" than with "standard" fertility. The impact of the age distribution is also pronounced: with high fertility there is an early reversal of the decline and then a sharp increase in the proportion under 20, instead of a continued reduction. There is also slower growth in the proportions 65-74 and 75 and over, although generally these proportions still continue to rise.

The differences from the standard projection are less marked under the other assumptions, but nevertheless substantial. With low fertility, for example, population growth ceases a decade earlier than under the standard assumptions, and the proportions in the older years increase somewhat more sharply. With higher mortality rates the population and its proportion in old age grow somewhat less, while with lower rates both the overall size and the proportion in old age are somewhat greater; however, the differences are not large, compared to the standard projection. Finally, the level of immigration also matters, but the differences from the standard projection in terms of the population age distribution are relatively slight.

In summary, aside from a possible (but one would think unlikely) return to high fertility levels, we can see that under a rather wide range of assumptions the population over the next several decades will have a considerably larger proportion of older people. Under the standard assumptions, more than one person in eight will be 65 and over within 20 years, and by the year 2036 the ratio will be close to one in four. These ratios differ somewhat, but not markedly, depending on the particular projection (again, aside from a possible return to high fertility rates). The increases in the elderly proportion are offset in part by decreases in the proportion of young people. The net result

of these offsetting changes at the two ends of the age distribution is that the proportion in the ages 20 to 64 falls somewhat, but not drastically. In fact, we can see that only with the assumption of an early return to high fertility rates does the proportion in the 20-64 group fall as low as it was in the 1960s, and even in that case the low levels of the 1960s do not recur until after the year 2021. This observation alone should be reassuring for those who are concerned about the possible inability of the economy to support its dependent population — young and old — in the decades ahead.

Summary information relating to the labour force associated with each of the above population projections is provided in Table 4, in each case based on the set of participation assumptions described earlier. Aside from the case of an assumed return to high fertility levels, the aggregate labour force continues to grow for a quarter-century or so, after which it declines. The details differ somewhat from one projection to another, but the picture is broadly similar in all cases: the large fraction of the labour force represented by the youngest age group will soon be a thing of the past as the baby-boom cohorts complete their passage into the 25-44 age group (roughly by the end of the 1980s) and then into the 45-64 group (by 2011).

Table 5 provides a variety of dependency ratios associated with each of the projections. The first two are based on population and the next three on ratios of population to labour force. These are the same ratios as reported in Table 1 for the period 1951-81. We observed earlier that both of the "young dependency ratios" were at record low levels in 1981, and both of the "old dependency ratios" at or near record high levels. It is clear from Table 5 that for the standard projection, as well as for all other projections except the one relating to high fertility, the two young dependency ratios continue to decline for at least another quarter century, while the old dependency ratios continue to rise. The old dependency ratios continue to rise even in the high fertility projection, and the young dependency ratios, although they rise, never attain the levels observed between the mid-1950s and early 1970s. In all projections except the one relating to high fertility, the total dependency ratio (shown in the last column) continues to fall for a time, and then rises somewhat, but remains far below the levels observed throughout most of the period since World War II. Again, these observations should be reassuring for those who are concerned that the prospective demographic changes will prove unduly burdensome for the economy: At least the demographic ratios suggest otherwise for the entire range of projections provided here. (It should be noted that the overall social costs associated with old dependents may exceed those associated with young dependents. Even so, the increase in total resource requirements is not

TABLE 4. PROJECTED LABOUR FORCE OF CANADA UNDER ALTERNATIVE ASSUMPTIONS, 1986 TO 2036

Year	Total Labour Force thousands	index	Percentage Distribution by Age 15-24	25-44	45-64	65+
1986	12,898	100.0	21.9	52.3	24.3	1.4
			- Standard Assumptions -			
1996	14,494	112.4	16.7	53.6	28.4	1.4
2006	15,364	119.1	16.9	47.0	34.8	1.3
2016	15,163	117.6	15.8	45.3	37.1	1.8
2026	14,408	111.7	15.5	47.0	35.2	2.4
2036	13,862	107.5	16.2	45.4	36.0	2.5
			- High Fertility -			
1996	14,494	112.4	16.7	53.6	28.4	1.4
2006	15,526	120.4	17.8	46.4	34.5	1.3
2016	16,949	131.4	22.8	42.4	33.2	1.6
2026	18,371	142.4	21.3	49.2	27.6	1.9
2036	20,868	161.8	22.9	50.2	25.3	1.7
			- Low Fertility -			
1996	14,494	112.4	16.7	53.6	28.4	1.4
2006	15,327	118.8	16.7	47.0	34.9	1.3
2016	14,750	114.4	13.9	46.0	38.1	1.9
2026	13,500	104.7	13.7	46.2	37.5	2.5
2036	12,368	95.9	14.3	43.1	39.8	2.8
			- High Mortality -			
1996	14,491	112.4	16.7	53.6	28.3	1.4
2006	15,352	119.0	17.0	47.0	34.8	1.3
2016	15,132	117.3	15.8	45.3	37.1	1.8
2026	14,357	111.3	15.5	47.1	35.1	2.3
2036	13,796	107.0	16.2	45.4	35.9	2.4
			- Low Mortality -			
1996	14,495	112.4	16.7	53.6	28.4	1.4
2006	15,373	119.2	16.9	46.8	34.8	1.3
2016	15,185	117.7	15.8	45.3	37.1	1.8
2026	14,450	112.0	15.5	46.9	35.2	2.4
2036	13,927	108.0	16.1	45.2	36.1	2.6
			- High Immigration -			
1996	14,790	114.7	16.8	53.8	28.1	1.3
2006	15,992	124.0	17.0	47.5	34.2	1.3
2016	16,150	125.2	16.0	45.8	36.5	1.8
2026	15,736	122.0	15.6	47.4	34.7	2.3
2036	15,496	120.1	16.3	46.0	35.3	2.4
			- Low Immigration -			
1996	14,197	110.1	16.6	53.4	28.6	1.4
2006	14,736	114.3	16.9	46.3	35.4	1.4
2016	14,175	109.9	15.6	44.7	37.8	1.9
2036	13,080	101.4	15.3	46.5	35.7	2.5
2036	12,228	94.8	·16.1	44.6	36.7	2.7

Note: Components may not add precisely to 100.0 because of rounding.

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TABLE 5. PROJECTED DEPENDENCY RATIOS UNDER ALTERNATIVE ASSUMPTIONS REGARDING POPULATION GROWTH, 1986 TO 2036

	Population Ratios		Labour Force Ratios		
	Pop 0-19	Pop 65+	Pop 0-19	Pop 65+	Pop
Year	Pop 20-64	Pop 20-64	LF	LF	LF
1986	0.48	0.18	0.57	0.21	1.98
	- Standard Assumptions -				
1996	0.44	0.21	0.51	0.25	1.92
2006	0.39	0.23	0.46	0.27	1.90
2016	0.36	0.29	0.43	0.35	1.98
2026	0.37	0.39	0.44	0.47	2.11
2036	0.37	0.46	0.44	0.54	2.16
	- High Fertility -				
1996	0.54	0.21	0.63	0.24	2.01
2006	0.60	0.23	0.70	0.27	2.12
2016	0.62	0.27	0.71	0.31	2.18
2026	0.69	0.32	0.78	0.37	2.29
2036	0.73	0.33	0.81	0.36	2.28
	- Low Fertility -				
1996	0.42	0.21	0.49	0.24	1.89
2006	0.34	0.23	0.40	0.27	1.84
2016	0.30	0.30	0.36	0.36	1.94
2026	0.30	0.41	0.37	0.50	2.08
2036	0.29	0.51	0.35	0.61	2.16
	- High Mortality -				
1996	0.44	0.21	0.51	0.24	1.91
2006	0.39	0.23	0.45	0.27	1.89
2016	0.36	0.28	0.43	0.34	1.97
2026	0.37	0.38	0.45	0.45	2.09
2036	0.37	0.44	0.44	0.51	2.13
	- Low Mortality -				
1996	0.44	0.21	0.51	0.25	1.92
2006	0.39	0.23	0.46	0.27	1.90
2016	0.36	0.30	0.43	0.36	1.99
2026	0.37	0.41	0.45	0.49	2.12
2036	0.37	0.49	0.44	0.57	2.19
	- High Immigration -				
1996	0.44	0.21	0.51	0.24	1.91
2006	0.39	0.22	0.46	0.26	1.89
2016	0.37	0.28	0.44	0.34	1.97
2026	0.38	0.38	0.45	0.45	2.09
2036	0.38	0.44	0.44	0.51	2.13
	- Low Immigration -				
1996	0.44	0.21	0.51	0.25	1.92
2006	0.39	0.23	0.45	0.27	1.90
2016	0.35	0.30	0.43	0.36	1.99
2026	0.37	0.42	0.44	0.50	2.13
2036	0.37	0.49	0.43	0.58	2.19

likely to be onerous provided that the *allocation* of resources responds appropriately to changes in the population proportions. We comment further on this matter in Denton and Spencer, 1987b.)

Some Implications of the Prospective Changes

We now turn to consider some implications of the trend towards slower rates of labour force growth. What impact will slower growth have on the circumstances of individual cohorts and members of those cohorts over the next few decades? What effect will it have on the economy's productive capacity?

Let us start with the idea of the economy's productive capacity. At a high level of aggregation, the productive capacity of the economy at any time reflects three things: the available stocks of capital and of labour and the state of technology. What then can be said about productive capacity when what is in prospect is a labour force that will grow increasingly more slowly and then, within a few decades, decline?

The answer depends, in significant measure, on one's views regarding how technological advances are introduced into production processes. Economists have come to distinguish between embodied and disembodied technological change, and this distinction is helpful for present purposes. *Embodied technological change* must be incorporated somehow into a factor of production before its effect can be felt. One possibility is that the latest technology could be incorporated into newly produced "vintages" (or cohorts) of machinery and equipment, in the sense that its physical characteristics would reflect and take advantage of the most recent developments. The other possibility is that advances would be reflected in those cohorts (or "vintages") of workers leaving the educational system, and newly entering the labour force. In either case, the technology, once embodied, is usually viewed as "fixed" for the life of the equipment or the worker, and the rate at which new technology could have an impact on productive capacity would be limited by the rate at which new cohorts were being added to the stock of either capital or labour. One implication of this view of technological advance is the possibility that workers would become increasingly technologically obsolete as they aged. And, of course, the problem would be more severe the more rapid the pace of change. Continued training throughout the working life would mitigate the "vintage" effect, and serve to maintain the investment in the human capital of older workers.

Disembodied technological change, on the other hand, is not limited by the rates at which additions are being made to current stocks. Instead, the na-

ture of disembodied technological change is that it affects the productive characteristics of all existing units in equal proportion, whether they are of the most recent vintage or not. In general, if technological advances were properly characterised as disembodied, they would have a more substantial impact on the economy's productive capacity, at least in the short run.

Whatever the form of technological change, there is reason to think that the slower rates of labour force growth that are in prospect will have somewhat less of an impact on the productive potential of the economy than one might have supposed. The reason has to do with the age pattern of productivity of typical labour force cohorts: with experience, individual average productivity levels and incomes rise with age, at first rather quickly, and then more gradually. Age-related productivity gains may act as an offset to the reduction in numbers associated with slower labour force growth and, at least for a period, the offset could be significant. (Some illustrative, but now dated, calculations relating to this matter are provided in Denton and Spencer, 1979.)

Another observation worth making is that individuals typically work well below their productive capacities. Thus, even though one's capacity (especially for manual tasks) may decline slowly with age, individual output need not. Greater attention to the design of jobs, so that they take into account the age-varying characteristics of workers, and the continued use of training programs for workers of all ages are possibilities.

The above comments suggest a number of possible directions for research. New age-productivity profiles for men and women could be developed, based on more recent data and perhaps improved methods. Account should be taken of recent literature which suggests that wage profiles may not satisfactorily represent relative productivity, since they reflect, among other things, a variety of institutional arrangements that tie wage gains to seniority, and hence may underestimate the productivity characteristics of relatively recent labour force entrants and overestimate those of older workers.

An issue closely related to the age-earnings profiles is that of income distribution. If members of any given birth cohort are regarded as both homogeneous and endowed with productive characteristics that distinguish them from members of other cohorts (for example, the date at which formal education was completed), each cohort might be appropriately viewed as a distinct factor of production. In that case the lifetime income, as well as the annual incomes, of each cohort will depend in part on its size relative to other cohorts. Various studies have found evidence of this type of effect but the impact of cohort size on cohort income would benefit from further investigation.

The prospective changes in the age distribution of the labour force may also give rise to concerns regarding the promotion and mobility prospects of

individuals. Various authors have paid attention to such considerations. The basic idea, as suggested by Keyfitz (1973), is that one's promotion prospects are influenced by age distribution: if organizations (and the labour force as a whole) tend to be structured in such a way that advancement is strongly associated with age (or experience), and the ratio of workers of a given rank to others above and below them is fixed, then the typical age at which a given rank is attained will vary inversely with relative cohort size. Hence one might anticipate that those now in their 30s or late 20s, who were born during the baby-boom period, would experience relatively slow rates of advancement, and that their attainment of senior rank would come rather late in their working lives.[4]

There are other age-related aspects of mobility too. Both geographic mobility and job mobility tend to decline with age, and one might anticipate more difficulty with economic adjustments in the years ahead, in consequence of labour force aging. However, it is easy to underrate the ability of the economy and of individuals to adjust when circumstances warrant and incentives are present.

The whole issue of the effects of population aging on labour force mobility — hierarchical, geographic, and between employers, industries, and occupations — seems important for further research.

Implications of Labour Force Change for Industries and Occupations

We consider next some implications of prospective labour force change for particular industries and occupations. While the age distribution of the labour force summed over all industries or all occupations is closely approximated by the age distribution of the total labour force (which includes persons with no industrial or occupational attachment), particular industries and occupations do not have the average distribution. Indeed, some are very different in that respect.

Figure 1 shows a pyramid representing the age-sex distribution of the labour force in all occupations (or, equivalently, all industries) taken together. The figure, which is based on 1981 census data, shows age in five-year intervals running from 15-19 at the base of the pyramid through to ages 60-64, and then the open-ended class, ages 65 and over, at the top. Males are plotted to the left of the vertical axis, females to the right. The length of each horizontal bar indicates the percentage of the total represented by an age-sex group; thus the lengths of the bars sum to 100.0. We observe a strikingly pyramidal shape, although the left side is relatively large (reflecting the ratio of males to fe-
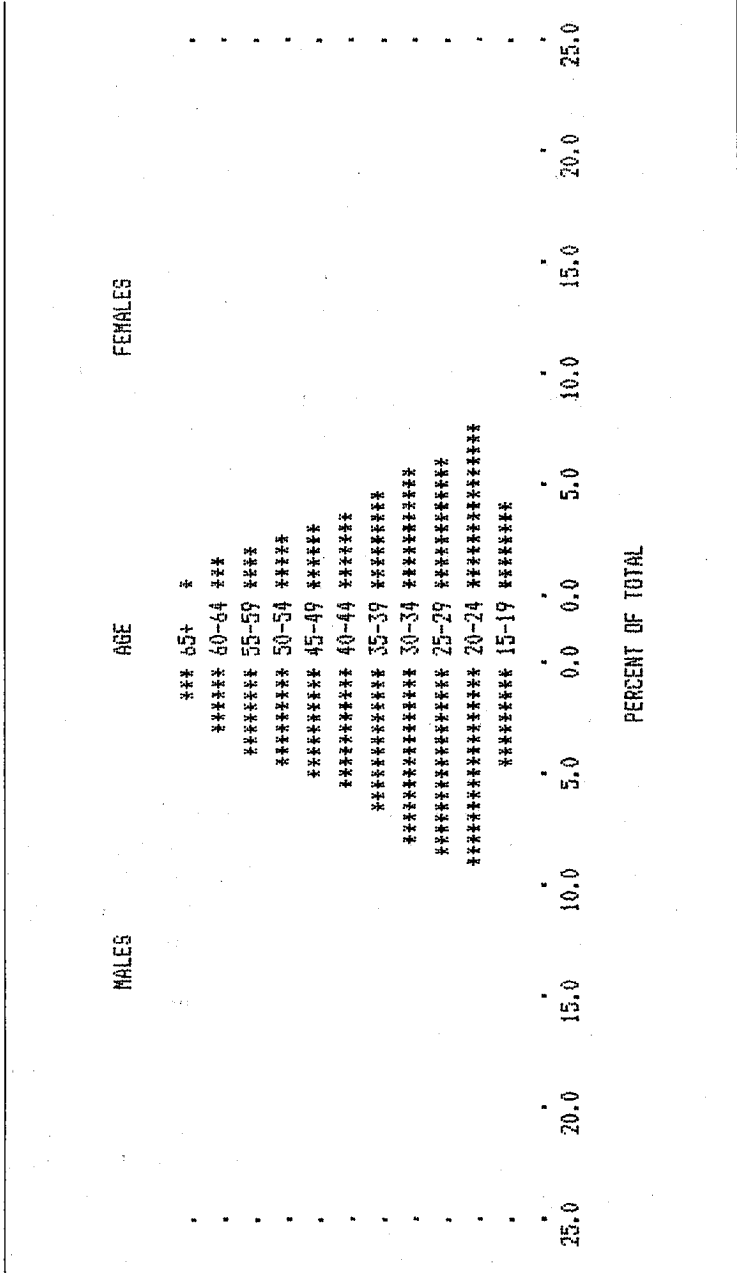
FIGURE 1.
DISTRIBUTION OF TOTAL LABOUR FORCE, CANADA, 1981

males in the labour force) and the base is narrow (reflecting both the impact of the early post-baby-boom group on the labour force and the fact that many in the youngest age group were still in school).

Let us consider now Figure 2, which shows the pyramid for the occupational group elementary and kindergarten teachers. We observe immediately the predominance of females who report this occupation, and the paucity of males: the ratio is about four to one. Figure 3 provides a variety of comparisons of the elementary teaching occupation with all occupations combined. (We refer to these plots as "pyramids" also, for want of a better term.) The first two pyramids in the upper row compare the age-sex distribution for the given occupation with the corresponding distribution for all occupations combined; the last pyramid in the first row compares the age distribution (disregarding sex) with the corresponding all-occupation age distribution. (The points plotted represent percentages in the given occupation less the corresponding all-occupation precentages.) They show that males of all ages tend to be underrepresented in this occupation and females, especially between the ages of 25 and about 50, to be greatly overrepresented. Furthermore, for both sexes together, there is a very considerable concentration of teachers aged 30-34 and 35-39 and, to a lesser extent, aged 25-29 and 40-44, as compared to overall distribution, and an underrepresentation at ages 15-19 and 20-24. The pyramids in the second row compare, separately for males and females, the age distribution within the occupation with that across all occupations. In the case of males there are relatively few elementary teachers 15-19, 20-24, and 45 and over, but relatively many in the age groups 25-29 through 40-44. The age pattern of females resembles that of males, but the relative abundance in the age groups 30-34 and 35-39 is less extreme.

The striking differences between the age patterns in this occupation and that of the overall labour force result in large measure from the rapid expansion of the elementary school system to accommodate the entry of the baby-boom generation. That expansion, which started in the 1950s, took place very largely through the hiring of young teachers, mostly female, who have simply aged along with the boom generation and, in many cases, remained as teachers. In consequence, there has been very little hiring in recent years. Casual reflection suggests possible difficulties for the future: the median age of elementary teachers was over 35 in 1981. With only low levels of new hiring in prospect, the median age can be expected to increase rapidly, and the entire age distribution of the occupation to become sharply skewed towards the older end. Aside from deaths and early retirements, it appears that the largest group of elementary teachers in 2011 will be in the age interval 60-64!
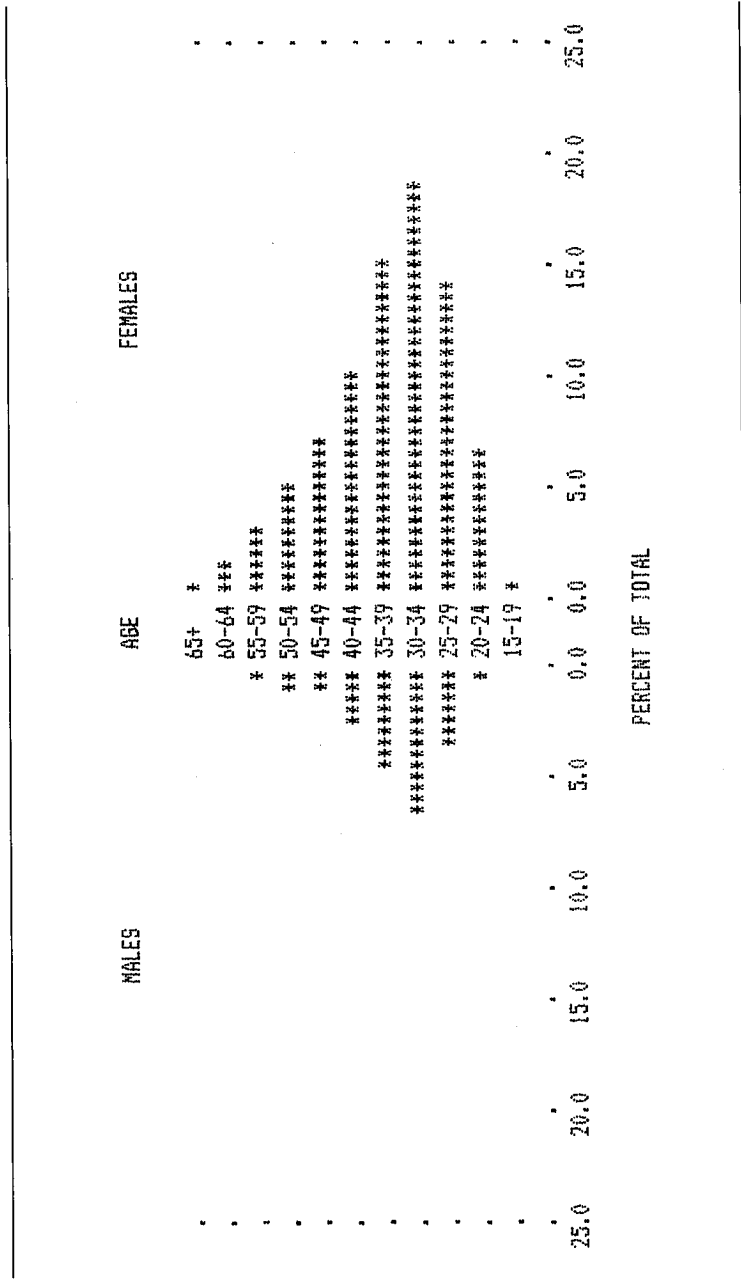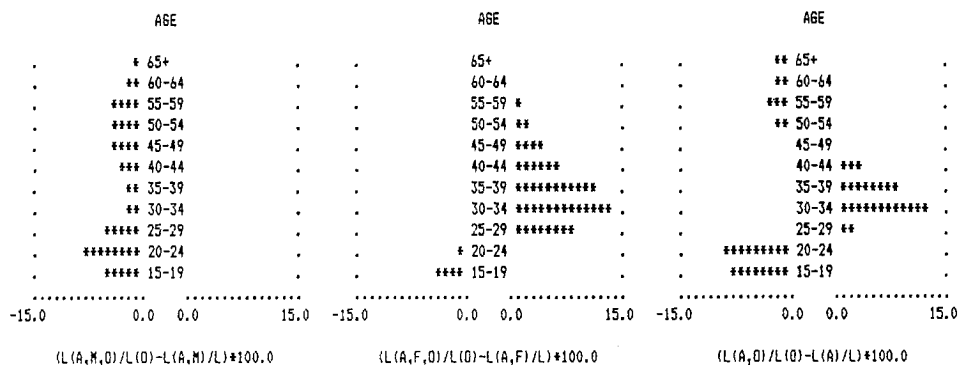
FIGURE 2.

DISTRIBUTION OF ELEMENTARY AND KINDERGARTEN TEACHERS, CANADA, 1981

```
            AGE                              AGE                              AGE

  .       * 65+           .      .      65+              .      .      ** 65+           .
  .      ** 60-64         .      .      60-64            .      .      ** 60-64         .
  .     **** 55-59        .      .      55-59 *          .      .      *** 55-59        .
  .     **** 50-54        .      .      50-54 **         .      .      ** 50-54         .
  .     **** 45-49        .      .      45-49 ****       .      .      45-49            .
  .      *** 40-44        .      .      40-44 ******     .      .      40-44 ***        .
  .       ** 35-39        .      .      35-39 ***********  .    .      35-39 ********    .
  .       ** 30-34        .      .      30-34 ************* .    .     30-34 ************ .
  .     ***** 25-29       .      .      25-29 ********     .     .     25-29 **          .
  .  ******** 20-24       .      .    * 20-24             .     .  ******** 20-24       .
  .    ***** 15-19        .      .    **** 15-19          .     .  ******** 15-19       .
  ................   .................   .................  .................   .................   .................
-15.0       0.0   0.0        15.0  -15.0       0.0  0.0        15.0  -15.0       0.0  0.0        15.0

   (L(A,M,0)/L(0)-L(A,M)/L)*100.0        (L(A,F,0)/L(0)-L(A,F)/L)*100.0        (L(A,0)/L(0)-L(A)/L)*100.0
```

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                                                              OTHER SUMMARY STATISTICS
                                                       !----------------------------------!
                                                       !GROUP! MEAN  !MEDIAN!PERCENT OF ALL!
            AGE                            AGE          !     !  AGE  ! AGE  ! OCCUPATIONS  !
                                                       !-----!-------!------!--------------!
  .      ** 65+            .      .      * 65+          !     !       !      !              !
  .     **** 60-64         .      .      * 60-64        !MALES! 35.8  ! 34.6 !     .48      !
  .     **** 55-59         .      .     ** 55-59        !     !       !      !              !
  .     **** 50-54         .      .      50-54          !-----!-------!------!--------------!
  .       ** 45-49         .      .      45-49 *        !     !       !      !              !
  .      40-44 ***         .      .      40-44 ***      ! FE- ! 36.5  ! 35.3 !    2.90      !
  .      35-39 ***********  .     .      35-39 ********  !MALES!       !      !              !
  .      30-34 **************X    .      30-34 **********!     !       !      !              !
  .      25-29 **           .     .      25-29 **        !-----!-------!------!--------------!
  . ************ 20-24      .      .  ************ 20-24 !     !       !      !              !
  .   ******** 15-19        .      .   ******** 15-19   !BOTH ! 36.4  ! 35.1 !    1.46      !
  ................   .................   ................   ................   !SEXES!       !      !              !
-15.0       0.0   0.0        15.0  -15.0       0.0  0.0        15.0  !     !       !      !              !
                                                       !----- ------- ------ --------------!
   (L(A,M,0)/L(M,0)-L(A,M)/L(M))*100.0   (L(A,F,0)/L(F,0)-L(A,F)/L(F))*100.0  !  FEMALE/MALE RATIO:  4.09     !
                                                       !----------------------------------!
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```
      X =    18.72 (EXCEEDS SCALE MAXIMUM)
```

LEGEND: L STANDS FOR LABOUR FORCE; A FOR AGE; M FOR MALES; F FOR FEMALES; 0 FOR OCCUPATION.
        THUS L(A,M,0) IS THE MALE LABOUR FORCE OF AGE A IN OCCUPATION 0, L(M,0) IS THE TOTAL MALE LABOUR FORCE IN
        OCCUPATION 0, L(M) IS THE TOTAL MALE LABOUR FORCE FOR ALL OCCUPATIONS COMBINED, ETC.

FIGURE 3. DISTRIBUTION OF ELEMENTARY AND KINDERGARTEN
TEACHERS COMPARED TO TOTAL LABOUR FORCE,
CANADA, 1981

With the aging of the baby-boom generation the average age of members of the labour force will increase, and one might anticipate various resulting difficulties. However, the age distributions of particular occupations and industries vary substantially from the overall distribution, and some industries may face difficulties of adjustment associated specifically with the age distribution of their labour forces.

Some Suggestions for a Research Agenda

One suggestion for further research concerns the population and labour force projections, which are at the heart of any analysis of the demographic future, and the assessment of their implications. The central issue has to do with the assumptions that underlie the projections – that is, with the rates of fertility, mortality, and migration in the case of the population projections, and with the participation rates in the case of the labour force projections. We suggest that particular thought to be given to the basic assumptions – especially to those relating to fertility and labour force participation rates. Much attention has been paid to the theoretical and empirical modelling of these rates, but no one approach has received wide acceptance. Nor does any approach that has been suggested thus far provide a satisfactory basis for making *long-term* projections.

Another suggestion concerns the analysis of the implications that a continued slower rate of labour force growth will have for the macro-economy, and specifically for its future productive capacity. We have suggested that changes in the labour force age-sex distribution are important in this regard, since there are differences in the productivity characteristics of average individuals at different ages. Further work could focus on the development of age-productivity profiles at different levels of education for eventual incorporation into a larger model of economic activity or, more simply, for use in conjunction with alternative labour force projections. Such profiles should take into account the view that the age pattern of wage rates may not adequately represent the age pattern of productivity.

Closely related to the prospective changes in productive capacity associated with population and labour force changes are possible effects on the distribution of income. The impact that the relative size of a cohort has on its return in the labour market is an issue of continuing importance.

Individual promotion prospects may be systematically related to changes in the population age distribution. Further work might explore the implications that prospective population and labour force change of the kind that we

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anticipate in Canada could be expected to have on the promotion prospects of typical members of various cohorts. Such analysis could be undertaken not just at the all-Canada level, but also at the level of individual regions, industries, and occupations. The analysis should pay particular attention to the labour force behaviour of women in this regard; the pattern of female labour force entry and exit are more difficult to incorporate into this kind of analysis than are the typical male patterns. Aside from promotion, there are broad issues relating to the effects of population aging on geographic, industrial, and occupational mobility, as well as on mobility between employers. Labour force mobility is a significant consideration if the economy is to adjust without undue difficulty to the changes that are in store.

We have illustrated some of the marked differences in age distributions that are apparent among occupations and industries. It would be useful to undertake a thorough review of the age-sex composition of a wide variety of industrial and occupational groups, working at a disaggregated level, with a view to identifying those in which the age distributions are suggestive of future difficulties. Aside from obvious concerns about pension funding, there are also more subtle concerns about problems with personnel relations in industries with disproportionate numbers of older workers: How is it possible to avoid discouraging younger workers in an industry or occupation when their promotion prospects are poor? How is it possible to ensure an appropriate supply of "new blood" in such an industry or occupation? What is the appropriate role of the government in such matters? There are industries and occupations in which federal or provincial governments play a major role in financing or in determining the numbers of people who receive training; examples include postsecondary education programmes (such as teacher training and medicine) and programs at least partly outside the formal education system (such as manpower training). In such cases, how should the changing composition of the labour force be taken account of in planning and policy decisions?

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