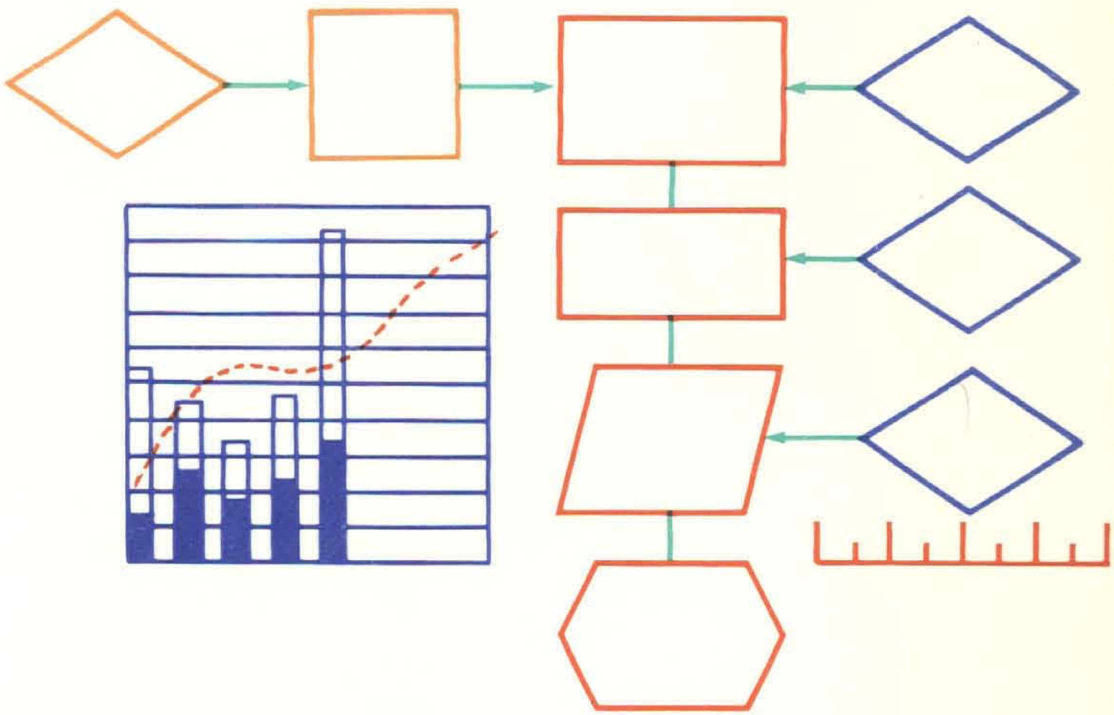
Regional Economic Expansion
Expansion Économique Régionale

Working Paper No.2

POPULATION IN CANDIDE-R

July 1975



ECONOMIC DEVELOPMENT ANALYSIS DIVISION
DIVISION DES ÉTUDES DE DÉVELOPPEMENT ÉCONOMIQUE

Quantitative Analysis Unit
Groupe D'Analyse Quantitative

Working Paper No.2

POPULATION IN CANDIDE-R

July 1975

This working document represents a partial regionalization of the CANDIDE 1.1 model. The acronym CANDIDE refers to the Canadian Disaggregated Interdepartmental Econometric model.

The CANDIDE-R version of the model outlined in this document is designed to help build an appreciation of the regional diversity of Canada. The authors draw attention to the tentative nature of the econometric work reported upon. So as to avoid attributing official status to the views expressed, prior consultation respecting quotation would be appreciated.

Economic Development Analysis Division,
Canada, Dept. of Regional Economic Expansion,
161 Laurier Avenue West,
Ottawa, Ontario,
K1A OM4.

POPULATION IN CANDIDE-R

1.- Introduction

The population sector in CANDIDE-R is completely regionalized and integrates the natural growth of the indigenous population of each region with inter-regional and international migration flows. The population variables are important explanatory variables throughout the model, notably, in regional equations for housing starts and the labour force. Particularly in a medium-term model, the size and composition of the population are important factors in determining economic growth. This paper describes the desired characteristics of a population projection mechanism, and notes the ways in which the mechanism of CANDIDE-R satisfies these requirements. There is a brief outline of historical trends in population composition and growth in the five regions under consideration[1], followed by a detailed explanation of the population projection mechanism itself. The results of the projections of this sub-model over the sample

1 The five regions used in CANDIDE-R are the Atlantic region, Quebec, Ontario, the Prairies and British Columbia.

period are discussed, followed by four exercises in population projection, using varying assumtions regarding fertility rates and migration flows.

2. Historical Perspective: Regional Population Growth and Composition

Although marked regional differences in in the birth rate have tended to diminish in the 1960's, there still remains considerable inter-regional disparities in the natural population growth rates due to the concentration of the population in comparatively young age groups in some regions. In 1966 the average age of the national population was estimated at 25 years. However, the average age in the Atlantic region was 22-5 years, in Quebec 24, in the Prairies 25, and 27 and 28 in Ontario and British Columbia respectively. As can be seen in table 1, however, the major cause of disparity in regional population growth rates can be attributed to the differences in net migration flows.

At the national level, usually over half of the population fluctuations about a trend are due to migration flows. At the regional level, where the impact of inter-regional and international migration flows is far greater, most of the disparity in population growth can be attributed to the source of fluctuations in migration.[2] These migration flows are largely endogenous in CANDIDE-R, thereby, allowing the population projection mechanism to explain regional population growth as a function of natural growth and net migration.

Table I: Composition of Population Growth 1961-1971

	Births (1)		Natural Growth (2)		Net Migration		Total	
	000	Rate	000	Rate	000	Rate	000	Rate
Atlantic	463	244	309	163	-149	-79	160	84
Quebec	1130	215	743	141	26	5	769	146
Ontario	1405	225	861	138	606	97	1467	235
Prairies	740	232	486	153	-123	-39	364	114
British Columbia	354	217	193	118	363	222	556	350
Canada	4102	225	2604	143	726	40	3330	183

(1) Rate per 1,000 people with respect to the 1961 population
(2) Natural Growth is births minus deaths
SOURCE: Calculations based on data from Statistics Canada

2. For a more detailed account of inter-regional and international migration in the framework of CANDIDE-R, see <u>Migration in CANDIDE-R</u>.

The regions also show considerable differences in the composition of their population. For example, the Atlantic region has a relatively small proportion of its population between the ages of 25 and 39, while the share of this age group in Ontario is relatively high (see Table 2).

Table 2: Population Distribution by Age Group: Percentage

		0-14	15-24	25-39	40-64	65+
Atlantic	1961	37.6	15.5	17.4	21.8	7.8
	1971	32.8	19.6	16.9	22.6	8.3
Quebec	1961	35.4	15.9	20.8	22.0	5.8
	1971	29.6	19.4	20.2	23.9	6.9
Ontario	1961	32.2	13.2	21.7	24.8	8.2
	1971	28.7	18.0	19.7	25.3	8.4
Prairies	1961	34.1	14.1	20.0	23.5	8.2
	1971	30.5	18.3	18.1	24.3	8.7
British Columbia	1961	31.3	12.8	20.3	25.5	10.2
	1971	27.9	17.8	19.2	25.8	9.4
Canada	1961	34.0	14.3	20.6	23.5	7.6
	1971	29.6	18.6	19.3	24.5	8.1

In examining the relative shares of the different age groups in the population, another factor worth noting is the effect of the decline in the birth rate, both in absolute terms and in rate of decline, particularly in Quebec where the share of the population aged 0-14 years fell from 35.4% to 29.6%. Thus the changes in relative shares of the age groups in a region between 1961 and 1971 is attributed not only to the natural aging of the population, and the decline in the birth rate, but, as was noted above, to migration flows as well. The breakdown of net migrants by region and age group, for 1966-69 is shown in Table 3. While this table does not show the regional differences in flows, it does show that most migrants are relatively young (between the ages of 20 and 30), and thereby contribute to important compositional effects on population growth and the labour force structure[3].

3. See: Migration in CANDIDE-R, Table 2, for a comparison of the sizes of inter-regional and international migration flows.

Table 3: Distribution of Net Migrants by Age Group
Percentage

	0-14	15-24	25-39	40-64	65 +
Atlantic[1]	31.4	22.5	29.5	14.4	2.3
Quebec	31.5	18.6	30.4	16.6	2.9
Ontario	31.6	21.5	30.4	13.5	3.0
Prairies	31.8	19.7	30.1	14.9	3.5
British Columbia	31.6	19.4	29.9	16.0	3.1
Canada[2]	25.4	24.5	34.2	13.6	2.3

(1) Estimated for inter-regional migration only, 1966-1969

(2) Estimated for international migration only

SOURCE: The regional estimates are derived from data of the Population Estimates and Projections Division, Census Field, Statistics Canada. The estimates for Canada are from "The Population Projections for Canada, 1969-1984" Analytical and Technical Memorandum #4, DBS April 1970.

2.1- Characteristics of a Population Projection Mechanism

Given the regionalization of CANDIDE-R and the importance of the age-sex structure and of migration flows on the regional populations, it is desirable that the population projection mechanism in CANDIDE-R incorporate the following functions:

(a) to explain separately for each region the components of population growth in order to break down migration flows by source and destination;

(b) to break down migration flows into appropriate age-groups and to determine the composition effects attributable to each group;

(c) to disaggregate population projections into age-sex groups in order to measure the composition effects attributable to these groups.

3.- The Population Projection Mechanism

Most demographic projection systems are based on an aging-process whereby each cohort (or group of persons of a specified sex and age) progresses to the next group after a certain number of years. Births are entered in the first age-sex cohort only, while deaths are taken into account in each cohort. The interval between cohorts is usually the same as the projection period. For instance in CANDIDE-R annual data is used to calculate the population in age-sex cohorts of 5 years for each region. The first cohorts are for males and females aged 0-4, the next 5-9, etc. The oldest cohorts are for males and females aged 65 and over. The result is 28 age-sex cohorts for each of the five regions, or 140 cohorts in total.

In the population projection mechanism each cohort advances to the next cohort every five years. In order to obtain values for the population in time t, there must exist values of the population in t-5, which are used as the base for the 5 year projection mechanism.

This mechanism takes into account the natural aging of each cohort, as well as births, deaths and migration in each age-sex group before arriving at a population estimate for year t. To give a more specific example, suppose we wanted to calculate the population, by age-sex cohort, by region in 1974. We would begin with the projection for 1969. By the natural aging process we could assume that those who were in the 0-4 year cohorts in 1969, would be in the 5-9 year cohorts in 1974, and those in the 15-19 year cohorts in the 20-24 year cohorts. However, over the five years, 1969-1974, there have been births, which are entered in the 0-4 year cohort, deaths which will affect all cohorts, and migration flows, which again affect all cohorts. The population structure of 1969 is adjusted to account for all these factors, with the final result being the 1974 population. To calculate the population in 1975, we have to revert to the 1970 population, and so on.

3.1 Example of the Population Algorithm

Ignoring migration flows for the moment, an example of the population mechanism can be summed up by the following equation:

$$(1) \quad P_{m,24,t} = S_{m,24} P_{m,19,t-5}$$

where $P_{m,24,t}$ = regional population of males in the 20-24 year age group in year t

$P_{m,19,t-5}$ = regional population of males in the 15-19 year age group in year t-5

$S_{m,24}$ = 5 year survival rate for males 15-19 in the observed region

Thus the male population 20-24 in a given region, in year t, is simply that proportion of the male population 15-19 in year t-5, who survived the five years between t-5 and t. However, as we cannot ignore the impact of migration on population, in the context of CANDIDE-R, (1) must be modified.

Introducing net migration into the population mechanism presents certain problems due to the 5 year aging process. There are five net migration flows, which, if broken down into age-sex cohorts, and estimated on that basis, would result in 140 migration flows, or 28 age-sex cohorts in each of the five regions. Since this type of specification is beyond the scope of CANDIDE-R, the breakdown of migrants into age-sex cohorts was assumed to be constant over time and it was also assumed that there are no deaths during migration. Equation (1) is then modified to give:

$$(2) \quad P_{m24t} = S_{m24} P_{m19,t-5} + W_{m20} M_{t-4} + W_{m21} M_{t-3} + W_{m22} M_{t-2} + W_{m23} M_{t-1} + W_{m24} M_{t}$$

where W_{m20} = proportion of males 16-20 in net regional migration flows

W_{m21} = proportion of males 17-21 in net regional migration flows

M_{t-i} = total net regional migration, in year t-i.

In a more general format (2) can be expressed as:

$$(3) \quad P_{xi,t} = S_{x,i} P_{xi-5,t-5} + W_{x\ i-4} M_{t-4} + W_{x\ i-3} M_{t-3} + W_{x\ i-2} M_{t-2} + W_{x\ i-1} M_{t-1} + W_{xi} M_{t}$$

where x refers to the sex, i refers to the age cohort and t refers to the year. 'In equation (2) x and i in the left hand side variable are m and 24 respectively.

In each region there are four age-sex cohorts which are treated somewhat differently from other cohorts. These are the male and female 0-4 cohorts, and the male and female 65 and over cohorts. For the two 0-4 cohorts births must be taken into account. An estimate of the fertility rate in each region is obtained by applying an exogenous birth rate to the number of women age 15-49 in the sample period.

Thus fertility rate is exogenous to the model, and its values over the sample period were calculated as follows:

$$(4) \qquad R_t = \frac{B_t}{PFF_{t-1}}$$

where R_t = regional fertility rate for year t

B_t = number of live births in year t (for example, for 1970 this would be the number of births from June 1, 1969 - May 31, 1970)

PFF_{t-1} = regional population of females 15-49 in year t-1 (for 1970, this would be the number of women 15-49 in 1969, or June 1, 1968- May 31, 1969).

Births are included in the 0-4 age cohorts in the following manner:

$$(5) \quad P_{m04,t} = S_{04} [0.514 (R_t (P_{F1519,t-1} + P_{F2024,t-1} + \ldots + P_{F4549,t-1}) + \sum_{i=1}^{4} R_{t-i} (P_{F1519,t-1-i} + P_{F2024,t-1-i} + \ldots + P_{F4549, t-1-i}))] + \sum_{i=o}^{4} (B_{t-i} * TNMr_{t-i})$$

where $P_{m04,t}$ = regional population of males age 0-4 in year t

R_t = fertility rate in year t

$P_{F1519,t-1}$ = regional population of females age 15-19 in year t-1.

TNMr = total net migration in region r

B_{t-i} = weights to express the number of births per total net migration, not already accounted for by the rest of the equation

S_{04} = five year survival rate for males 0-4

The constant 0.514 is the ratio of male births to total births. The female 0-4 age cohort is calculated in a similar manner.

For the male 65 and over cohort, the equation is as follows:

$$(6) \quad P_{m65,t} = S_{m,65}\, P_{m65,t-5} + S^{*}_{m65}\, P_{m65,t-5} + W_{m61}\, M_{t-4}$$

$$+ W_{m62}\, M_{t-3} + \ldots + W_{m65}\, M_{t}$$

where $P_{m65,t}$ = regional male 65 and over population in year t

S_{m65} = 5 year survival rate for males 60-64

S^{*}_{m65} = 5 year survival rate for males 65 and over

The female 65 and over cohort is determined in an identical manner.

3.2 Generalized Form of the Algorithm

The demographic sector of CANDIDE-R can be viewed as a series of five distinct regional models. Each model is composed of 28 simultaneous equations, covering 14 age groups and two sexes. Each regional model has two equations resembling (5), one for males 0-4, one for females 0-4; and two equations resembling (6), males 65 and over, females 65 and over, while the remaining 14 equations are similar in construction to (2).

The algorithm <u>for each region</u> may be expressed in the following matrix notation:

(7) $$P_t = SP^* + WM$$

Where the vectors P_t, P^* and M represent:

$$P_{t\,(28x1)} = \begin{bmatrix} P_{mo4,t} \\ P_{mo9,t} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ P_{m65,t} \\ P_{F04,t} \\ P_{F09,t} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ P_{F65,t} \end{bmatrix} \quad \underset{(30x1)}{P^*} = \begin{bmatrix} 0.514\ R_t(P_{FF}+W_{FF}M)_{t-5} \\ P_{mo4,t-5} \\ P_{m09,t-5} \\ \cdot \\ \cdot \\ \cdot \\ \cdot \\ P_{m65,t-5} \\ 0.486\ R_t(P_{FF}+W_{FF}M)_{t-5} \\ P_{F04,t-5} \\ P_{F09,t-5} \\ \cdot \\ \cdot \\ \cdot \\ P_{F65,t-5} \end{bmatrix} \quad \underset{(5x1)}{M} = \begin{bmatrix} M_{t-4} \\ M_{t-3} \\ M_{t-2} \\ M_{t-1} \\ M_t \end{bmatrix}$$

The values for the five-year survival rates, which make up matrix S, are the result of an unpublished study carried out by the Institute of Quantitative Analysis, Toronto, for the Department of Regional Economic Expansion. Matrix S has the following form.

$$S_{(28x30)} = \begin{bmatrix} S_{m04} & 0 & & 0 & & & & 0 \\ 0 & S_{m09} & & & & & & \\ & & \ddots & & & & & \\ & & & S_{m65},\ S^*_{m65} & & & & \\ & & & & S_{F04} & & & \\ & & & & & S_{F09} & & \\ & & & & & & \ddots & \\ 0 & & 0 & & & & & S_{F65}, S^*_{F65} \end{bmatrix}$$

Finally matrix W, which represents the breakdown of migration flows into age-sex cohorts for each region has the following format:

$$
W_{(28x5)} = \begin{bmatrix}
W_{m00,t-4}, W_{m01,t-3}, W_{m02,t-2}, W_{m03,t-1}, W_{m04,t} \\
W_{m05,t-4}, W_{m06,t-3}, \cdots\cdots\cdots, W_{m09,t} \\
\cdot \\
\cdot \\
\cdot \\
\cdot \\
W_{m61,t-4}, \cdots\cdots\cdots\cdots, W_{m65,t} \\
W_{F00,t-4}, W_{F01,t-3}, W_{F02,t-2}, W_{F03,t-1}, W_{F04,4} \\
\cdot \\
\cdot \\
\cdot \\
\cdot \\
W_{F61,t-4}, \cdots\cdots\cdots\cdots, W_{F65,t}
\end{bmatrix}
$$

An explanation of W follows directly.

3.3 The Breakdown of Net Migration Flows

Before explaining the individual elements of matrix W, it is useful to look at equation (2), which is repeated below:

$$(2) \quad P_{m24,t} = S_{m24} P_{m19,t-5} + W_{m20} M_{t-4} + W_{m21} M_{t-3} + W_{m22} M_{t-2} + W_{m23} M_{t-1} + W_{m24} M_{t}$$

In order to explain the male population, 20-24, in year t, one must consider not only the survival of the idigenous population 14-19 over the five year span from t-4 to t, S_{m24}, $P_{m19,t-5}$, but also migration flows in each of those years. The migration flow in year t-4 which affects the male 20-24 population in year t, is the net immigration of males 16-20, $W_{m20} M_{t-4}$, since by year t this group will have aged to 20-24. Similarly the relevant migrant group in year t-3 is males 17-21, $W_{m21} M_{t-3}$, who by year t will be aged to 20-24. Similarly the relevant migrant group in year t-3 is males 17-21, $W_{m21}\ M_{t-3}$, who by year t will be aged 20-24, and so on. The W_i weights in equation (2) represent one row of the W matrix. Similar use of W and M is made in all population equations, as can be seen in equations (5) and (6).

Note that in relation to equation (2) once more the net immigrants who in year t-5 were aged 14-19 do not enter explicity into the calculations. They already been included in the determination of $P_{m19,t-5}$ and as such are part of the indigenous population in year t. For example:

$$(8)\quad P_{m19,t-5} = S_{m19}\ P_{m14,t-10} + W_{m15}\ M_{t-9} + W_{m16}\ M_{t-8} + W_{m17}\ M_{t-7} + W_{m18}\ M_{t-6} + W_{m19}\ M_{t-5}$$

The last term in equation (8), $W_{m19}\ M_{t-5}$ is included in $P_{m19,t-5}$ in equation (2).

The values for the last column of the W matrix are observed values, calculated as averages of observations over 1966-1969. The remaining elements of the W matrix were calculated by interpolation between observed values. For example the values for the row W_{m20} to W_{m24} are determined by interpolating between observed W_{m19} and W_{m24}

$$(9) \quad W_{m19+i,t} = {}^{i}/5\ (W_{m24,t} - W_{m19,t}) + W_{m19,t} \qquad i=1,2 \ldots 4$$

This results in weights for net immigrants of ages 0-1, 0-2, 0-3, 0-4, 1-5, 2-6, 3-7, 4-8, 5-9, etc. continuing in 5 year cohorts up to 60-64, and 65 and over for males and females. These weights are invariant to the year chosen. However, for purposes of calculation in the equation

$$(7) \quad P_t = SP^* + WM$$

the weights are assigned to certain years. For example the row in matrix W which is calculated from equation (9) has the following notation $W_{m20,t-4}$, $W_{m21,t-3}$, $W_{m22,t-2}$, $W_{m23,t-1}$, $W_{m24,t}$.

The sum of the observed values in the last column of matrix W is equal to 1, and it can be shown that by construction[4] the sum of each other column is also equal to 1.

3.4 The Population Blocks in CANDIDE-R

For simulation purposes and due to the large number of equations in the Population sector, the population model comprises Blocks 47 and 48. The family formation, and household equations are in Block 22, while migration flows are determined in Block 49. Block 47 contains population equations by

(4) Without giving a formal proof this statement can be illustrated by examing the first column in matrix W. By construction in (9) the weights in the first column are:

$$W_{00} = 1/5\ W_{04} + 0$$

$$W_{05} = 1/5\ W_{09} + 4/5\ W_{04}$$

$$W_{10} = 1/5\ W_{14} + 4/5\ W_{09}$$

$$\cdot$$

$$\cdot$$

$$\cdot$$

$$W_{60} = 1/5\ W_{64} + 4/5\ W_{59}$$

$$W_{64} = 1/5\ W_{65t} + 4/5\ W_{64} + 4/5\ W_{65t}$$

Given that $W_{04} + W_{09} + W_{14} + \ldots + W_{65} = 1$, it is easily shown that the sum of all right-hand members of the equations above equals 1.

age-sex group for the Atlantic, Quebec and Ontario regions, and Block 48 completes the algorithm with equations for the Prairies and British Columbia. The age 14 and over civilian source population, used in the determination of the labour force, is also calculated in Block 48, for 21 age-sex groups.

The definition of the civilian source population from the labour force census is those persons 14 years and over excluding members of the Armed Forces, religious orders and persons who are institutionalized. Since this definition differs from an aggregation of appropriate age-sex groups in the population block, the following type of adjustment mechanism is used in Block 48 to determine civilian source population.

(9) $LFP_{m24} = P_{m19} + P_{m24} - RES$

where LFP_{m24} = regional civilian source population of males 14-24, per labour force census.

P_{m19} = regional male population 15-19

P_{m24} = regional male population 20-24

RES = observed difference between regional population of males 15-24 and labour force census population, LFP_{m24}

Values for RES are observed during the sample period and are exogenous to the model. There are 10 identities in Block 48 which define the regional primary and total secondary labour force.

The total population of Canada, broken down into 28 age-sex groups, is calculated in Block 22 from the results of the regional demographic blocks. However, the population of the Yukon and North West Territories (POPYNW) is exognous and is broken down into cohort groups with fixed coefficients which sum to one.

4.- Some Population Projection Exercises

The demographic model of CANDIDE-R has been used as an autonomous population projection model, for different assumptions of fertility rates and net migration. Given the structure of the algorithm, there is no limit to the projection period, although in the following examples it is restricted to 1971-1985. In order to demonstrate the dynamic properties of the model four different projection exercises were selected This allows the establishment of a parallel between the desired characteristics of a demographic model (as outlined in 2.1 above) and the behaviour of the model in simulation. The four hypotheses shown below have the common assumption that the regional fertility rates will converge towards a common value at some time in the future, and that they will retain this value over the rest of the period. The fertility rates for each region from the last observed value to the convergence date were calculated through linear interpolation The four projections can be summarized as follows:

(1) Hypothesis 1: This projection exercise is characterized by very low fertility rates and the continuation of the trend observed in regional migration flows for 1961-1971. Net international immigration is set at 75,000 per year for the whole period, with the following division : Atlantic 2.5%, Quebec 19.8% Ontario 53.4%, Prairies 11.5% and British Columbia 12.6%. Net inter-regional migration is assumed to be: -11,600 for the Atlantic region; -6,200 for Quebec 13,500 for Ontario, -17,500 for the Prairies and 22,000 for British Columbia. The birth rates were set at 1.8 children per woman aged 15-49 in 1978.

(2) Hypothesis 2: This exercise is characterized by a slightly higher birth rate of 2.0 children per woman of child-bearing age. Net international immigration is maintained at a constant level of 0.3520 per thousand people throughout the period.

(3) Hypothesis 3: The fertility rates of Hypothesis 2 were retained, but the total net migration flow was set at zero for the whole period.

(4) Hypothesis 4: In this exercise, an attempt was made to obtain the same total population figure for Canada in 1985 as in Hypothesis 2, by varying only the fertility rates, leaving net migration flows constant at zero as in Hypothesis 3. The fertility rates converge in 1985, and the object of this projection was to compare the age structure of the population 1985 with the same total population obtained through a higher birth rate.

These differing assumptions for fertility rates and migration flows are summarized in the tables below. While not all of the assumptions are completely realistic, they do serve to demonstrate the impact of varying assumptions on demographic projections.

Table 6: Regional Fertility Rate Assumptions

	Last Observation 1971	1978	1985
Atlantic			
Hypothesis 1	0.08960	0.05140	0.05140
Hypothesis 2 & 3	0.08960	0.07335	0.05714
Hypothesis 4	0.08960	0.08730	0.08500
Quebec			
Hypothesis 1	0.06002	0.05140	0.05140
Hypothesis 2 & 3	0.06002	0.05856	0.05714
Hypothesis 4	0.06002	0.07251	0.08500
Ontario			
Hypothesis 1	0.07407	0.05140	0.05140
Hypothesis 2 & 3	0.07407	0.06559	0.05714
Hypothesis 4	0.07407	0.07954	0.08500
Prairies			
Hypothesis 1	0.08237	0.05140	0.05140
Hypothesis 2 & 3	0.08237	0.06974	0.05714
Hypothesis 4	0.08237	0.08369	0.08500
British Columbia			
Hypothesis 1	0.07284	0.05140	0.05140
Hypothesis 2 & 3	0.07284	0.06497	0.05714
Hypothesis 4	0.07284	0.07892	0.08500

Table 7: Net Migration Assumptions
('000 people)

	Last Observation 1971	1972	Projected Values 1976	1985
Atlantic				
Hypothesis 1	-3.3	-9.7	-9.7	-9.7
Hypothesis 2	-3.3	-9.7	-9.6	-9.4
Hypothesis 3 & 4	-3.3	0.0	0.0	0.0
Quebec				
Hypothesis 1	-36.2	8.6	8.6	8.6
Hypothesis 2	-36.2	8.7	9.5	11.3
Hypothesis 3 & 4	-36.2	0.0	0.0	0.0
Ontario				
Hypothesis 1	72.2	53.5	53.5	53.5
Hypothesis 2	72.2	54.0	56.0	60.8
Hypothesis 3 & 4	72.2	0.0	0.0	0.0
Prairies				
Hypothesis 1	-18.5	-8.9	-8.9	-8.9
Hypothesis 2	-18.5	-8.9	-8.3	-7.3
Hypothesis 3 & 4	-18.5	0.0	0.0	0.0
British Columbia				
Hypothesis 1	37.5	31.4	31.4	31.4
Hypothesis 2	37.5	31.4	32.0	33.1
Hypothesis 3 & 4	37.5	0.0	0.0	0.0

Table 7: (Cont'd) Net Migration Assumptions

Canada	1971	1972	1976	1985
Hypothesis 1	53.9	75.0	75.0	75.0
Hypothesis 2	53.9	75.5	79.6	88.5
Hypothesis 3 & 4	53.9	0.0	0.0	0.0

The most interesting results for the four different hypotheses are found in tables 8, 9 and 10. As was expected the rate of population growth is much weaker in Hypothesis 3, than in 2 and 4. The regional distribution of the Canadian population is strongly affected by both inter-regional and international migration flows. In order to replace the growing international migration of Hypothesis 2 (53,900 in 1971, 88,500 in 1985) the fertility rate was increased from 2.0 births per woman of child-bearing age to 3.0. The first three hypotheses result in a proportionally older population than in 1966 (see Table 9), which would confirm the effects of compositional changes on the medium term potential of the Canadian economy. There is an appreciable slowdown in the aging of the population only in Hypothesis 4, where net migration is zero,and the birth rate relatively high. Hypotheses 3 and 4 are compatible with an equilibrated growth of the labour force between regions. This would tend to show that the maintenance of the observed migration flows of the 1960's would have the effect - particularly in the Atlantic and Prairie regions - of increasing that proportion of the population which depends on the labour force.

Table 8: Projection and Distribution of the Regional Population

	Hypothesis 1 Pop.	%	Hypothesis 2 Pop.	%	Hypothesis 3 Pop.	%	Hypothesis 4 Pop.	%
Atlantic								
1971	2063.7	9.6	2063.7	9.6	2063.7	9.6	2063.7	9.6
1976	2118.9	9.3	2142.6	9.3	2193.0	9.7	2208.1	9.7
1981	2130.7	8.9	2205.2	9.0	2309.3	9.8	2369.3	9.8
1985	2143.2	8.7	2239.9	8.8	2388.1	9.9	2509.0	9.8
Quebec								
1971	6034.4	28.0	6034.8	28.0	6034.8	28.0	6034.8	28.0
1976	6317.8	27.7	6345.5	27.6	6297.6	27.8	6345.9	27.9
1981	6574.5	27.5	6668.6	27.3	6565.4	27.8	6751.9	27.9
1985	6772.6	27.4	6921.1	27.1	6768.8	27.9	7135.2	28.0
Ontario								
1971	7702.9	35.8	7702.9	35.8	7702.9	35.8	7702.9	35.8
1976	8298.4	36.4	8366.4	36.4	8080.0	35.8	8137.9	35.8
1981	8801.5	36.9	9025.1	36.9	8417.4	35.7	8640.5	35.7
1985	9211.8	37.3	9534.2	37.4	8645.5	35.7	9084.5	35.6
Prairies								
1971	3542.0	16.4	3542.0	16.5	3542.0	16.5	3542.0	16.5
1976	3656.1	16.0	3691.4	16.1	3736.0	16.5	3761.7	16.5
1981	3707.3	15.5	3819.0	15.6	3908.6	16.6	4009.1	16.6
1985	3746.4	15.2	3896.6	15.3	4021.7	16.6	4221.6	16.6
British Columbia								
1971	2190.0	10.2	2190.0	10.2	2190.0	10.2	2190.0	10.2
1976	2433.4	10.7	2450.9	10.7	2286.3	10.1	2302.3	10.1
1981	2656.3	11.1	2715.3	11.1	2373.0	10.1	2434.3	10.1
1985	2841.2	11.5	2926.8	11.5	2434.2	10.0	2554.6	10.0
Canada								
1971	21533.0	100.0	21533.0	100.0	21533.0	100.0	21533.0	100.0
1976	22824.6	100.0	22996.8	100.0	22592.9	100.0	22755.9	100.0
1981	23870.3	100.0	24433.2	100.0	23573.7	100.0	24205.1	100.0
1985	24715.2	100.0	25518.6	100.0	24258.3	100.0	25504.9	100.0

Table 9: Distribution of the Regional Populations by Age Group in 1985 under the four Hypotheses (%)

	Observed 1971	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
Atlantic					
0-14	32.7	21.2	24.6	24.8	28.4
15-24	20.6	19.3	18.6	18.4	17.6
25-39	16.2	27.7	26.5	26.7	25.5
40-64	22.4	21.7	20.7	20.8	19.8
65 +	8.0	10.1	9.7	9.2	8.8
Quebec					
0-14	29.5	20.5	21.9	21.8	25.8
15-24	19.6	17.1	16.8	16.8	15.9
25-39	20.0	27.2	26.7	26.6	25.3
40-64	24.3	26.6	26.1	26.2	24.8
65 +	6.6	8.6	8.4	8.6	8.1
Ontario					
0-14	29.3	21.2	23.4	22.9	26.7
15-24	17.6	17.6	17.1	17.0	16.2
25-39	19.2	25.5	24.8	24.2	23.0
40-64	25.7	26.4	25.6	26.2	25.0
65 +	8.1	9.3	9.0	9.6	9.1
Prairies					
0-14	30.8	20.5	23.4	23.5	27.1
15-24	18.5	18.3	17.7	17.7	16.8
25-39	17.3	25.7	24.8	24.9	23.7
40-64	24.8	24.5	23.7	23.6	22.5
65 +	8.6	10.9	10.5	10.3	9.8
British Columbia					
0-14	28.5	21.0	23.0	22.1	25.8
15-24	17.4	17.2	16.8	16.7	15.9
25-39	19.4	25.4	24.8	24.0	22.9
40-64	25.8	26.6	25.9	26.5	25.3
65 +	8.9	9.7	9.5	10.7	10.2

Table 9 (Cont'd): Distribution of the Regional Populations by Age Group in 1985 under the four Hypothesis (%)

Canada	Observed 1971	Hypothesis 1	Hypothesis 2	Hypothesis 3	Hypothesis 4
0-14	29.8	20.9	23.1	22.8	26.6
15-24	18.6	17.7	17.2	17.2	16.3
25-39	18.9	26.2	25.5	25.2	24.0
40-64	24.9	25.8	25.1	25.3	24.0
65+	7.8	9.5	9.2	9.5	9.0

Table 10: Projection of the Regional Civilian Population 14 Years and Over ('000)

	Hypothesis 1		Hypothesis 2		Hypothesis 3		Hypothesis 4	
	Primary[1]	Secondary	Primary	Secondary	Primary	Secondary	Primary	Secondary
Atlantic								
1971	283	1127	283	1127	283	1127	283	1127
1976	318	1233	318	1233	318	1256	318	1256
1981	364	1302	365	1303	391	1350	391	1350
1985	408	1300	409	1301	447	1370	447	1370
Quebec								
1971	1084	3292	1084	3292	1084	3292	1084	3292
1976	1211	3670	1211	3672	1199	3651	1199	3651
1981	1346	3932	1349	3937	1322	3891	1322	3891
1985	1474	3983	1480	3992	1439	3922	1439	3922
Ontario								
1971	1410	4111	1410	4111	1410	4111	1410	4111
1976	1569	4635	1571	4638	1506	4506	1506	4506
1981	1741	5102	1748	5115	1606	4829	1606	4829
1985	1912	5339	1926	5366	1715	4937	1715	4937
Prairies								
1971	567	1882	567	1882	567	1882	567	1882
1976	609	2076	609	2077	620	2097	620	2097
1981	671	2206	673	2209	694	2250	694	2250
1985	729	2234	733	2240	763	2300	763	2300
British Columbia								
1971	419	1166	419	1166	419	1166	419	1166
1976	485	1351	485	1352	444	1279	444	1279
1981	557	1512	558	1515	470	1361	470	1361
1985	623	1614	626	1619	497	1390	497	1390
Canada								
1971	3764	11577	3764	11577	3764	11577	3764	11577
1976	4192	12965	4195	12971	4100	12788	4100	12788
1981	4680	14054	4693	14079	4483	13681	4483	13681
1985	5147	14470	5173	14519	4861	13919	4861	13919

1 Primary refers to male population aged 29-54, secondary to all other civilian population 14 years and over.

5. - Concluding Comments

The demographic sub-model of CANDIDE-R includes approximately 300 equations in Blocks 22, 47 and 48. The population algorithm is designed to calculate the population for 28 age-sex groups per region using the components of demographic growth, that is births deaths and net regional migration as explanatory variables. In general, the age-sex groups represent 5-year cohorts. The total population, and national population by age group are obtained by summing regional projections. The only exogenous variables directly related to the algorithm are the five regional fertility rates and the population of the Yukon and North West Territories. Net migration flows are endogenously determined in Block 49 of CANDIDE-R.

Since the age distribution of the migrating population is substantially different from that of the stable population, it seemed essential to specify the population model in such a way as to break down immigration flows into the appropriate age-sex groups. This allows us to keep track of the compositional effects caused by migration flows. The overall age-sex breakdown also allows us to measure the compositional effects through time due to the aging of the post-war generation, and the sharp drop in the birth rate during the 1960's.

The results obtained to date demonstrate the precision of the model and the sensitivity of its projections to compositional effects outside of the sample period, allowing detailed analysis of the effects of a broad range of changes in regional population growth.