Microsimulation of language use at home in a multilingual region with high immigration

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Abstract

Québec is the second largest Canadian province and the only one with a French speaking majority. The province has a little under 8 million people, 79% of which having French as its mother tongue. Like many western countries, Québec is facing, in the coming decades, declining, and perhaps negative, natural increase and rapid population aging. Partly in response to those demographic challenges, Québec has increased its immigration intakes.

The composition of international immigration is increasingly diversified in its ethnocultural and linguistic characteristics. According to the 2006 census, 81% of the Québec population declared French as the language most often spoken at home, but this proportion reached 88% among its native born population and as low as 31% among its immigrant population.

New immigrants have to learn either one or both of French (official language at the provincial and federal level) and English (official language at the federal level) to fully integrate to the host society. In this context, their linguistic choices will have an increasing impact on the linguistic composition of Québec’s population, which is an important political issue. The aim of this paper is to build a dynamic model based on the Modgen microsimulation programming language. The model will include a module assessing language shifts over life course. Linguistic composition of the future Québec population will be projected up to 2051 for different scenarios. Stable populations will also be derived for all scenarios.
Introduction

Canada, which is an immigration country, has two official languages, French and English. English dominates the linguistic landscape of nine of its ten provinces. In one province, Québec, French speakers form the majority. Québec is the second largest province in Canada with an estimated population of 7.9 million. Although French and English are official languages at the national level, French is the only official language in the province of Québec. Nearly 80% of Québécois have French as their mother tongue and 88% of Québec native population speaks French most often at home. In contrast, in the rest of Canada, 75% have English as a mother tongue and 94% of the native population speaks English most often at home.

The Canadian linguistic landscape is in continuous change. In the past, the high fertility of the French Canadians somewhat compensated for the higher proportion of English speakers among the immigrants. Nowadays fertility is low among both English and French Canadians and about two thirds of the Canadian population growth is due to an increasingly diverse immigration. Between 2001 and 2006, Canada’s foreign-born population increased by 14% – four times faster than the growth rate of the Canadian-born population during the same period – and most immigrants have a mother tongue that is neither English nor French. Consequently the share of the Allophone population – those having a non-official language as a mother tongue – is growing rapidly: from 18% in 2001 to 20% in 2006.

In order to fully integrate to their host society, new immigrants have to learn either one of French and English, or both. Most immigrant Allophones living in English Canada will eventually learn and use English in their day to day activities. In Québec, the linguistic choice of immigrants is not so one-sided. French is not the sole option for immigrants as English is strong in Montréal where most immigrants establish themselves. English is quite attractive among newcomers as it benefits from its majority position in the rest of Canada (and America) and its well established institutions (education, health care, community, etc.). In addition, its attractiveness and status as a global language also plays a role in the fact that immigrants in Québec either know English prior to arrival or are motivated to learn it after immigration. Looking at statistics on knowledge of official languages in 2006, 87% of the Canadian immigrants living outside Québec declared that they knew only English as an official language and an additional 6 % knew both English and French, but about almost none of them (0.1%) declared knowing only French. In Québec, the corresponding figures show that 17% of the immigrants knew only English as an official language, 50% where bilingual and 27% knew only French.

In this context, linguistic choices of immigrants have an increasing impact on the linguistic composition of the Québec population. «Linguistic equilibrium» is an important social cohesion issue in Québec and one that has political implications at both the provincial and the federal levels. Citizenship and Immigration Canada, the federal department that regulates Canadian immigration, has recently created a program that favours French speakers immigration in provinces other than Québec. Although it is too soon to assess its success, this policy may be cited as the most recent initiative showing
federal efforts in maintaining the demographic weight of official language communities in Canada.

Most recent attempts to project linguistic composition of the population in Québec have used the traditional cohort-components population projection model (Termote 2008). Those projections did not take into consideration important factors such as the mother tongue, the immigrant generation status or the age at immigration, all of which are important variables in determining the risk of making a language shift.

More recently, a microsimulation model called Demosim (Bélanger and Caron Malenfant 2005, Caron-Malenfant and al. 2010) was used to project several dimensions of the ethnocultural composition of the future Canadian population, including the mother tongue. Unfortunately, Demosim does not include the language most often spoken at home, a variable that would have been a more informative measure of actual linguistic behaviour.

Although we do not question the general validity of the projections made by Termote, we believe that microsimulation should be the preferred tool to realise demolinguistic population projections for several reasons.

First, it allows for explicit consideration of all important factors that drive the future linguistic composition of the Canadian population. Fertility and internal migration differentials by place of birth or duration of residence in Canada are easily implemented. Some variables such as the probability of intragenerational language shift given the duration of residence can hardly, if not at all, be modeled in a multi-state model, whereas they are relatively easily included in a microsimulation model (Van Imhoff and Post, 1998). Intergenerational language shifts are easily implemented by using an origin-destination matrix between the mother’s mother tongue and the child’s mother tongue at birth. Language dynamics are complex phenomena and are best modeled using microsimulation.

Second, microsimulation can more easily projects multiple dimensions of the language profile of the population. The model we present in this paper, which includes mother tongue and language used most often at home, may be expanded to project other linguistic variables such as knowledge of official languages, language most often used in the workplace and, possibly, language used in the public space (which could be achieved using a multi-agents model).

Third, since most policy relevant variables are included in the model, microsimulation is better suited to the creation of scenarios that can illustrate the potential effects of policy changes. The model may be easily parameterised to realise virtual social experiments.
Objectives

The main objective of this paper is to develop a dynamic microsimulation population projection model to depict the future linguistic composition of the population of Québec and Canada. Currently, the model projects both the mother tongue and the language most often used at home and is conceived so that it may be expanded to encompass other linguistic dimensions such as knowledge of official languages and language used most often in the workplace.

The model allows for scenario building in order to investigate potential impacts of changes in differential demographic behaviours such as fertility, internal migration, and more importantly, given the importance of immigration as a component of population growth, changes in the linguistic composition of immigration. Consequently, this paper has the objective to investigate the impacts of different immigration and integration policies on the linguistic composition of the future population.

Definitions and Concepts

Since language dynamics is complex and multifaceted, one might get easily lost among the various linguistic characteristics and processes involved. This section aims at clarifying the vocabulary and concepts used throughout this paper.

The **mother tongue** refers to «the first language learned at home in childhood and still understood by the person at the time the data was collected»\(^1\). An individual having French or English as his/her mother tongue will be referred to as a **Francophone** or **Anglophone**, respectively. Individuals having a non-official language as their mother tongue will be denoted as **Allophones**\(^2\).

The **home language** is defined as the language most often spoken at home. Individuals using a language X at home will be called “speakers” or “users” of X. A person may or may not speak most often at home a language that is the same as his/her mother tongue.

The census questionnaire does not solicit but captures multiple declarations to questions related to language. As such, a person may declare having two mother tongues or speaking most often at home more than one language. Such multiple declarations were simplified by randomly retaining one of the indicated languages and dropping the other(s).

We have defined two types of language shifts. An **intergenerational language shift** occurs when a child has a mother tongue that is different from his/her mother’s mother tongue. Intergenerational language shifts are most common for children born in linguistically mixed unions. An **intragenerational language shift** occurs when an

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\(^1\) If the person no longer understands the first language learned, the mother tongue is the second language learned. This definition is the one used by Statistics Canada.

\(^2\) The prefix “allo” comes from Greek for “other”.
individual speaks most often at home a language that is different from his/her mother tongue.

Finally, Allophones may be further categorised in order to account for their proximity or affinity to French or English. For example, Allophones having a Latin language as a mother tongue, should they make a language shift, may be more prone to choose to speak French at home rather than English, particularly in Québec. Individuals having a Latin mother tongue, or a mother tongue that is spoken in former French colonies, will be called **Francotropes**\(^3\). Conversely, individuals having a Germanic mother tongue, or a mother tongue that is spoken in former English colonies, will be called **Anglotropes**. Some Allophones, Chinese as an example, may be neither Francotrope nor Anglotrope.

**Hermès, a microsimulation model of demolinguistic population projection**

The microsimulation model we developed is called *Hermès* in honour of the Greek god of communication\(^4\). *Hermès* is a dynamic, continuous-time case based model created using the Modgen generic microsimulation programming language. Modgen is being developed at Statistics Canada and is freely available on the agency’s web site.

Modgen, an extension of the C++ programming language, greatly facilitates the development of dynamic microsimulation models by the automatic management of event queues. It also includes an interface that allows for easy manipulation of parameter inputs and table outputs to create scenarios and export results into Excel spreadsheets.

In Modgen, dynamic microsimulation models are created by defining two functions for every single type of event. One function is used to specify the time of occurrence of the event, whereas the other function specifies the actions to be taken when the event actually occurs. For instance, in our model, a time function determines the moment at which a language shift occurs. Once the language shift has occurred, another function determines the destination language of the individual affected by this event. Modgen automatically takes care of the event loop to make the time progress in undefined time steps and changes individual attributes during the execution of the program. Modgen also automatically creates a new case when the event is the birth of a child.

The model developed for this paper is open to immigration, an important component of population change in Canada and undoubtedly the most important driving factor in the transformation of the Canadian linguistic composition. The model allows for individuals to migrate between Canadian provinces and is fully parameterised to allow for changes in level and, more importantly, in differential demographic behaviours between linguistic or immigrant groups.

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\(^3\) The suffix “trope” comes from the Greek *troypos* and means “turn” or “turning”. As an analogy, plants orienting towards the sun are called “heliotropes”.

\(^4\) *Hermès* is also the god of commerce.
Because we believe that immigration and language shifts are important factors influencing linguistic composition of the population, these two components are given particular importance in Hermès. The model user can make immigration vary in level; he can also control its linguistic composition and regional distribution using exogenous parameters as input to the model. Table 1 shows the linguistic composition (language spoken most often at home) of immigrants in the reference scenario for Québec and the rest of Canada.

Table 1: Distribution of recent immigrants according to language spoken most often at home, immigrants arrived between 1996 and 2001.

<table>
<thead>
<tr>
<th></th>
<th>Québec</th>
<th>ROC</th>
<th>Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td>English</td>
<td>12%</td>
<td>32.5%</td>
<td>29.7%</td>
</tr>
<tr>
<td>French</td>
<td>35.7%</td>
<td>0.9%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Others</td>
<td>52.3%</td>
<td>66.6%</td>
<td>64.8%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

A particular feature of the model is that it allows for both intergenerational and intragenerational language shifts. Thus, when a child is born in the fertility module of the model, his or her mother tongue can be different from his or her mother’s mother tongue. These intergenerational language shifts are set to depend on the mother’s mother tongue, her home language, her region of residence and her immigration status according to a user-predefined matrix of transitions estimated from census data. Table 2 below shows an example of such an intergenerational mother tongue transition matrix. Language shifts occur away from the diagonal.

Tableau 2: Example of a transition matrix for intergenerational mother tongue transmission, Québec immigrant mothers speaking French most often at home

<table>
<thead>
<tr>
<th></th>
<th>English</th>
<th>French</th>
<th>Others</th>
<th>Others</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mother</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>English</td>
<td>14%</td>
<td>86%</td>
<td>0%</td>
<td>100%</td>
</tr>
<tr>
<td>French</td>
<td>1%</td>
<td>96%</td>
<td>3%</td>
<td>100%</td>
</tr>
<tr>
<td>Others</td>
<td>1%</td>
<td>63%</td>
<td>36%</td>
<td>100%</td>
</tr>
</tbody>
</table>

At birth, a child home language is set to be equal to his/her mother tongue. However, during a simulation, individuals may start using at home a language that is different from their mother tongue, thus making an intragenerational language shift. These intragenerational language shifts are modeled in a manner that is similar to internal migration: first, the probability of occurrence of a language shift is used to determine its exact time of occurrence; the destination language is then determined from a “mother tongue to home language” matrix in a way that is similar to how a migrant’s destination is derived from an origin-destination matrix.
Unfortunately, no longitudinal data exists to estimate the age-specific probabilities of intragenerational language shifts. Previous attempts to estimate intragenerational language shifts used a cohort approach by comparing, in the same cohort, the number of French, English and third language speakers at two different points in time using two consecutive censuses. This method often provides unreliable results because language shifts constitutes fairly rare events and the estimates are therefore affected by differentials in net under enumeration by age and between censuses, and by imperfect estimation of emigration and deaths by linguistic groups. Moreover, this approach doesn’t take into account the immigration status, nor the duration since – or the age at – immigration.

We derived the probability of shifting to a home language that is different from one’s mother tongue from a single census using cross-tabulated data on mother tongue and home language by age or by duration since immigration. We plotted the percentage of individuals still speaking their mother tongue at home against their age, or, in the case of immigrants, against the number of years since arrival to Canada. The resulting fitted curves were treated as regular survival curves. Figure 1 below shows an example of the “persistence” (percentage of individuals still speaking their mother tongue at home) of Allophones from which the probabilities of intragenerational language shifts were derived. Different persistence curves were derived depending on the age at immigration.

![Persistence Curves](image)

**Figure 1:** Percentage of immigrants still speaking their mother tongue at home (persistence) with respect to the length of their stay in Canada. Immigrants were divided in three groups: those arrived at age 15 or before, those arrived between age 16 and 35 and finally those arrived at age 36 or after.

The age-specific transition probabilities are assumed to be equal to the fitted variation in the survival curve, which is equal to one minus the percentage of individuals who still use their mother tongue at home at a given time divided by the percentage that do so at the
previous time. In *Hermès*, these probabilities can vary by mother tongue (French, English or others), immigration status, age at immigration and region of residence.

When a language shift occurs, the model attributes a new home language to the simulated individual according to his/her characteristics: mother tongue, immigrant status and, for Allophones, the mother tongue affinity, or “tropism”, to English or French.

**Hypotheses and Scenarios**

All parameters were taken from Statistics Canada population projections (2005) or were derived from the census public use microdata files.

Total fertility rates were set to be around 1.5 at the national level. Age specific fertility rates were allowed to vary by province and by language spoken at home. Total fertility rates were held constant for the whole simulation and across scenarios.

Mortality rates were allowed to vary by age, sex and province of residence. We assumed that there was no differential mortality with respect to language spoken at home, mother tongue or immigration status. Age specific mortality rates were increased every year to allow life expectancy to increase according to recent trends. For men, life expectancy increases from 77.2 years at the beginning of the simulation to 81.9 years in 2031; for women, life expectancy goes from 82.2 to 86.0 years. Life expectancy was not allowed to increase further after 2031. Mortality rates were held constant across all scenarios.

Interprovincial migration rates were set according to recent trends and were allowed to vary with respect to age, sex and province. Interprovincial migration rates were also modulated according to the language most often spoken at home. In the model, individuals realise an interprovincial migration in two steps. First, the model calculates the time at which migration should occur. Second, once the time of occurrence is reached, a destination province is chosen according to an origin-destination matrix. Origin-destination matrices vary according to immigrant status and language spoken most often at home and were established according to recent trends. Language spoken most often at home is an important determinant of interprovincial migration. It is well established that English speakers in Québec have a higher risk of leaving the province whereas French speakers from the Rest of Canada show a stronger propensity to migrate to Québec. Interprovincial migration rates and origin-destination matrices were held constant for the whole simulation and across scenarios.

Emigration rates were set according to Statistics Canada’s estimates and were allowed to vary by age, sex and province. Emigration rates were also modulated according to the country of birth and the duration of residence of immigrants. Emigration rates were held constant for the whole simulation and across scenarios.

Immigration level and linguistic composition were varied in order to assess the impact of immigration policies on the demolinguistic composition of Canada. Six scenarios were
designed with respect to immigration. For brevity, all of them but one (CANFR) are described here using Québec’s parameters.

- Reference (REF): Québec’s annual immigration rates are approximately 0.55%\(^5\) of the total population. 36% percent of immigrants speak French at home and 17% are Francotropes.
- More immigration (MORE): Annual immigration rates are increased by approximately 20% compared to the reference scenario. This represents a rate of approximately 0.66% (or 0.85% at the national level).
- Mostly French immigration in Québec (FR): French speakers and Francotropes are increased by 50% in the immigrant population. In this scenario 50% of immigrants speak French at home (compared to 36% in the reference scenario) and 25% are Francotropes (compared to 17% in the reference scenario).
- Mostly English immigration in Québec (ENG): Linguistic composition of immigration in Québec is set to the national average (the average includes Québec). This significantly lowers the percentage of immigrants speaking French at home (from 36% to 6%) or that are Francotropes (from 17% to 8%).
- Higher French immigration in the rest of Canada (CANFR): Linguistic composition of immigration in the rest of Canada is set to the national average. This scenario multiply by more than five the number of French speaking immigrants arriving in provinces other than Québec. Linguistic composition of immigration in Québec is as in REF.
- No immigration scenario (NO IMM): Immigration rates are set to zero. This scenario is highly unrealistic and serves only the purpose of defining a baseline.

Absolute number of immigrants was not allowed to grow beyond the 2031 level, which approximates to 280 000 immigrants per year. Immigration level after 2031 was set to the 2031 absolute number of immigrants. Provincial distribution of immigrants was set constant for the whole simulation, with approximately 18% of all Canadian immigrants settling in Québec.

Intragenerational language shifts are modeled in a way akin to internal migration. First, the time of occurrence of a language shift is calculated. Once the language shift occurs, a destination language is randomly attributed according to an origin-destination matrix. The origin corresponds to the mother tongue of an individual and the destination refers to his/her new home language. Intragenerational language shifts rates are allowed to vary according to immigration status, age at immigration and mother tongue. Rates also vary according to age, for natives, or the number of years since immigration, for immigrants. Because of a lack of reliable estimates, multiple language shifts over life course are not allowed. Only individuals still speaking their mother tongue at home are at risk of making a language shift. Rates of language shift were assumed to be robust across time and were held constant for the whole simulation. Origin-destination matrices varied according to immigration status, province of residence and mother tongue.

\(^{5}\) The immigration rate of the province of Québec is lower than the national average which is 0.70%.
Origin-destination (mother tongue to home language) matrices of Allophone immigrants varied according to two scenarios.

- **Linguistic behaviour of old immigration (OLD IMM):** language shifts of Allophones in Québec are made according to the linguistic behaviour of immigration arrived before 1986. Immigrants arrived before 1986 in Québec showed a higher propensity to adopt English as the language most often spoken at home.

Intergenerational language shifts (non transmission of mother tongue from mother to child) was allowed to vary by immigration status, province of residence, mother tongue and language used at home by the mother. Origin-destination matrices were defined by comparing the mother tongue of the mother to the mother tongue of a child, 17 years old or less, still living at home. Intergenerational language shifts parameters were held constant across time and across all scenarios.
Table 3 below summarizes all the scenarios that were simulated for this paper.

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Immigration volume (Québec rate)</th>
<th>Linguistic composition of immigration</th>
<th>Language shifts</th>
</tr>
</thead>
<tbody>
<tr>
<td>REF</td>
<td>~0.55%</td>
<td>Recent trend</td>
<td>Recent trend</td>
</tr>
<tr>
<td>MORE</td>
<td>~0.66%</td>
<td>Recent trend</td>
<td>Recent trend</td>
</tr>
<tr>
<td>FR</td>
<td>~0.55%</td>
<td>50% more French speakers and Francotropes in Québec</td>
<td>Recent trend</td>
</tr>
<tr>
<td>MORE+FR</td>
<td>~0.66%</td>
<td>50% more French speakers and Francotropes in Québec</td>
<td>Recent trend</td>
</tr>
<tr>
<td>CANFR</td>
<td>~0.55%</td>
<td>More than five times the number of French speakers in the rest of Canada compared to REF</td>
<td>Recent trend</td>
</tr>
<tr>
<td>ENG</td>
<td>~0.55%</td>
<td>2.5 times more English in Québec compared to REF</td>
<td>Recent trend</td>
</tr>
<tr>
<td>OLD IMM</td>
<td>~0.55%</td>
<td>Recent trend</td>
<td>Behaviour of immigrants arrived in Québec before 1986</td>
</tr>
<tr>
<td>NO IMM</td>
<td>N/A</td>
<td>N/A</td>
<td>Recent trend</td>
</tr>
</tbody>
</table>
Results

Three indicators are calculated to illustrate the results of the projections of the linguistic composition of Québec and the rest of Canada (ROC). First, annual growth rates of French, English and third language speaker populations are presented for Québec and the ROC using results from the reference scenario. Then, the impact of variations 1) in the number of immigrants, 2) in their initial linguistic composition and/or 3) in their language shift behaviours were studied. The percentage of speakers using the region official language of the majority (French in Québec and English in the ROC) over all official language users was calculated and plotted for all scenarios. This latter indicator is interpreted as a measure of the majority language sustainability under different situations driven by parameters that can be influenced by immigration or linguistic integration policies. Finally, the linguistic distribution for a stable population is contrasted for the two regions and for all scenarios.

It is of particular interest here to contrast results for the two regions under study as one of them, Québec, is a truly multilingual region where two languages are competing, whereas English is preponderant in the rest of Canada. Although the country is officially bilingual and the province of Québec is officially French unilingual, in reality, the latter is the only region under study where English and French can coexist and are effectively in competition for users and resources.

Population annual growth rates by home language use
In the long run, third language speakers tend to adopt at home one of the two official languages in order to fully integrate to the host society. Heritage languages are seldom transmitted to descendants beyond one or two generations (Rumbaut, Massey and Bean, 2006; Turcotte, 2006; Bélanger, Sabourin and Lachapelle, 2010). Consequently, considering a period of high immigration of foreign language speakers such as the one Canada and Québec have been facing since the 1990’s, it is not surprising to observe fairly high initial annual growth rates of third language speakers that are declining rapidly over the projection period (figures 2 and 3). Although Québéc has an immigration rate slightly lower than the rest of the country, we note that the population annual growth rates of third language speakers are similar in both regions with initial growth rate of about 35 per thousand. In both regions, the evolution of these growth rates follow essentially the same linearly declining trend reaching about 10 per thousand in the rest of Canada and 15 per thousand in Québéc in 2050.

6 Actually, other Canadian regions such as the northeast of New-Brunswick or the North and Eastern parts of Ontario count sizeable French minorities. It would be of interest to study such regions in more details, but the PUMS files don’t allow for analysis of the situation at a finer geographical scale than the province. Future work using full Census data available in Statistics Canada’s Research Data Centers will permit a more detailed analysis.
Figure 2: Population annual growth rate of Québec

Figure 3: Population annual growth rate of Canada
Contrasting the trends in annual growth rates of French and English speakers is of greater interest. In both regions, the trends for majority and minority languages are following similar trends, that is a declining growth rate for the population using the majority language and more stable, albeit slightly declining, rates of growth for minority language speakers. This can be explained by fertility rates under replacement level that are not fully compensated by immigration and language shifts.

Although the trends are similar for majority and minority languages in both regions, the growth rate of French speakers is negative at around -10 per thousand over all the projection period in the rest of Canada and fall below zero in Québec between 2025 and 2030. In contrast, the growth rates of English speakers remain positive over all the projection period in both regions. Moreover, in Québec, after an initial period when growth rates of English and French speakers are similar at around 5 per thousand, they rapidly diverge, the French growth rate falling below zero while the English growth rate remaining slightly positive until 2050. Consequently, the number of French speakers is declining in both regions: rapidly and constantly in the rest of Canada and slowly after 2025 in Québec. In contrast, the number of English speakers is continuously increasing, although at a declining rate over the projection period.

**Majority language sustainability**

Figures 4 and 5 illustrate the consequences of projected population growth rates under different scenarios on the sustainability of the majority official language in each of the Québec and ROC regions. Under most scenarios, the strength of English as an official language used in the rest of Canada is almost invariably increasing from 97% of official language speakers in the beginning of the projection to about 98.5% of them in 2050. An increase of a little more than 1 point in percentage may appear rather small, but remains important for two reasons. First, it is clear that English does not suffer from competition with French in the rest of Canada, regardless of the size or composition of future immigration. The situation of French as a language used at home in English Canada, however, is decreasing. Not only is it already very low, but from this point of view, a variation of 1 percentage point represents a decline of more than a third of the initial share. Only in the CANFR scenario – in which the number of French speaking immigrants in the ROC was increased more than five-fold – does the proportion of French speakers increase.
Figure 4: Percentage of English speakers among speakers of official languages, Canada excluding Québec

Figure 5: Percentage of French speakers among speakers of official languages, province of Québec.
In contrast, all scenarios for the province of Québec show a decline over time in the percentage of French speakers among the users of an official language (see Figure 5). Important variations are also apparent in the trend of the indicator according to the different assumptions. In the scenario that projects the most current trend in terms of immigration level and composition as well as in terms of language shifts (reference scenario), the proportion of French declines from about 89% at the beginning of the projection to about 86% in 2050. Increasing immigration intakes while maintaining constant its linguistic composition and language shift behaviours would reduce this percentage in 2050 only slightly. Assuming that the language shift behaviours of older immigrants – most of which arrived before Bill 101 came into effect – would return, we would have almost twice the effect of an increased immigration. This demonstrates the relative importance of language shift behaviours in shaping the demolinguistic composition of the province. Nevertheless, both changes in immigration levels and changes in language shift behaviours appear to have small consequences compared to the linguistic composition of the annual immigration vector. Assuming that the linguistic composition of Québec’s immigration would be the same as the more English weighted national one, the proportion of French in Québec would decline fairly rapidly and reach 81% of official languages speakers in 2050.

On the other hand, increasing by 50% the share of French speakers or Francotropes in the future immigration generates the most favourable scenario for French sustainability in Québec. Under this scenario, the proportion of French speakers first increases very slightly and then declines by about 0.5% point below the initial level. A scenario assuming both an increase in the French share of future immigration and an increase in immigration volumes will produce essentially the same results, indicating that it isn’t so much the level of immigration that matters, but rather its linguistic composition. Interestingly, a scenario with no immigration would also produce very similar results, another indication that the most important factor to insure French language sustainability in Québec is to act upon the linguistic composition of its immigration.

**Stable equivalent population distributions**

The demolinguistic process under study can be treated as a semi-markovian process and stable equivalent population distributions can be obtained by projecting constant assumptions regarding all components of change over a long period of time. Previous works in multistate demographic modeling have shown that stable age structures are attained relatively rapidly, but that stable regional distributions take longer to be reached. It this model, whereas several dimensions are at play (fertility, internal migration, immigration and emigration, language shifts and duration of residence in Canada for immigrants), a 500 year projection period was necessary to reach stable state. Of course, projections over such a long term cannot, and should not, be taken as anything near prediction of the future. Rather, the stable equivalent population distributions that result from this process should be interpreted as a magnified portrait of the intrinsic demographic forces implied by the scenarios under study.

Table 4 below contrasts the initial linguistic composition of the population with the stable equivalent under the assumptions of various scenarios. In both regions, the stable non-official language share of the population represents about 25% of the total population, a
little more in the rest of Canada and a little less in Québec, where immigration rates are lower. The proportion of French speakers in Québec declines from 83% in the initial population to 60% in the stable equivalent population for the reference scenario. English, the minority language, increases from an initial 11% of the population to 16%, illustrating its attractiveness over the other languages.

<table>
<thead>
<tr>
<th>Scenarios</th>
<th>Québec</th>
<th>Rest of Canada</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>English</td>
<td>French</td>
</tr>
<tr>
<td>2002</td>
<td>10.5%</td>
<td>82.7%</td>
</tr>
<tr>
<td>REF</td>
<td>16.3%</td>
<td>59.7%</td>
</tr>
<tr>
<td>MORE</td>
<td>16.2%</td>
<td>59.8%</td>
</tr>
<tr>
<td>FR</td>
<td>13.1%</td>
<td>66.4%</td>
</tr>
<tr>
<td>MORE+FR</td>
<td>13.1%</td>
<td>66.4%</td>
</tr>
<tr>
<td>OLD IMM</td>
<td>18.6%</td>
<td>57.7%</td>
</tr>
<tr>
<td>ENG</td>
<td>26.0%</td>
<td>41.8%</td>
</tr>
<tr>
<td>CANFR</td>
<td>14.3%</td>
<td>64.0%</td>
</tr>
</tbody>
</table>

Table 4: Equivalent stable population linguistic distributions for all scenarios with immigration

In the rest of Canada, most scenarios yield similar results. French speakers only account for 0.5% to 0.7% of the equivalent stable population whereas English speakers represent about 74%. Only in the CANFR scenario does the French speaking minority reaches 1.7%, which is to be expected since the number of immigrants speaking French was significantly increased in this scenario. In all scenarios, the percentage of third language speakers stabilises around 25%.

In Québec, it is interesting to note that all equivalent stable populations show an increase in the percentage of English speakers. Even in the scenarios with a high number of French speaking immigrants (FR and MORE+FR), the percentage of English speakers increases from 10.5% to 13.1%.

In the long run, the effect of an increase in the rate of immigration wanes and only the effect of the linguistic composition of immigration is notable. Only the scenarios with an immigration more oriented towards French (FR, MORE+FR and CANFR) yield results showing a proportion of French speakers that is significantly larger than the reference scenario. Interestingly, the CANFR scenario is also favourable to French in Québec. Even though CANFR only involves increasing the number of French speakers among immigrants to the ROC, Québec benefits from this situation through interprovincial migration (recall that French users have a higher propensity to migrate to Québec).
The stable population for the OLD IMM scenario illustrates the long-term effects of English-oriented language shift behaviours in Québec. The proportion of French speakers in the stable population is two percentage points lower than in the reference scenario, whereas the proportion of English speakers is 2.3 percentage points higher. The negative impact of the OLD IMM scenario on the proportion of French speakers in Québec is somewhat smaller (in absolute value) than the positive impact of a more Francophone-oriented immigration, confirming again that the linguistic composition of immigration is an important factor in determining the demolinguistic landscape.

The ENG scenario yields the most dramatic effect. The proportion of French speakers in the stable population is only half of what it was in the initial population. Although the ENG scenario is highly unrealistic, it might be interpreted as the situation that would prevail in the absolute worst case scenario.

**Discussion and conclusion**

The linguistic projection model developed here is a prototype of a more elaborated model in development which will project additional linguistic dimensions such as knowledge of official languages and language used most often at work. The current model is based on initial populations and parameters estimated from the public use microdata files (PUMF), which have limitations not only in terms of number of simulated cases but more importantly regarding the number of categories that variables can have.

The most important limitation concerns the geography. PUMF files don’t provide all the information necessary to create an internal migration module at a finer geographic scale than the provinces. It is interesting to contrast Québec to the rest of the country at the provincial level, as we did here, but there are other regions, at a finer geographical scale, where it would be interesting to study the linguistic dynamics. First of all, it would be very interesting to study the dynamics in Montréal where most of immigrants who settle in the province of Québec reside, and where the attraction of English is more prevalent. It would also be of prime interest to study the future evolution of the linguistic composition of populations in regions where French speakers represent a sizable minority and have access to better established French institutions, notably in eastern Ontario or Northern New-Brunswick. More detailed data by country of birth and mother tongue of Allophones can also help in better defining the Francotrope and Anglotrope categories.

These limitations will be solved by moving the model to Statistics Canada’s Research Data Center (RDC) where the full 20% Census sample with detailed information is available to researchers. Accessing more detailed data in the RDC should improve the model: it will make possible the definition of linguistically meaningful regions inside and outside Québec and will also allow us to refine the definition of tropism using more detailed data.

Nevertheless, the current model has been successfully validated both in terms of demographic and demolinguistic behaviours. Results of scenarios limited to demographic
components replicate those obtained using the same inputs and a simpler cohort-component macro model in terms of total population, regional distribution and components of population change (births, deaths, migrants). Random variations due to the Monte-Carlo process are not major, but will be further reduced when accessing the full 20% sample. Results from the reference scenario were also coherent with the linguistic distribution obtained by Termote (2008) at the provincial level.

We also proposed a new method to estimate intragenerational language shifts. Although we are confident about the quality of the parameters obtained, more work in this direction is necessary to validate them. Since this projection model is the first one to take into consideration both inter- and intragenerational language shifts, it is not possible to validate its results regarding the effect of those behaviours by comparison with results from other prospective exercises. Right now, we can only say that results of alternative scenarios appear plausible and reliable.

The scenarios compared in this paper put emphasis on immigration level, linguistic composition of immigration and language shifts. The main reason for this choice is that those are the factors that can be influenced by changes in immigration or linguistic integration policies. Yet, other factors can also play a role in the future linguistic composition of the regional populations in Canada. Most importantly, the internal migration behaviours have quite important effect in the linguistic distribution of the Canadian population. We prefer to address this issue in a future paper in which linguistically meaningful regions will be included.

Although more work has to be done to develop a more satisfying model, the results presented here may be of interest to those interested in linguistic dynamics in unilingual and multilingual regions. We were able to illustrate potential impacts on linguistic composition of future populations of immigration and linguistic integration policies and show how dramatically different the effect of high immigration of foreign speakers can be on regional population in a multilingual country given the language choices that newcomers make.

In the English speaking provinces of Canada, immigration never reduces the share of the majority language population except in the very unlikely scenario where French speaking immigrants are increased more than five-fold. Regardless of the level, linguistic composition of immigration or language shift behaviours, the number of English speakers continues to increase in number and proportion of official languages speakers over all the projection period and under all but one scenario. Although the number of third language speakers increases faster due to high immigration, English is a quasi-absorbing state and the proportion represented by English speakers among the two official languages is increasing to near 99% in most scenarios. Even in the scenario where French speaking immigrants are increased more than five-fold, English speakers represent about 96% of official language users in 2050.

In Québec, the situation is significantly different. The number of third language speakers also increases due to immigration, but because French does not benefit as much from the
language shifts of newcomers, the English speaking population tends to increase in numbers and proportion. Even if French remains the majority official language, its majority status is weakened by immigration, particularly if the proportion of newcomers speaking French or being Francotropes declines. Our scenarios demonstrate that the linguistic composition of new immigrants is the most important factor to reduce the rate of decline of French among the two official languages in both Québec and Canada. This is placing Québec’s immigration policy makers in a difficult situation. As Chiswick and Miller (1994) noted, a fully French speaking immigration might not be desirable, or even possible, given the limited number of potential international immigrants having French as a mother tongue and still speaking French at home. Limiting the immigration to French speakers might have a negative impact on the economic integration of newcomers and possibly also on productivity.

Linguistic integration to the French majority language is difficult among immigrants who don’t speak French or a language close to French at arrival, even though Québec has adopted a series of linguistic laws that are often perceived as unjustifiably repressive in English Canada. As an example, the Québec’s linguistic legislation adopted in 1977 (Bill 101) makes public education in French mandatory for children of immigrants until the end of high school (students may nevertheless attend private English schools). Yet, results from the reference scenario, which is based on language shift behaviours of the most recent cohorts of immigrants (more pro-French), are not much different than the results obtained from the scenario OLDIMM, which assumes linguistic transition rates of older cohorts, mostly arrived before the adoption of the law.

Across all Canada, including Québec after the year 2025, the number of French speakers declines in the reference scenario. Conversely, under all scenarios, the number of English speakers increases over the projection period both in the English speaking provinces and in Québec. Sustainability of English in Canada, even in Québec despite its minority status and strong legislative actions in favour of French, does not appear to be weakened by high immigration of third language speakers. Sustainability of French, however, is seriously weakened all across the country. Québec appears to be in a better position, although the percentage of English and third language speaker are also increasing at the expense of French speakers.

Those results raise several questions. Are the resources sustaining the English minority in Québec and the French minorities in English Canada allocated equitably, given the very different challenges that the minority communities are facing? How would it be possible to insure the sustainability of both official languages outside of Québec? How can the French majority in Québec be maintained in a context of high immigration given the high status of English at the national and international levels? Answer to those questions will determine the future of Canada as a truly bilingual country, or as a unilingual country comprising several minority languages.
References


