WP. 8 (draft only)
3 October 2007

ENGLISH ONLY

UNITED NATIONS STATISTICAL COMMISSION and ECONOMIC COMMISSION FOR EUROPE

STATISTICAL OFFICE OF THE EUROPEAN COMMUNITIES (EUROSTAT)

CONFERENCE OF EUROPEAN STATISTICIANS

Joint Eurostat/UNECE Work Session on Demographic Projections
(Bucharest, 10-12 October 2007)

Agenda item 8: Specific projection issues

PROJECTING ETHNO-CULTURAL DIVERSITY OF THE CANADIAN POPULATION USING A MICROSIMULATION APPROACH

Invited Paper
(Under revision/Not to be quoted)

Submitted by Statistics Canada [1]

Abstract:

Sustained immigration from non-European countries over the last decades has contributed to an increase in the ethnocultural composition of the Canadian population. From census to census, we observe an increase in the number and proportion of people belonging to ethnic, religious or linguistic minorities. These changes have many implications, for example, in terms of social cohesion, racial and religious discrimination, labour market integration or social services. In this context, Statistics Canada developed a microsimulation model to project the ethnocultural composition of the Canadian population.

The model allows the projection of several dimensions of the population such as its ethnic, religious, foreign-born and linguistic characteristics. Contrary to the traditional approach which would have supposed a set of derived projections, one for each ethnocultural dimension, the results of our model are consistent among themselves. A multistate approach, on the other hand, was not possible given the number of characteristics projected and the size of the matrix required to do so.

The model takes as its starting point the 2001 Census complete microdata file (20 % sample). It uses a Monte Carlo process and the probabilities associated with each possible event to project the population according to a set of assumptions related to the components of population growth and the differential in demographic behaviours of subgroups. Development of the model required analysis of other data sources, such as surveys and vital statistics, to estimate

---

[1] Prepared by Alain Bélanger, Institut national de la recherche scientifique (Alain Bélanger was a Statistics Canada employee when the projection model was developed), Éric Caron Malenfant, Laurent Martel and René Gélinas.

its parameters, including differential demographic behaviours and intergenerational transfers of some of the characteristics.

Key results of the projections show that the ethno-cultural minorities would grow at a much faster pace than the rest of the population and would comprise most of the Canadian demographic growth until 2031. As a result, the share of the ethno-cultural minority groups in the population would continue to increase and more than one out of four Canadians would belong to a "visible minority group" by 2031. Ethnocultural diversity would continue to concentrate in the largest urban centers of the country, Toronto, Montreal and Vancouver. In Toronto for example, it is expected that 60% of the population will be foreign-born by 2031.

Introduction

Sustained immigration from non-European countries for over 15 years has increased Canada's cultural diversity, and is still doing so. The 2001 Census showed an increase in the numbers and proportions of immigrants, people belonging to visible minorities, allophones and people whose religion is non Christian (Statistics Canada, 2002, 2003a and 2003b). Canada's ethno-cultural makeup, especially in large urban areas, is changing rapidly, bringing political decision-makers to deal with a number of challenges, particularly in the areas of urban development, labour market integration, health and social services, and public institutions.

Differentials in demographic behaviours and settlement patterns (at time of arrival as well as after) of the newcomers tend to speed up the process of change. In particular, recent immigrants to Canada tend to show higher fertility, lower mortality because of the selection effect, and above all a much higher concentration in the largest metropolitan areas than the Canadian-born population. Immigrants' internal migration behaviours further intensify this concentration. This transformation may continue for the medium and long term if current trends are maintained in the forthcoming years. This paper is an attempt to chart some of these future transformations in terms of visible minority status[2], religious denomination, mother tongue and regional distribution under several scenarios of change through micro-simulation modeling. This paper should be viewed as a supplement to a report published by Statistics Canada in 2005 and titled *Population projections of visible minority groups, Canada, provinces and regions 2001-2017* (Bélanger and Caron Malenfant 2005).

The next section of the paper first explains why a microsimulation model was developed rather than using a more traditional approach such as the cohort component or the multistate projection models. It then describes PopSim, a microsimulation model specifically developed to realize these projections, its method, parameters and assumptions. It is followed by a brief analysis of the projections' key results for some of the projected characteristics. The paper concludes with a description of future developments planned for PopSim.

[2] Visible minority groups are defined according to the Canadian Employment Equity Act. Under this Act, members of visible minorities are "persons, other than Aboriginal persons, who are non-Caucasian in race and non-white in colour". The ten specific groups designated by the Act are: Chinese, South Asian, Black, Filipino, Latin-American, South East Asian, Arab, West Asian, Korean and Japanese, excluding thus all Aboriginal peoples and Whites. A question on visible minority groups (self-declared) has been asked in the five-year Canadian census since 1996.

Data and method

The increasing diversity in the origins of Canadian immigrants is expressed in various dimensions. Thus, to paint a portrait of the Canadian diversity in 2031 requires the simultaneous projection of a large number of individual characteristics: age, sex, place of residence, visible minority group, religious denomination, mother tongue, age at immigration, period of immigration. The traditional cohort component or the multistate projection models are not suited to the large number of characteristics needed to be projected.

Taking only one of these dimensions, let's say belonging to a visible minority group, using the cohort component method to project the future ethnic diversity of the population would necessitate projecting separately each of the 10 visible minority groups and adding the results of each of these sub-projections to another separate projection for the rest of the population to get the total. Each of these projections would have its own set of assumptions for fertility, mortality and migration to try to take into account some of the group's differentials in their demographic behaviors. From this base, prevalence rates or another distribution function could be applied to derive population numbers by religious denominations or mother tongue in a manner similar to the application of headship rates in household projections. Keeping track of age at immigration or period of immigration would generate even greater difficulties without providing satisfying results. In any case, such an approach would share the limitations of this cell-based methodology: homogeneity and stationarity. In addition, results are likely to be inconsistent with each other as they will come from separate derived projections.

Using a more dynamic approach such as the multistate population projection model would rapidly turn out to be unmanageable given the size of the matrix needed to simultaneously project all possible transitions. In the case of the projections realized for this project, the transition matrix would have had to count billions of cells. Clearly, another projection model had to be developed. Using a Monte Carlo process and the probabilities associated with each possible event, we can develop such a model through microsimulation. Microsimulation enables us to model complex demographic behaviors in a consistent and flexible way (Nelissen, 1991). The microsimulation model has several theoretical advantages over traditional projection models: 1) it can project a large number of characteristics simultaneously; 2) it allows for differentials in behaviors and thus can take into account theoretical as well as past empirical findings in regards to fertility, mortality and migration differentials in the estimation of the projection parameters, and 3) it accounts for changes in population composition over the projected period.
This is why we developed **PopSim**, a Canadian, dynamic, continuous time, longitudinal, event based, open, stochastic (Monte Carlo) spatial microsimulation projection model. PopSim is:

- dynamic as opposed to static in the sense that population aging and growth are the result of a life-cycle behavioral model applied at the micro- level, while in a static model, population aging and growth are usually performed by re-weighting the initial database using exogenous information (usually, cell-based demographic projections);
- continuous time as opposed to discrete time;
- longitudinal as opposed to cross-sectional in the sense that the model simulates the entire life course of an individual until death or the projection horizon before starting a new case, while a cross-sectional model simulates the entire population over one time period (usually one year) and then moves to the next time period.
- event-based as opposed to time-based in the sense that individual characteristics as well as time are incremented conditionally to the outcome of other modules while time-based models

implement modules following a predetermined order (e.g., fertility before mortality or vice-versa);
- open as opposed to closed in the sense that the model allows for new individuals to enter the projected population through birth or immigration or to leave the population through death or emigration;
- spatial as opposed to single region (national) model in the sense that the model explicitly simulates internal migrations between (currently) 29 Canadian metropolitan and non-metropolitan regions.

The advantages of such a design are that its dynamic and open features explicitly account for changes in population composition over the projected period. Its continuous time event based approach is the best way to deal with competing risks as it does not request to specify the order in which the specific events have to occur, as is the case in discrete-time, time driven simulation models. Finally, its spatial feature allows for spatial analysis of the consequences of immigration, a key element of policy analysis in ethnic diversity and immigration studies.
Another advantage of PopSim is that it is designed so that it does not have to deal with the problem of the lack of robustness of the results encountered when the parameters are estimated from surveys with small samples and large variances (Caldwell, 1983) or when the limited sample size of the simulated population increases the Monte Carlo variance. PopSim doesn't face these limitations because it simulates the future life cycle of all the respondents to the 2001 Canadian census long form. The starting database contains therefore about 20% of the Canadian population or about 6 million records reducing the Monte Carlo variance to negligible proportions. In addition, to reducing the parameter's variance for most of the demographic modules, PopSim used vital statistics and census data to estimate the base risk or the probability of the occurrence of an event.

In the case of fertility, as an example, the base risk is computed from vital statistics and is entered as input into the microsimulation model in the form of a probability (of having a child) table by age and parity. The base risk of a given individual woman is then increased or decreased according to her characteristics: age, parity, marital status, area of residence, immigrant status and length of residence in Canada, visible minority group and religious denomination. The parameters of this equation are obtained from a logistic regression performed on the full census. This approach also allows for scenarios to be built in a manner similar to the traditional cohort-component projection model. For example the base risk of the reference scenario corresponds to a total fertility rate of 1.5 children per woman. Increasing this base risk by 20% is equivalent to assuming an increase in future fertility to 1.8 children per woman.

Figure 1 contains a diagram of the projection model used[3]. As in the traditional model, the population at time t+1 results from the demographic changes that affected the population during the previous year. In the model used, an individual can change marital status, bear a child, move to another area of residence, die or emigrate to another country. A number of new individuals are also added over time by birth or by immigration.

For each component of population change (except immigration) and for each individual, we calculate the probability that one of these events will occur on the basis of the individual's

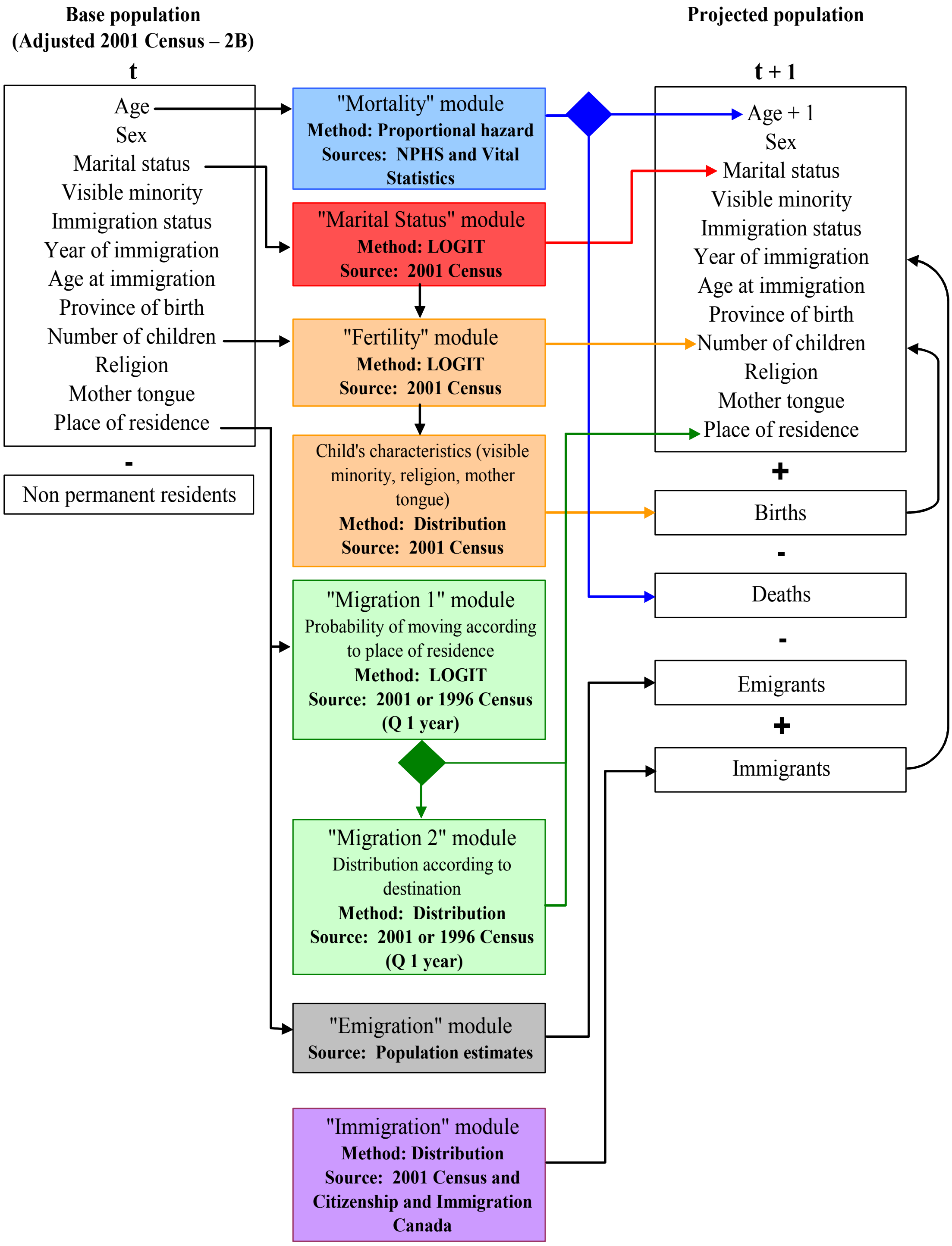
[3] This is a schematic representation since the model is actually continuous in time and event based. However the figure captures in a single image all the methods and sources used to estimate the microsimulation model's parameters.

specific characteristics. We can thereby take into account the differential behavior of each individual based on his/her characteristics; for example, the risk of giving birth to a child will vary depending on whether the woman is a recent immigrant, belongs to a visible minority group or some other group, and so on.

Using a Monte Carlo process and the probabilities associated with each possible event, we can determine which event will occur first and compute the amount of time that will elapse before it occurs, thus moving each individual forward through time until he/she dies or reaches the projection horizon. Whenever an event occurs (including an anniversary) a characteristic of the simulated individual changes, the probabilities of all possible events are estimated again using the updated individual's characteristics and the potential events are reordered.

The rest of this section summarizes the approach taken for each component of population change. As shown in Figure 1, the model is composed of six modules, each one representing a demographic component. The parameters of the microsimulation model, particularly for the estimation of relative risks, were generally computed using logistic regressions, usually based on the 2B sample from the 2001 Census, or proportional risk regressions based on longitudinal data. To reduce the variability of the results, we used vital statistics to estimate the base risk for fertility and mortality.

Figure 1. Schematic representation of the population microsimulation model{tc "Figure 1. Schematic representation of the population microsimulation model"}



Fertility has a direct impact on the population's size and age structure. Moreover, given that there is differential fertility by immigration status and duration of residence in Canada (Bélanger and Gilbert, 2003), between visible minority groups (Caron-Malenfant E. and A. Bélanger, 2006) and between religious groups (McQuillan, 2004), and given that each group's share of the total population will vary, differential fertility is an important factor in the future evolution of the population's composition. To fully take its effect into account, the modelled probability of having a child depends on the mother's age, parity, marital status, area of residence, immigrant status and length of residence in Canada, visible minority group and religious denomination.

Analysis showed, in part, that women who were recent immigrants were more fertile than other women and that Black, Arab and Filipino women had a greater probability than other women of having a child, particularly at high parities. In contrast, women who belonged to the Chinese, Korean, Japanese and West Asian visible minority groups had lower relative risks (Caron-Malenfant and Bélanger, 2006). The model takes all of these differentials into account.

The fertility module has a submodule that assigns characteristics to newborns and takes account of the intergenerational transfer of selected characteristics. For a number of characteristics, such as region of residence, the mother's characteristic is assigned to the child, but because of interethnic marriages, for example, newborns do not necessarily have the same visible minority group, religious denomination or mother tongue characteristics as their mother. In this model, intergenerational transfers of mother tongue depend on the mother's mother tongue, immigrant status and area of residence; transfers of visible minority group depend on the mother's immigrant status and visible minority group; and religious denomination transfers are influenced solely by the mother's religious denomination. Those transfers of the ethnocultural characteristics are based on transition matrices computed with census data. Finally, the child's sex is assigned to ensure that, overall, the sex ratio at birth is maintained.

A number of studies have shown that immigrants have lower mortality than native-born Canadians (Ng. and all., 2005; Chen and all., 1996; Trovato, 1985). Their higher life expectancy is generally attributed to a selection effect, since landed immigrants are required to undergo a medical examination before they arrive in Canada. In the projection model, the risk of dying varies with immigrant status and length of residence in Canada, the latter variable reflecting the fact that the selection effect fades over time. Survivorship proportions for the projected period were estimated by combining the relative risks based on National Population Health Survey (NPHS) data with projected age-, sex- and province-specific death rates projected using Li and Lee (2005) mortality forecasting model.

The marital status transition module essentially creates an intermediate variable that provides a better estimate of fertility and, indirectly, internal migration, phenomena that are strongly affected by family composition. Three marital statuses were used: married, common-law and not in a union. Since transition probabilities for this component cannot be estimated from the census, multinomial logistic regressions were used to estimate parameters for redistributing the population according to the above statuses. In the model, the probability of being in one of the three statuses varies with age, the number of children at home, immigrant status and length of residence in Canada, visible minority group and area of residence. The marital situation of each individual is reassessed on the basis of how these characteristics have changed on each anniversary. This approach does not provide coherent marital histories for individuals, but it yields a plausible distribution of the population by marital status at least in the short term. Since marital status is merely an intermediate variable used to estimate fertility, this approach is considered satisfactory, but may necessitate improvements in future developments of the model. The development of a full marriage market module would also have advantages for the analysis of interethnic marriages, the second generation of immigrants and the occurrence of multiple ethnic origins.

Internal migration has little effect on the total size of the population at the national level, but it is one of the two components, international migration being the other, that have the greatest impact on the population's geographic distribution. A number of studies have shown that immigrants and non-immigrants exhibit differential behaviors with regard to the probability of internal out-migration and the choice of destination (Newbold, 1996).

Our analysis of census data has shown that immigrants were less likely to migrate than native-born Canadians if they were living in one of Canada's large metropolitan areas (Toronto, Vancouver and Montreal) and more likely to do so if they were living outside those areas. It also revealed important differences between visible minority groups by area of origin. To take this differential migration into account, the migration module first estimates the specific probability of out-migrating for each individual by region of origin, age group, sex, presence of children in the family, visible minority status, mother tongue, place of birth and length of residence in Canada. Then a second module allocates a new region of residence (destination) to out-migrants on the basis of region of origin, their age group, visible minority status, mother tongue and place of birth.

The projection model sets the annual numbers of immigrants and assigns them individual characteristics (age, sex, area of residence, visible minority group, religious denomination, etc.) based on the characteristics of recent immigrants enumerated in the census. The immigration module's parameters can be defined so that the characteristics of future immigrants will be representative of the characteristics of immigrants who arrived during an earlier period, or so that the proportion of each visible minority group will be predetermined.

Lastly, the projections must consider not only the arrival of new immigrants, but also the departure of emigrants. The propensity to leave the country is related to the immigrant status and duration of residence in Canada (Michalowski, 1991). Accordingly, the emigration module uses annual emigration rates by sex and year of age for each province or territory as the base risk to which a parameter that takes into account the higher propensity to leave the country of recent immigrants' is applied.

The projection program is written using MODGEN, a microsimulation modeling language developed at Statistics Canada, based on C^{++} and freely available[4].

Assumptions and scenarios

As is generally done in a traditional population projection exercise, various scenarios were developed from a series of assumptions about the evolution of the components of population growth. The report from which this paper is a supplement (Bélanger and Caron-Malenfant, 2005) compares results from five different scenarios with varying fertility, immigration and internal migration assumptions. However, for the sake of brevity, results from only one scenario are presented in this paper in order to give an example of what PopSim can

---

[4] Information on MODGEN is available on the Statistics Canada's web site at www.statcan.ca.

generate as outputs[5]. This scenario is similar to the reference scenario of the original publication. However, it differs from it in a few aspects.

First, the horizon is longer. The 2005 report projected the ethnocultural composition of the Canadian population to the year 2017, in this paper the horizon is the year 2031.

Second, immigration levels are higher than in the previous reference scenario. Rather than a fixed number of immigrants, we assumed a fixed immigration rate of 7.0 per thousand, the average immigration rate observed during the 1990-2005 period. Although immigration rates were relatively stable in Canada during that 15 years period, past evolution of immigration levels shows that a reversal of trends can be both sudden and sizable. In addition, Canada could increasingly be looking at immigration to lessen some consequences of the inevitable aging of its population. Canada is one of the countries where the baby-boom was the most pronounced. The first baby-boom cohorts are now reaching the age of retirement or, at least, ages where we observe reduced labour force participation. Immigration can be part of the solution to the projected increase in the labour force demand resulting from the increasing number of persons withdrawing from the labour market. As the Canadian population presents a positive growth rate during the projection period, we therefore assume that the number of immigrants increases across time from about 235,000 at the start of the projection to about 280,000 in 2031.

The model is built to allow the formulation of different assumptions concerning characteristics of future immigrants. In view of the specific objectives of these projections, immigration level has to be considered together with a set of sociocultural and geographic characteristics, including the immigrant population composition by visible minority group. The model is built in such a way that the user can choose to let the characteristics of new immigrants reflect the characteristics of immigrants landed during a given period in the past, or the user can specify the future proportion of immigrants in each of the visible minority groups. In the scenario used in this paper, new immigrants are randomly chosen from the Census data base among those who landed in Canada during the 1996-2001 period. As a group each new cohort of immigrants will show on average the characteristics (age at immigration, sex, place of residence, visible minority and religious denominations) of immigrants who landed in Canada during that period.

Thirdly, life expectancy at birth would reach 81.9 years for Canadian males and 86.0 years for Canadian females in 2031. This assumption is slightly more optimistic than the one used in the previous report, which assumed levels of 80.0 and 84.0 years in 2026 for males and females, respectively. However, the model does consider the differential mortality of the immigrant population. Analysis of NPHS data shows that immigrants who arrived within the last 10 years have a relative risk of dying of 0.35, which means that, all other things being equal, their death rate is a third that of the total population. Immigrants who arrived in Canada more than 10 years ago also have a lower relative risk than the total population, but the difference is not significant. The projections reflect the significant difference between recent immigrants and the rest of the population.

[5] Readers interested in the other scenarios can contact the authors of this paper or demography@statcan.ca. The other scenarios show similar results although of a different magnitude: higher immigration and higher fertility assumptions translate into higher population growth and ethnocultural diversity while it is the opposite with lower fertility and immigration assumptions.

Assumptions about fertility, internal migrations and marital status transitions are the same as in the 2005 report (Bélanger and Caron-Malenfant, 2005). In Canada, the total fertility rate has been fairly stable, around 1.5 children per women for a number of years (Bélanger, 2006) and the base risk estimated from the vital statistics reflects this level. While the total fertility rate is the same as the one used in the medium assumption of the most recent national, provincial and territorial projections (Bélanger, Martel and Caron-Malenfant, 2005), it should be noted that, unlike the latter, this projection model takes differential fertility into account. Analysis of 2001 Census data shows that, all other things being equal, women who immigrated in the previous 10 years were 19% more likely than other women to have borne a child during the year. This relative risk varies with birth order. When we take age, marital status, recent immigrant status, religion and place of residence into account, we find that, apart from Aboriginal women, who are a unique case, the most fertile women are those who reported belonging to the Black, Filipino or Arab visible minority groups (they were, respectively, 60%, 28% and 22% more likely than Whites to have a child under the age of 1 at home). Chinese, Korean, Japanese and West Asian women are the least fertile. Analysis of 1996 Census data produces very similar results regarding the effect that ethnocultural characteristics have on fertility. Our projections take these differential relative risks into account. As the population of the more fertile groups is likely to increase faster than the population of less fertile groups, their share of the population will also increase. Consequently, because of changes in population composition and differentials in fertility, the resulting total fertility rate at the national level can increase over time even if both the base risks and the parameters of fertility differentials remain constant.

Internal migration is a particularly important component for these projections since we are interested in the geographic distribution of visible minority persons. The assumption used is based on migration observed between 2000 and 2001 from the Census. Analyses of the probability of migrating and the destination of internal migration clearly indicate the importance of taking differential migration into account. For example, when the population is separated into groups defined by place of birth, we find that native-born Canadians who live outside their province of birth have the strongest propensity to migrate. Their probability of migrating is nearly three times that of Canadians who live in the province where they were born. They are also more mobile than very recent immigrants (those who arrived in Canada in the five years prior to the Census), who in turn are more mobile than other immigrants. Analysis of visible minority data also corroborates the assumption of differential migration for visible minority groups. Koreans are the most mobile, with a 40% greater chance of migrating than Whites, while Filipinos are the least mobile. With regard to choice of destination, it is worth noting that migrants who report belonging to a visible minority group are far more likely to move to Canada's largest urban centres (Toronto, Vancouver, Montreal, Ottawa, Hamilton and Calgary). About 65% of visible minority persons who change areas of residence move to one of these seven metropolitan areas, whereas 65% of Whites choose to settle elsewhere in Canada.

Demographic statistics indicate that total emigration is fairly stable in Canada, at around 50,000 a year on average over the last 15 years. It also has a relatively minor impact on projected population size, though the higher propensity of young adults to leave the country may have a slightly larger effect on the population's age structure. Furthermore, studies show that new immigrants are more likely to emigrate again, either back to their country of origin or to another destination, especially the United States. The projected emigration rates by sex, age and province of residence are the same as those used to produce the most recent projections for Canada, the provinces and territories (Bélanger, Martel and Caron-Malenfant, 2005). However, to reflect the higher propensity of immigrants to emigrate, the rates are multiplied by 2.4 for recent immigrants and by 0.67 for native-born Canadians, an estimate obtained from the Reverse Record Check study.

Results

Table 1 contains population figures for visible minorities and the rest of the population on January 1, 2001, and in 2031 based on the projection scenario described above and the percentage change in those populations over the period considered.

Table 1. Population[1] (in thousands), percentage distribution and growth rate by visible minority status, Canada, 2001 and 2031{tc "Table 2. Canadian population[1] in 2001 and 2017 (in thousands) and percentage changes by visible minority status and projection scenario"}

	2001		2031		
	Number	%	Number	%	Growth rate (per thousand)
Visible Minority	4,116	13,4	10,621	27,4	32.1
Rest of the population	26,616	86,6	28,165	72,6	1.9
Total	30,732	100,0	38,786	100,0	7.8

1. Excluding non permanent residents

The data show that under the scenario considered, Canada's visible minority population could be 10,621,000 in 2031, or 2.6 times larger than in 2001, when it was estimated at about 4,000,000. This increase in the population extends the upward trend that saw the visible minorities population go from 1.1 million in 1981 to 1.6 million in 1986, 2.5 million in 1991 and 3.2 million in 1996.[6]

The increase in the rest of the population would be much smaller. The population that does not report belonging to a visible minority group, estimated at 26,616,000, would rise to 28,165,000, an increase of about 6% in 30 years.

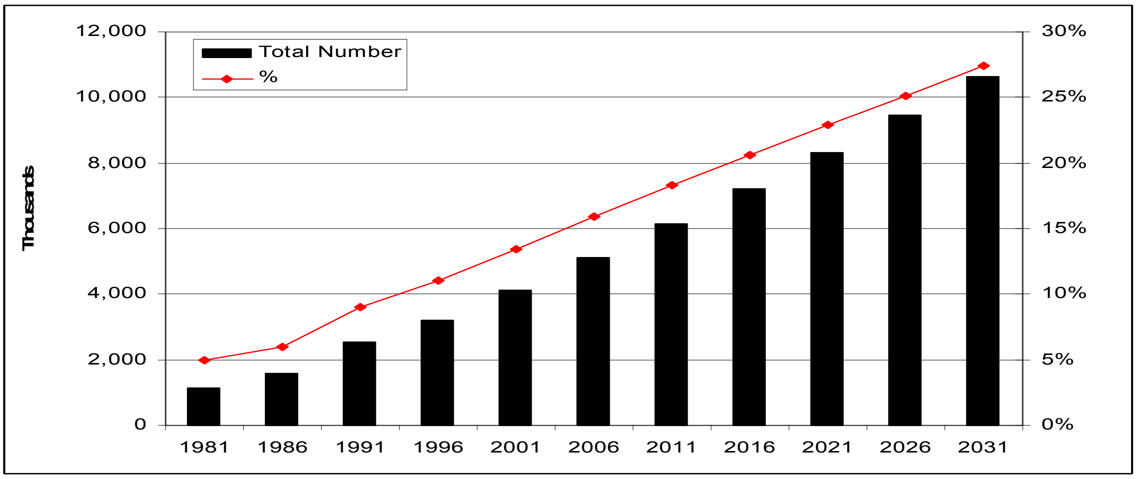
While the annual growth rate of the total population would be slightly lower than the current level, this would result from a dramatic differential in the growth rate of the two subpopulations. During the 30 years of the projected period, the visible minority could grow at an average rate of 32 per thousand a year while the rest of the population would grow at a pace 17 times slower at about 2 per thousand a year.

By the end of this differential growth in 2031, more than one person in four (27.4%) would be a member of a visible minority in Canada (see Figure 1). In 2001, 13% of respondents reported belonging to a visible minority as defined in the Employment Equity Act; this was already an increase over the 11% who did so when the question was introduced in the 1996 Census. In 1981, the proportion of persons belonging to the visible minority groups within the Canadian population was 4.7%.

---

[6] See the analysis that accompanied the release of 2001 Census data, at the following address: http://www.statcan.ca/english/census01/products/analytic/companion/etoimm/contents.cfm

Figure 1. Total number and proportion (%) of visible minorities observed (1981-2001) and projected (2001-2031) in Canada

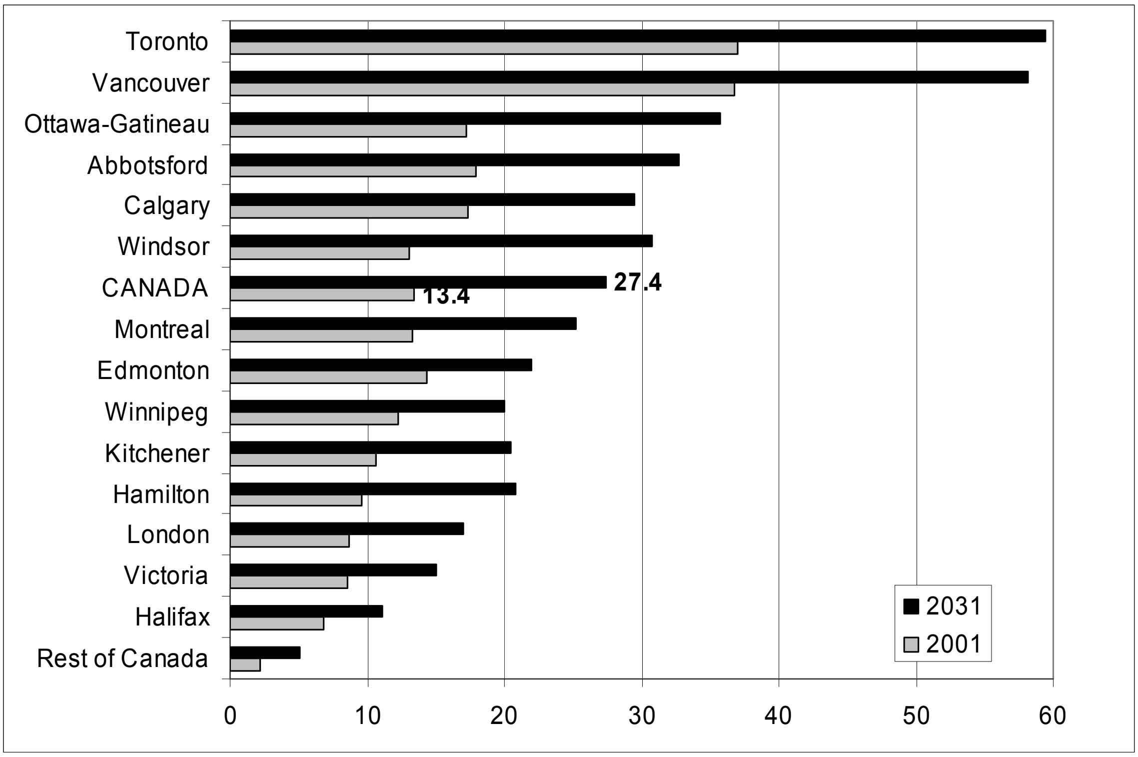


Among the factors that account for this more rapid growth in the visible minority population, the most important are unquestionably the sustained immigration and the high percentage of visible minority persons among the new arrivals in the scenarios developed for these projections. Other factors include a higher fertility and a younger age structure, which result in fewer deaths, and a higher life expectancy for visible minorities than for the rest of the population.

The data presented so far have shown that the evolution of Canada's ethnocultural diversity is particularly sensitive to immigration. Newly arrived immigrants are very selective in their destination choice when landing in the country and Canadian immigration is increasingly an urban phenomenon. More than 70% of the immigrants who came to Canada in the five years preceding the 2001 Census chose to settle in one of the country's three largest census metropolitan areas: Montreal, Toronto and Vancouver.

Figure 2 shows that if the current trends continue, the evolution of Canada's ethnocultural portrait will not take place uniformly across the country. It is worth noting which of Canada's major urban areas have particularly high concentrations. The visible minority population is heavily concentrated in a small number of metropolitan areas. According to these projections the six largest metropolitan areas - Toronto, Montreal, Vancouver, Ottawa-Gatineau, Calgary and Edmonton - will present large proportions of visible minorities among their population in 2031. More than 2 out of 5 of their residents would be a visible minority in 2031. The cases of Toronto and Vancouver warrant special attention since, in 2031, almost 60% of their respective population would belong to a visible minority group. In this scenario, Toronto would have a population of 8,056,000 including 4,788,000 visible minority persons and Vancouver would count 3,239,000 people among which 1,883,000 would belong to a visible minority group.

Figure 2. Proportion of visible minority population by selected regions, Canada 2001 and 2031.



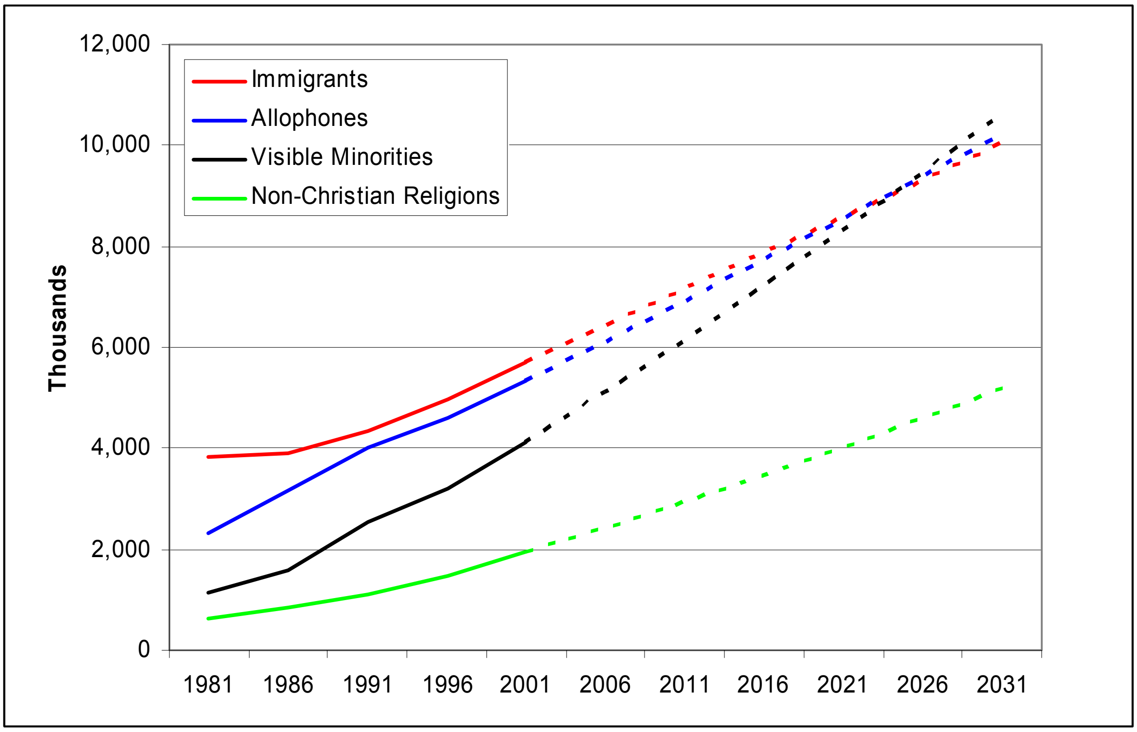
It is also interesting to note that some metropolitan areas such as Abbotsford, Windsor, Kitchener, Hamilton and London show a rapid increase in their proportion of visible minorities between 2001 and 2031, some of them doubling their 2001 proportions. This certainly results from a dissemination process of the visible minority population over time. These metropolitan areas are geographically close and economically linked to either Toronto or Vancouver, two of the largest points of entry for new immigrants.

However, the dissemination process might be much slower in other areas of the country. Under the scenario developed for these projections, the rest of the country, which is composed mostly of non-metropolitan areas, but also counts smaller metropolitan areas such as St.John's, Saint John, Regina and Saskatoon, would remain fairly homogeneous in its ethnic composition. The region titled "Rest of Canada" on figure 2 represented 46% of the total population in 2001 and 38% in 2031, but it would count only about 5% of its population in a visible minority group. Its population would also be growing at a much smaller pace, 0.1 % per year compared to 1.7% and 1.5% for Toronto and Vancouver, respectively.

These findings are not without policy relevance. Clearly, if the current trends continue, Canada might well be facing increasing demographic challenges in managing with areas that will be growing fast and will rapidly become more diverse while other regions will have to deal with the opposite problem of declining population, rapid aging, albeit with a more homogenous ethnic composition.

Figure 3 reveals other aspects of the transformation of Canada's ethnocultural landscape. The increasing importance of immigration as a component of population growth and the diversity in the countries of origin of new immigrants will also result in major changes in the number and proportion of foreign-born, of allophones (people whose mother tongue is neither English nor French) and of persons who are members of non Christian denominations. According to these projections, the number of immigrants would increase from 5,700,000 in 2001 to 10,042,000 in 2031 when they would represent nearly 26% of the total Canadian population compared to 18.5% in 2001. The number of allophones would grow faster as their number is projected to increase from 5,328,000 in 2001 to 10,247,000 in 2031 rising from 17.3% to 26.4% of the total population. Finally, the number of persons who are members of non Christian denominations would increase from 1,959,000 to 5,200,000 during the projected period with their share of the total population doubling from 6.4% in 2001 to 13.4% in 2031.

Figure 3. Population of visible minorities, immigrants, allophones and members of non-Christian religious denominations, Canada, 1981 to 2031.



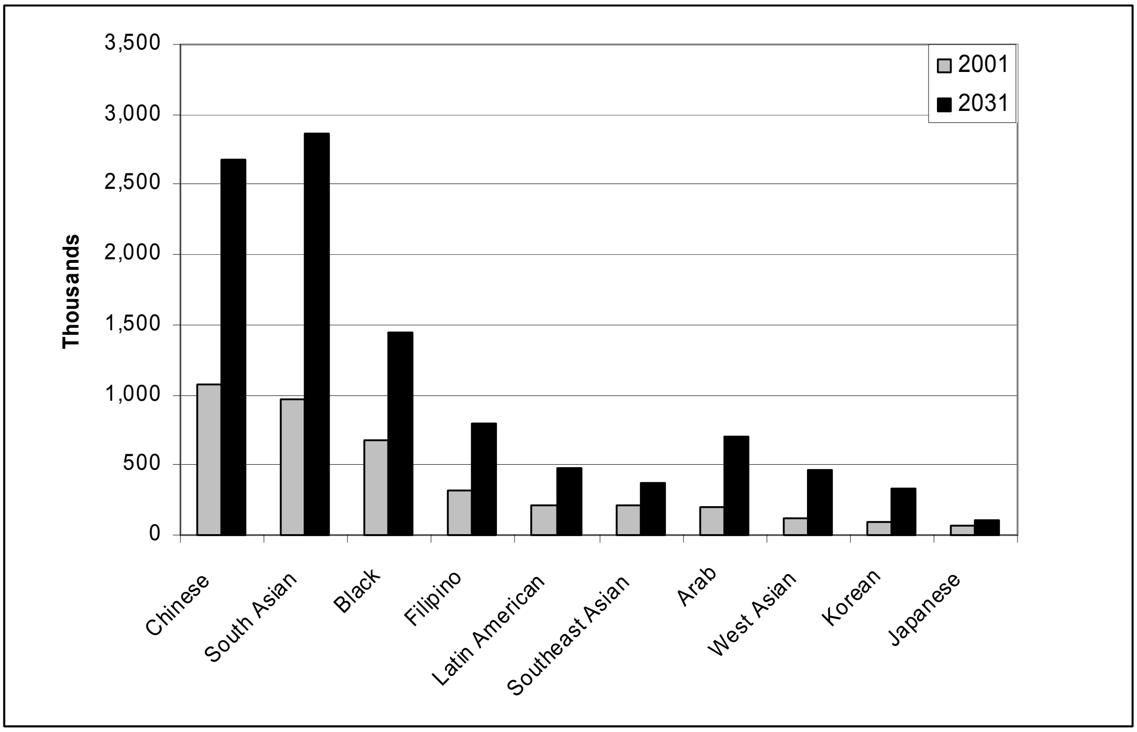
It is interesting to note that if in 2001 the number of immigrants was higher than the number of allophones or of persons belonging to a visible minority, in 2031 the number of immigrants would be lower than both, illustrating that projecting a single dimension of ethnocultural diversity is not sufficient to foresee the global changes to come. This is because past immigration was mostly from European countries with a large proportion coming from the United Kingdom. Immigrants who came prior to 1970 were therefore much more likely than newer immigrants to be non-visible (white), to have English as their mother tongue and to belong to a Christian religion. Increasingly, immigrants are coming from non-European countries and have ethnocultural characteristics that differ more from the characteristics of the majority. It is also due to the fact that in the model the visible minority group and the mother tongue can be transfered from the mother to their Canadian-born children, which, of course, is not the case for the immigrant status.

This will also have several policy implications as their integration into the Canadian labour market, as an example, might be more difficult than it was for former European immigrants, either because of discrimination based on their color or religious beliefs, or because of other factors such as reduced recognition of their academic credentials if they are from non-European or non-American countries, or because of lower proficiency in English or French.

It will also have consequences on urban planning. In places of rapid demographic and economic growth, land is scarce and expensive and it might become difficult to build new places of worship (Germain, 2004) or provide adapted sport and recreational facilities to a multiethnic population with different tastes and different needs (Poirier, Germain and Billette, 2006).

As noted earlier, the composition of cohorts of new immigrants as well as differentials in demographic behaviours, particularly fertility differentials between groups, could lead to differences in projected growth rates of subpopulations. PopSim also allows the users to analyse future changes in the ethnocultural composition of the population in more detail. Figure 4 shows the size of the various visible minority groups in 2001 and 2031.

Figure 4. Population by visible minority group, Canada, 2001 and 2031.



As in 2001, the South Asian and Chinese groups would be the largest in 2031 with 2.86 and 2.67 millions respectively, and together they would represent a little more than half (52%) of all visible minority persons.

They were already the largest groups in 2001, but their share of the total population was different then. While the Chinese group outnumbered the South Asian group in 2001, under this projection scenario, the latter may catch up to the former by 2031. As the South Asian group has higher fertility than the Chinese group and almost as big a share of immigration, the South Asian population would grow at a rate of 36.9 per thousand between 2001 and 2031 compared to a growth rate of 31.0 per thousand for the Chinese population.

After the South Asians and the Chinese, the two largest visible minority groups in 2031 would be the two groups who, all other things being equal, were among the most fertile[7] according to an analysis of the fertility of ethnocultural groups: the Blacks and the Filipinos. Immigration would also play a role in the two groups' population growth, as they fall just below the Chinese and South Asian groups in their share of annual immigration, at 7% and 6%, respectively. The Black population could reach 1,445,000 in 2031. In 2001, it was estimated at 681,000. The Filipino population, estimated at about 321,000 in 2001, would grow to 798,000 by 2031.

However, the visible minority groups that would grow fastest between now and 2031 are the West Asian, Arab and Korean groups, with annual growth rates of 47.3, 42.6 and 41.9 per thousand, respectively. At the horizon of the projection, under the scenario considered, there would be 697,000 Arabs, 457,000 West Asians[8] and 326,000 Koreans in Canada. With populations of 200,000, 114,000 and 95,000 respectively, these visible minority groups together made up about 10% of the Canadian visible minority population in 2001, but their overrepresentation among the immigrants who arrived during the period used to develop the immigration assumptions, if maintained until 2031, could raise their share of the total visible minority population to 14%.

Immigrants from different origins tend to settle in different locations when they land in Canada. Vancouver receives a larger proportion of Chinese immigrants, Toronto is the destination of choice of South Asians while Montreal attracts proportionaly more Blacks and Arabs.
Table 2 shows how the visible minority groups vary in their composition in the three largest metropolitan areas. In Toronto, South Asians outnumbered Chinese in 2031 by more than 50%, while in Vancouver, Chinese are by far the most populous visible minority group more than doubling the size of the South Asian group, the second in importance. Montreal presents a more diversified portrait with both Chinese and South Asian groups smaller in population than the Black and Arab groups.

---

[7] Excluding Aboriginals, who are not considered a visible minority group.
[8] Most West Asians born outside Canada are natives of Iran and Afghanistan.

Table 2. Population[1] (in thousands) by region of residence and visible minority group, Canada, 2001 and 2031.

	Montréal		Toronto		Vancouver		Rest of Canada	
	2001	2031	2001	2031	2001	2031	2001	2031
Total - visible minorities	461.3	1,084.4	1,788.7	4,787.7	754.6	1,883.2	1,111.3	2,865.8
Chinese	53.5	142.9	428.2	1,071.0	359.2	875.8	229.8	585.6
South Asian	57.1	133.5	501.8	1,634.5	174.3	393.6	230.8	700.2
Black	139.7	275.3	322.4	649.7	19.5	55.0	199.5	464.9
Filipino	18.2	45.7	140.1	344.1	60.0	176.0	102.8	231.8
Latin American	52.7	108.7	76.7	181.9	18.4	44.5	68.1	137.1
Southeast Asian	40.8	60.8	55.9	113.9	29.7	49.4	79.8	142.0
Arab	68.8	229.1	45.0	181.5	6.1	31.1	79.7	255.7
West Asian	11.7	37.7	56.0	232.9	22.6	88.4	24.1	98.5
Korean	3.5	10.2	42.0	128.9	26.1	84.9	23.4	101.8
Japanese	1.9	4.7	16.5	27.7	22.0	36.0	27.5	39.8
Others[2]	13.3	35.8	104.1	221.6	16.8	48.5	45.9	108.5
Rest of the population	3,018.6	3,213.1	3,045.1	3,268.0	1,295.6	1,356.3	19,256.8	20,327.3
Total	3,479.9	4,297.4	4,833.7	8,055.7	2,050.1	3,239.4	20,368.1	23,193.1

1. Excluding non-permanent residents.
2. Multiple visible minorities or not elsewhere identified.

This trend is likely to continue if new immigrants continue to establish themselves in the largest cities of the country. Results from the Longitudinal Survey of Immigrants to Canada (*The Daily*, September 4, 2003) are instructive concerning the possible reasons for new immigrants' choice of area of residence. According to the survey, 78% of newcomers "settled in areas where their network of friends and relatives lived." Among economic class immigrants who settled in Toronto, Montreal or Vancouver, the main reason for choosing their area of residence was that family members or friends were already living there. This reason ranks ahead of job prospects in all three areas.

Conclusion

These are only some of the results that can be generated from PopSim. As the unit of projection is the individual, the complete distribution of any of the projected population characteristics can be generated. Tables cross-tabulating any of the variables included in the model can therefore be easily created. Since the release of the Report in 2005 (Bélanger and Caron-Malenfant, 2005), Statistics Canada has received several demands for more detailed outputs from federal, provincial or municipal agencies and from academics. Results of these projections have proven to be useful for policy planning in several areas: city infrastructure, education and language formation needs, retirement and intergenerational challenges, labour market needs and changes, etc.

As useful as these projections can be, the model can be further developed to go beyond demographic modeling. This projection model is fairly detailed in its demographic components and takes into account theoretical as well as empirical findings regarding ethnocultural differentials in demographic behaviours. However, the benefits of a microsimulation model are not fully encompassed. The policy relevance of the projection results can be much enhanced with the addition of some socioeconomic dimensions to the model.

Ongoing developments will simulate the educational achievements and the labour force participation of the Canadian population. These developments are expected to increase the policy relevance of the projection results and also improve their accuracy. Both education and labour force participation of new immigrants and visible minority groups are the subject of important research initiatives looking at social cohesion and immigrant integration in Canada. In addition, education and labour force are important explanatory variables for fertility (Becker, 1960; Macunovich, 1996) and internal migration decisions, while life expectancy varies by education level. Including these variables into the model should improve the accuracy of the demographic projections.

Accuracy of the projections can also be improved by adding a module dealing with intragenerational transfers of religion. Currently, religious denomination is not allowed to change over the life time of an individual. Using data from the Ethnic Diversity Survey which contains information on an individual's religious affiliation at different ages will permit the introduction of changes in religion over the life cycle and thus enhance the policy relevance of the projections.

Bibliography

Becker, G. (1960). *An Economic Analysis of Fertility. Demographic and Economic Changes in Developed Countries*. Princeton University Press. 536 pages.

Bélanger,A. (2006). Report on the Demographic Situation in Canada, 2003-2004. Statistics Canada Cat. No. 91-209-XIE. 128 pages. http://www.statcan.ca/english/freepub/91-209-XIE/91-209-XIE2003000.pdf

Bélanger, A.,L. Martel and É. Caron Malenfant (2005). Population Projections for Canada, Provinces and Regions 2005-2031. Statistics Canada. Cat. No. 91-520-XWE. 214 pages. http://www.statcan.ca/english/freepub/91-520-XIE/0010591-520-XIE.htm

Bélanger, A. and É. Caron Malenfant (2005). Population Projections of Visible Minority Groups, Canada, Provinces and Regions 2001-2017. Statistics Canada.Cat. No. 91-541-XIE. 78 pages. http://www.statcan.ca/english/freepub/91-541-XIE/91-541-XIE2005001.pdf

Bélanger, A. and S. Gilbert (2003). The fertility of immigrant women and their Canadian-born daughters. in A.Bélanger (ed.), *Report on the Demographic Situation in Canada, 2002*, Ottawa : Statistics Canada, 135-161.

Caldwell, S.B. (1983). Modeling Demographic-Economic Interactions : Micro, Macro and Linked Micro/Macro Strategies. *Socio-Economic Planning Sciences* Vol. 17(5-6): 365-372

Caron Malenfant, É. and A. Bélanger (2006). The Fertility of Visible Minority Women in Canada. In A. Bélanger (ed.) Report on the Demographic Situation in Canada. Statistics Canada Cat. No. 91-209-XIE. Pp. 79-95.

Chen, J., Wilkins, R. & Ng, E. (1996). Life expectancy of Canada's immigrants from 1986 to 1991. *Health Report, 8*(3), 29-38.

Germain, A. (2004). Religious Diversity: A Problem for Municipalities?. *Our Diverse Cities* Vol. 1 (Spring):143-145.

Li, N. and R. Lee (2005). Coherent Mortality Forecast for a Group of Population. *Demography* 42(3): 575-594.

Macunovich, D.J. (1996). Relative Income and Price of Time: Exploring their Effects on US Fertility and Female Labor Force Participation, in Casterline, J.B. R.D.Lee and K.A.

Foote (Eds). Fertility in the United States: New Patterns, New Theories. *Population and Development Review*, Supplement to Volume 22: 223-257.

Michalowski, M. (1991). Foreign-born Canadian Emigrants and their Characteristics, 1981-1986. *International Migration Review* Vol. 25(1): 28-59.

Nelissen, J.H.M. (1991). Household and education projections by means of a microsimulation model. Economic Modelling. October 1991: 480-511.

Newbold, K. B. (1996). Internal migration of the foreign-born in Canada. *International Migration Review, 30*(3), 728-747.

Ng, E., Wilkins, R., Gendron, F. & Berthelot, J.-M. (2005). Dynamics of immigrants' health: Evidence from Canada, 1994-95 to 2002-03. *Canadian Studies in Population, 32*(1), 131-133.

Poirier, C., A. Germain and A. Billette, (2006). Diversity in Sports and Recreation: A Challenge or an Asset for the Municipalities of Greater Montreal. *Canadian Journal of Urban Research* 15(2): 28-49.

Rephann, T.J. and E. Holm (2004). Economic-Demographic Effects of Immigration: Results from a Dynamic Spatial Microsimulation Model. International Regional Science Review 27(4):379-410.

Statistics Canada (2002). *Profile of Languages in Canada: English, French and Many Others*. Census 2001 Analysis Series. Accessed at http://www12.statcan.ca/english/census01/Products/Analytic/companion/lang/contents.cfm

Statistics Canada (2003 a). *Canada's Ethnocultural Portrait: The Changing Mosaic.*Census 2001 Analysis Series. http://www12.statcan.ca/english/census01/products/analytic/companion/etoimm/contents.cfm

Statistics Canada (2003 b). *Religions in Canada*. Census 2001 Analysis Series. http://www12.statcan.ca/english/census01/Products/Analytic/companion/rel/contents.cfm

Trovato, F. (1985). Mortality differences among Canada's indigenous and foreign-born populations, 1951-1971. *Canadian Studies in Population, 12*(1), 49-80.