Language assimilation in bilingual countries*

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Abstract

We consider a bilingual country with immigration, where only agents who share the same language can produce together. Immigrants cannot communicate with each other nor with natives unless they learn to speak one of the two languages of the country. We model immigrants' choice of language. With an exogenous language composition of natives, immigrants tend to choose the language of the majority. Endogenising the choice of minority natives to become bilingual does not alter the set of production partners of other minority members but reinforces the incentives of the immigrants to learn the majority language. In order to learn the minority language, immigrants would require a larger subsidy the smaller the minority. Using Canadian language data from the 2001 Census at the city level, we show that the assimilation of anglophone minorities into French negatively and strongly depends on the size of the city's anglophone minority, while the assimilation of francophone minorities into English is lower only when the number of Francophones is above a 5% threshold. In addition, the size of the anglophone group is the driving force in explaining immigrant assimilation in both types of cities: a larger anglophone minority deters immigrant assimilation into French in francophone cities, and a larger anglophone majority fosters immigrant assimilation into English in anglophone cities. Instead, the size of francophone minorities (respectively, majorities) does not reduce (respectively, increase) assimilation into English (respectively, French). Finally, overall assimilation displays the same pattern as immigrant assimilation.

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1 Introduction

Bilingual countries are often characterised by the existence of heated debates on the role of the existing languages. This may be, as stressed by sociolinguists, because bilingualism is seldom purely symmetric (see e.g. Fishman, 1967) or because it is generally unstable in the sense that, over generations, populations shift from the weak to the dominant language (Paulston, 2003).[1] In addition, when the bilingual country grows through immigration, the assimilation choices of immigrants become an important ingredient of these debates.

In analysing immigrant and minority assimilation, the case of Canada is particularly interesting for several reasons. First, the majority language and the size of the language majority greatly vary across Canadian provinces and cities, and, in contrast with other multilingual countries as Belgium and Spain, the Canadian Census includes questions on the mother tongue of individuals and their knowledge of the two official languages (English and French). Second, English-French bilingualism is likely to be asymmetric, as native Anglophones account for a much larger share (57.4%) of the population than Francophones (20.1%) and English is currently the international *lingua franca.* At the same time, the extent of this asymmetry is unclear, as French remains an international language, both languages have been given co-official status since the 1969 Official Language Act, and the province of Quebec has implemented a very active policy of promotion of French. Finally, immigration is a central phenomenon as the non native anglophone or francophone immigrants accounted for nearly 20% of the population in 2001.

With these characteristics in mind, it is probably unsurprising that the legal history of Canada contains examples of legislation aimed at favouring assimilation of immigrants or minorities in a particular language. For instance, after the British North America Act (1867) established the provincial responsibility over education, the corresponding provincial educational acts (except in the cases of Quebec and Ontario) "banned the use of French as a medium of instruction in the system of public schools and/or abolished the provision of financial support to Catholic [French-speaking] schools" (Mougeon, 1998, p. 227). More recently, Bill 101 of Quebec (1977) stated that "only children whose father or mother received most of their primary education in English, in Quebec, have access to English schools" (Barbaud, 1998, p. 185). While the children of immigrants in Quebec can still only attend schools in French, the Canada Constitution Act (1982) partly overturned Bill 101 by establishing the right for Canadian citizens whose mother tongue is English or French to get education in that same language everywhere in Canada (when the number of children so warrants).

Using data from the 2001 Census, we exploit the great variation in the language composition of Canadian cities to study the determinants of assimilation into the city's majority

[1] "The major point about bilingualism (...) is that maintained group bilingualism is unusual. The norm for groups in prolonged contact with a nation-state is for subordinate group to shift to the language of the dominant group" (Paulston, 2003, p. 401)

language. Cities differ a lot in terms of the majority language (French for 35 cities, English for the remaining 106), the size of this majority, and the proportion of individuals having a language other than the two official languages as their mother tongue.

We show that bigger official mother tongue minorities tend to learn less the language of the majority, and that this effect is particularly important for francophone cities. In addition, when threshold effects in minority size are allowed for, the pattern by which minority size impacts minority assimilation is different in francophone and anglophone cities. More precisely, the assimilation of Anglophones in francophone cities remains very sensitive to the number of Anglophones, while the assimilation of Francophones in anglophone cities is more uniform across cities, and francophones assimilate less only in those cities with a critical mass of Francophones.

We next turn to the analysis of immigrant assimilation, accounting for possible immigrant selection biases. We show that a larger minority deters immigrant assimilation only in francophone cities: while a larger anglophone minority is associated to lower immigrant assimilation into French in francophone cities, immigrant assimilation into English in anglophone cities does not depend on the size of the francophone minority. In addition, a larger majority fosters immigrant assimilation only in anglophone cities. Put together, these two results show that, as far as language group sizes are concerned, only the size of the anglophone group is relevant in explaining immigrant assimilation in Canada in both types of cities. We interpret this as providing evidence of the asymmetric nature of Canadian bilingualism: while in anglophone cities, immigrant assimilation into English crucially depends on the attractiveness of English, in francophone cities the driving force for assimilation into French may not be the attractiveness of French, but rather the lack of attractiveness of English.

Finally, we show that overall assimilation rates are higher in anglophone cities, and are still mainly driven in both types of cities by the proportion of native Anglophones. In addition, immigrants tend to have higher assimilation rates than anglophone minorities in francophone cities, while the reverse is true in English-speaking Canada.

We consider a bilingual country with immigration, where value comes from bilateral production among agents who speak the same language. Immigrants cannot communicate with each other nor with natives unless they learn to speak one of the two languages of the country. We model the decision of learning the language of the native majority or of the native minority as a non cooperative game in which each immigrant takes into account the decision of other immigrants in her choice.

We first consider a benchmark situation in which natives cannot modify their initial language endowment. In that case, immigrants tend to choose the language of the majority, as this allows them to produce with more partners. More precisely, if the native majority constitutes more than half of the total population, all immigrants choose to learn the majority

language. If instead the native majority is smaller, the interactions among the assimilation decisions of immigrants become relevant at equilibrium and a bandwagon effect can lead either to all the immigrants learning the minority language or to all of them learning the language of the majority.

We determine the socially optimal choice of the immigrants. When the central planner follows an utilitarian criterion, the optimum is reached when the immigrants learn the majority language. Thus, the decentralised equilibrium fails to attain that outcome only when the native majority is small and the immigrants coordinate in the equilibrium in which they all learn the language of the minority. Instead, a Rawlsian central planner would favour assimilation of all the immigrants into the minority language if the native majority constitutes more than half of the population or would otherwise allocate immigrants so as to equalise the sizes of the two language groups after assimilation. Clearly, the decentralised equilibrium does not satisfy the Rawlsian objective.

Next, we endogenise the language composition of natives by allowing minority members to become bilingual as empirically bilingualism is more prevalent among minorities than among majorities. We show that while the choice of minority natives to become bilingual does not alter the set of production partners of other minority members, it reinforces the incentives of the immigrants to learn the majority language as the bilingual minority members can be reached with the majority language. As a result, with (potentially) bilingual minority members, immigrants choose more often to assimilate into the majority language.

Finally, we show that to get immigrants learning the minority language, a subsidy must compensate them for the decrease in the production opportunities they incur by choosing not to learn the majority language. This subsidy must be larger the smaller the minority.

Our model is related to the growing literature on language adoption, and in particular to Church and King (1993) and Lazear (1999).[2] Church and King (1993) shows in a game-theoretic setting that minorities rather than majorities will tend to become bilingual. Lazear (1999) shows how a slow and balanced immigration results in a more rapid assimilation of immigrants than an immigration coming from one particular group.

2 Empirical evidence

Canada is a multilingual country in which English and French have been given co-official status since the 1969 Official Language Act. In 2001, 57.4% of the Canadian residents declared to be native Anglophones, while 21.1% described themselves as native Francophones.

[2] Other related papers in this literature are John and Yi (2001), and Ortega and Tangerås (2007). John and Yi (2001) develops a dynamic setting to provide an explanation of the factors behind the decline or development of languages. Ortega and Tangerås (2007) studies the political economy of the choice between a unilingual and a bilingual education system.

In addition, 20.1% of the Canadian residents (immigrants and Native Americans) had another mother tongue, and 1.4% declared to have two or three mother tongues (with at least one of them being English or French).

The majority language and the size of the language majority greatly vary across Canadian cities, which provides an opportunity for analysing how the knowledge of the city majority language by city language minorities depends on the language composition of the city, and in particular to understand whether the patterns of assimilation to the majority language are similar in anglophone and francophone cities.

This section thus relates immigrant and official language minority assimilation across Canadian cities to the mother tongue composition of the cities. Canada includes 28 Census Metropolitan Areas (CMAs, with a population of at least 100,000) and 113 Census Agglomerations (CAs, with at least 10,000 individuals).

2.1 Mother tongue composition of cities

The information on the language composition of the cities is obtained from the 2001 Census question by which individuals declare their mother tongue (English, French, other languages, with multiple answers possible).[3] Cities differ a lot in terms of the majority language (French for 35 cities, English for the remaining 106), the size of this majority, and the proportion of individuals having a language other than the two official languages (English and French) as their mother tongue. This important cross-city heterogeneity is already apparent when considering the most populated seven cities in the country (see Table 1). Quebec City is overwhelmingly native French-speaking, while Toronto, Vancouver, Calgary or Edmonton have less than 2% native Francophones and a large proportion non-official mother tongue speakers (ranging between 18 and 40%), and finally cities as Montreal or Ottawa have significant shares of both official languages.

Let x_j be the total population of city j and x_j^l the number of city j inhabitants having language l as their mother tongue. Denoting by M the majority mother tongue in a given city, the share of the majority language among mother tongues (the "majority", for short) is given by $s_j^M = x_j^M/x_j$. Note that those immigrants having the city majority language as their mother tongue are thus included in the language majority. Analogously, the share of the official mother tongue minority m (the "minority", for short) and of all the remaining languages are respectively $s_j^m = x_j^m/x_j$ and $s_j^o = x_j^o/x_j$.[4] Disaggregating the category "other languages" to separate the immigrants and the Native Americans, we can then define the share of non mother-tongue anglophone or francophone immigrants (the "immigrants", for

[3] The question is as follows: "What is the language that this person first learned at home in childhood and still understands? If the person no longer understands the language learned, indicate the second language learned".

[4] Because of the existence of bilingual and trilingual individuals, these shares do not add up to one.

short) in the city population, $s_j^i = x_j^i / x_j$.

2.2 Assimilation rates to the city majority language

The assimilation rates of the minority and the immigrants into the city majority language are computed using question 13 of the Census which provides information on the spoken knowledge of official language(s) (English, French, both of them, neither of them) by individuals.[5] With $\widetilde{x}_j^m$ and $\widetilde{x}_j^i$ respectively denoting the number of city j minority members and immigrants with knowledge of the city majority language, the assimilation rates are simply given by $a_j^m = \widetilde{x}_j^m / x_j^m$ and $a_j^o = \widetilde{x}_j^o / x_j^o$.

Table 2 ranks CMAs according to the proportion of minority members who declare to have a knowledge of the majority language in the city. It can already be noted that this proportion was systematically lowest (with the exception of Ottawa-Gattineau-Ontario part) in the French-speaking CMAs.

Table 3 performs the same ranking for the immigrants. As for minorities, immigrants in francophone cities tend to experience lower assimilation rates than in anglophone cities. However, the picture is not as neat as before, as the highest assimilation rate is actually found in a francophone city and there are some anglophone cities as Vancouver or Abbotsford which have relatively low assimilation rates.

2.3 Relating assimilation to the language composition of the city

We now turn to the determinants of assimilation in anglophone and francophone cities. As the patterns of assimilation of the official minorities and the immigrants may be different, we first treat each of these two groups separately, and then turn to a joint analysis of the assimilation of all minorities, including the Native Americans.

2.3.1 Minority assimilation

Table 4 regresses the assimilation rate of the city's official mother tongue minority on a number of variables characterising the language composition of the city.

Column 1 shows that bigger official mother tongue minorities tend to learn less the language of the majority, and that effect is particularly important for francophone cities, as indicated by the negative and significant coefficient associated to the interaction term between the size of the minority and the dummy for French-speaking cities. This is illustrated in Figure 1, which plots the minority assimilation rate against the size of the city minority and shows the relation to be much steeper for francophone cities. The stronger impact in francophone cities is confirmed comparing the estimated coefficients associated to "minority"

[5] Question 13 is as follows: "Can this person speak English or French well enough to conduct a conversation?"

in regressions (3) and (5), which indicates that a 1 percentage point increase in the size of the anglophone minority decreases by 1.5 percentage points the assimilation of the English-speakers, while an equivalent increase in the size of the francophone minority decreases only by 0.5 percentage points their assimilation into English.[6] In contrast, majority size has no impact on minority assimilation. Finally, assimilation is lower in big cities and in francophone cities.

Column 2 further explores the nature of the impact of minority size allowing for the existence of a 5% threshold effect. This regression shows that the pattern by which minority size impacts minority assimilation is different in francophone and anglophone cities. Indeed, once the threshold effect has been allowed for, the variable "minority" ceases to be significant in explaining minority assimilation in anglophone cities, while the variable "minority below 5%" has a positive and highly significant impact on minority assimilation. This result is confirmed in regression (4) when restricting the analysis to anglophone cities.[7] Instead, the exact size of the minority continues to play a role in explaining minority assimilation in francophone cities, while threshold effects are less relevant in that case, as shown both in regressions (2) and (6). These results put together indicate that the assimilation of Anglophones in francophone cities is very sensitive to the number of Anglophones, while the assimilation of Francophones in anglophone cities is more uniform across cities, and Francophones assimilate less only in those cities with a critical mass of Francophones.

2.3.2 Immigrant Assimilation

Our regressions on immigrant assimilation include new variables to deal with two potential selection problems in the distribution of immigrants across cities.

First, immigrants in different cities may have different durations in Canada. For this reason, we use the 2001 Census information on the decade of arrival of immigrants to Canada, and construct a city level variable "years in Canada" assuming the immigrants residing in a city came into Canada in the middle of their corresponding decade.[8]

In addition, it may be the case that immigrants having knowledge of one Canadian official language prior to their arrival to Canada are more likely to end up living in a city

[6] With a quadratic specification of the minority variable in the regression which allows us to take into account that the average francophone minority (3.5% of anglophone city population) is smaller than the average anglophone minority (9.9%), the same qualitative result holds. More precisely, a 1 percentage point increase in the size of the anglophone (respectively, francophone) minority decreases its assimilation by 2.6 (respectively 1.5) percentage points.

[7] The same qualitative result holds when the threshold is set at 6% or 7%. A 4% threshold is insignificant for both francophone and anglophone cities, while a 8% threshold becomes significant for both types of cities, but the coefficient associated to the variable "minority" becomes positive and significant for anglophone cities.

[8] We have information on the proportion of immigrants in each city that arrived between 1996 and 2001 (2.5 years in Canada), between 1991 and 1996 (8 years), between 1981 and 1990 (15.5 years), and so on for each decade, until "before 1961" (45 years assumed since arrival).

where the majority speaks that language. This may be due to self-selection, or to some institutional feature, as for example the points awarded by Quebec immigration authorities to potential immigrants with knowledge of French. As native francophone (respectively, anglophone) immigrants residing in francophone (respectively anglophone) cities are counted as majority members, over-representation of French immigrants in francophone cities or British or U.S. immigrants in anglophone cities does not bias our estimates of immigrant assimilation. Avoiding biases for non native anglophone and francophone immigrants is difficult, as we do not have information on knowledge of these languages upon arrival to Canada. However, we choose here to use the information on the immigrant's country of origin by defining countries where the knowledge of English or French is "common". There are of course several ways of identifying the countries where English or French are common languages. For the regressions in Table 5, the variable "composition of recent immigration" computes the proportion of immigrants in the city coming from a country where the city's majority language is an official language, but where at the same time no sizeable group of individuals have this language as their mother tongue.[9] Similar results are obtained in the regression if the variable is instead constructed on the basis of the proportion of immigrants in the city coming from a country where at least 10% of the population speaks the majority language as a lingua franca.[10]

A first result in Table 5 is that a larger minority deters immigrant assimilation only in francophone cities: while a larger anglophone minority is associated to lower immigrant assimilation into French in francophone cities (see columns 1, 2, and 8-10), immigrant assimilation into English in anglophone cities does not depend on the size of the francophone minority (see in particular regression 4). This result is illustrated in Figures 2 and 3 respectively for anglophone and francophone cities.

Second, a larger majority fosters immigrant assimilation only in anglophone cities: a larger anglophone majority is associated to more assimilation into English in anglophone cities (columns1-3 and 4-6), while assimilation into French in francophone cities is not related to the size of the francophone majority. Indeed, while regression 7 displays a positive and significant coefficient associated to the size of the francophone majority, this variable becomes insignificant when the size of the anglophone minority is included, as in regressions 9 and 10.

Put together, these two results show that, as far as language group sizes are concerned,

[9] In addition, according to this definition, creoles are considered as proper languages. In this case, the set of countries whose natives are familiar with English are India, Hong Kong, The Philippines, Trinidad and Tobago, Fiji, Kenya, Tanzania, Jamaica, Guyana and South-Africa, while only Haitians are familiar with French.

[10] This is done using data from the Encyclopaedia Britannica. In this case, immigrants from Algeria, Haiti, Lebanon, and Morocco are supposed to be familiar with French, while immigrants for Fiji, Guyana, India, Jamaica, Malaysia, Pakistan, The Philippines, Sri Lanka, Hong Kong, Trinidad and Tobago and Tanzania are supposed to be familiar with English.

only the size of the anglophone group is relevant in explaining immigrant assimilation in Canada in both types of cities. We interpret this as providing evidence of the asymmetric nature of Canadian bilingualism: while in anglophone cities, immigrant assimilation into English crucially depends on the attractiveness of English, in francophone cities the driving force for assimilation into French may not be the attractiveness of French, but rather the lack of attractiveness of English.

The impact of length of residence appears also to be different for anglophone and francophone cities. More precisely, while anglophone cities whose immigrant population has a longer duration in Canada are unsurprisingly characterised by higher assimilation rates (see columns 1,2, 5, and 6), the length of residence in Canada does not generally have an impact on immigrant assimilation in francophone cities, as can be readily seen from inspection of columns 1, 9, and 10. This result is in accordance with previous analysis with individual data by Chiswick and Miller (1994) for the 1981 Census, where it was found that the predicted proportion of immigrants with knowledge of English in English Canada was monotonically increasing in the length of residence, while the proportion of immigrants with knowledge of French in Quebec displayed a U-shape.[11]

Finally, columns 2 and 10 show that francophone cities getting more immigrants from countries where French is a common language experience higher immigrant assimilation rates, while no effect of this type is found for anglophone cities.

2.3.3 Overall assimilation

We next turn to the determinants of overall assimilation rates across cities, which enables us in particular to study whether cities that include different proportions of immigrants, Native Americans, and official minority members experience *ceteris paribus* higher or lower assimilation rates. This is done by including two additional explanatory variables in the regressions, namely the share of immigrants in all minorities and the share of Native Americans in all minorities.[12]

The regressions in Table 6 systematically show that anglophone cities with a larger share of immigrants experience lower assimilation levels, while the reverse is true in francophone cities. This result simply comes from the fact that taking the city as given, immigrants tend to have lower (respectively, higher) assimilation rates than official minority members if the city is anglophone (respectively, francophone). In addition, the proportion of Native Americans is not correlated with overall assimilation.

[11] See Table 2, p. 127.

[12] As the share of Native Americans is very small in many cities (or even equal to zero), the share of immigrants and the share of official minority members add up in many cases to one. Thus, introducing the share of official minority members instead of the share of Native Americans would have lead to a multicolinearity problem.

The language composition of the city population impacts the overall assimilation rate following a pattern close to that found for immigrant and minority assimilation. First, the extent of assimilation is still mainly driven by the proportion of native Anglophones, with larger anglophone groups deterring assimilation into French in francophone cities and boosting assimilation into English in anglophone cities. Second, assimilation in anglophone cities is higher when the francophone minority is below a 5% threshold.

Finally, overall assimilation is lower in francophone cities, as reflected by the positive and significant coefficient associated to the dummy "francophone city" in regressions (1) and (2).

3 The Model

Consider a country inhabited by a continuum of individuals normalised to 1. The population is constituted of natives N and immigrants I. A natives speak the language a while B natives speak language b. Initially, each native speaks one language only. The immigrants do not initially speak neither of the native languages and there is a continuum of different immigrant languages. In addition, we assume that immigrants are a minority of the total population, i.e., $I < A + B$.

Value is created through bilateral production between individuals.[13] Each individual has the opportunity of producing once with every other individual.[14] Bilateral production occurs if and only if the two partners are able to communicate. We assume that communication is possible only if the two agents speak a common language. If they cannot communicate, the value of production is equal to zero.

In this context, each immigrant can produce only if she learns some native language. Immigrants will thus choose between learning one of the two languages.[15] We model this decision as a non cooperative game in which each immigrant takes into account the decision of other immigrants in her choice. We first consider the case in which natives cannot modify their initial language endowment.

3.1 Exogenous language composition of natives

3.1.1 Decentralised equilibrium

Let α denote the proportion of immigrants learning language a. Denote by c the cost of learning a native language, assumed to be the same for both languages. The expected utility

[13] As e.g. in Diamond (1982) or Lazear (1999).

[14] Equivalently, agents consider their expected payoffs when taking decisions. We are assuming away the possibility that agents belonging to a certain language group are concentrated in a particular location. For an analysis including this geographical dimension, see John and Yi (2001).

[15] We assume that immigrants cannot become bilingual in the two native languages.

U_I^a associated to learning language a for an immigrant is:

$$U_I^a(\alpha) = -c + A + \alpha.I \tag{1}$$

the immigrant pays cost c, ends up speaking language a and can thus produce an amount equal to one with each of the A native a speakers and the αI immigrants who have learned language a. Clearly, the payoff associated to learning a is increasing in the number of immigrants who learn a.

Analogously, the pay-off associated to learning language b is:

$$U_I^b(\alpha) = -c + B + (1 - \alpha).I \tag{2}$$

Subtracting (2) from (1) gives the net benefit $\Delta U_I^a(\alpha)$ for an immigrant of learning language a rather than language b:

$$\Delta U_I^a(\alpha) = A - B + (2\alpha - 1).I \tag{3}$$

We compute the different Nash equilibria of this game, depending on the exogenous parameters A and B. The equilibrium choices of immigrants are presented in Proposition 1.

Proposition 1 *If the native language majority constitutes more than half of the total population, all the immigrants choose to learn the majority language. Otherwise, the assimilation decision is characterised by the existence of multiple equilibria with* $\alpha = \{0, \frac{1-2A}{2I}, 1\}$.

Proof. Let α^e denote the equilibrium proportion of immigrants learning language a. From (3), $\Delta U_I^a(\alpha)$ is increasing in α. $\Delta U_I^a(1) = 1-2B$ and thus $\alpha^e = 0$ if $B > 1/2$. Symmetrically, $\alpha^e = 1$ if $A > 1/2$. Finally, if $A < 1/2$ and $B < 1/2$, three equilibria co-exist. $\alpha^e = 0$ is an equilibrium since $\Delta U_I^a(0) = 2A-1 < 0$, $\alpha^e = 1$ is an equilibrium since $\Delta U_I^a(1) = 1-2B > 0$ and there is also an (unstable) interior equilibrium $\alpha^e = \frac{1-2A}{2I}$ as $\Delta U_I^a\left(\frac{1-2A}{2I}\right) = 0$. ■

The different equilibria are represented in figure 1 in the (A, B) space for an arbitrarily fixed I. Given I, the downward sloping line corresponds to the different possible language compositions of the native population.

If the native language majority L constitutes more than half of the total population ($L > 1/2$), all immigrants choose to learn language L.Indeed, even in the case in which all immigrants chose to speak the minority language, the number of traders that could be reached by an immigrant learning the minority language $(1-L)$ would be smaller than if she learned the majority language (L). So in that case, the possible interactions in the choices made by different immigrants do not play a role in equilibrium.

In contrast, if the native majority is not too big (i.e. $A < 1/2$ and $B < 1/2$), the optimal choice for an immigrant depends on the decisions of others immigrants, which leads to multiple Nash equilibria. In the two stable equilibria, all immigrants choose to learn the same

language. As a result, after the assimilation decision of immigrants, a majority of the population ends up speaking the native majority language, i.e., the size of the language majority increases with respect to the language minority. Another possible (unstable) equilibrium is one in which a proportion of the immigrants learns the native majority language, while the rest learns the native minority language. As the cost of learning the two languages has been assumed to be the same, an immigrant will be indifferent between learning one language or the other if the total number of speakers is the same for each language at equilibrium. Thus, immigrant assimilation leads in this case to a situation of perfectly balanced bilingualism.

To summarise, the economic incentives for assimilation are such that immigrants tend to choose to learn the language of the native majority group, hence reinforcing the predominance of the majority language among natives.

In order to compare the results of this section with the case of an endogenous language composition of the natives, Fig. 2 represents the results in the (A, I) space:

3.1.2 Welfare

We have seen previously how unpredictable is the language choice of immigrants in a balanced situation and how immigrants choose to join the majority when it exists. We now identify the welfare maximizing language acquisition of immigrants.

We consider two different specifications of the welfare function. First, if society wishes to maximize the expected number of trade, then we consider a utilitarian specification. Then, if the society wishes to preserve the welfare of the minority group, we could model that preference through a Rawlsian welfare function.

Utilitarian Welfare With a utilitarian welfare function, the social planner solves:[16]

$$\underset{\alpha}{Max}\ W(\alpha) = AU_A^a(\alpha) + BU_B^b(\alpha) + \alpha I.U_I^a(\alpha) + (1-\alpha)I.U_I^b(\alpha) \tag{4}$$

where $U_I^a(\alpha)$ and $U_I^b(\alpha)$ are respectively given by (1) and (2), and

$$U_A^a(\alpha) = A + \alpha I \tag{5}$$
$$U_B^b(\alpha) = B + (1-\alpha)I \tag{6}$$

Simplifying (4) using (5) and (6),

$$\underset{\alpha}{Max}\ W(\alpha) = (A + \alpha I)^2 + (B + (1-\alpha)I)^2 - cI. \tag{7}$$

We can then state the following proposition:

[16] Here, the welfare of the immigrants is taken into account. This may not be the case if immigrants do not have political rights.

Proposition 2 *With utilitarian welfare, immigrants should learn the language of the majority.*

Proof. $\frac{\partial W}{\partial \alpha} = 2I(2A + 2\alpha I - 1)$. If $A > 1/2$, $\frac{\partial W}{\partial \alpha} > 0 \ \forall \alpha$, *i.e.* the welfare function monotonically increases in α. Then, if $A > 1/2$, the welfare maximising α is $\alpha^* = 1$. Symmetrically, $\frac{\partial W}{\partial \alpha}$ can be rewritten $\frac{\partial W}{\partial \alpha} = 2I(1 - 2B - 2I(1 - \alpha))$ and thus $\alpha^* = 0$ if $B > 1/2$. If instead $A < 1/2$ and $B < 1/2$, $\frac{\partial W}{\partial \alpha} = 0$ for $\widetilde{\alpha} = \frac{1-2A}{2I}$. As $\frac{\partial W}{\partial \alpha} < 0 \Longleftrightarrow \alpha < \widetilde{\alpha}$, $\widetilde{\alpha}$ corresponds to a minimum. Then $\alpha^* = 0$ if $W(0) > W(1) \Longleftrightarrow B > A$ and $\alpha^* = 1$ if $W(0) < W(1) \Longleftrightarrow B < A$. In the case where $A = B$, both $\alpha^* = 0$ and $\alpha^* = 1$. ■

The intuition associated to this proposition is simple. Given that the cost of learning each of the two languages is the same, the utilitarian central planner decides that the immigrants learns the language which opens more production opportunities, i.e. the language of the majority. Thus, optimal immigrant assimilation increases the utility of the native majority while it does not affect the utility of minority members.

Another way of interpreting this result is to study the efficiency costs of bilingualism. In a unilingual country all agents can produce with each other, so social welfare is equal to $W^{uni} = 1 - cI$. Instead, in a bilingual country, $W(\alpha) = (A+\alpha I)^2 + (B+(1-\alpha)I)^2 - cI$. The cost is thus: $W^{uni} - W(\alpha) = 1 - (A + \alpha I)^2 + (B + (1 - \alpha)I)^2$. This cost is strictly positive since we have assumed in this section that natives cannot shift language and it is minimised when immigrants learn the majority language.

Comparing the decentralised equilibrium with the utilitarian welfare, we can see that the decentralised outcome is efficient whenever the language majority among natives is also a majority in the population as a whole. Instead, if $A < 1/2$ and $B < 1/2$, immigrants may coordinate in an inefficient equilibrium in which they learn the language of the minority instead of that of the majority.

3.1.3 Rawlsian Welfare

As we have seen, with a utilitarian welfare function, bilingualism is not efficient and everything that can increase the size of the majority improves economic efficiency because it implies more people being able to produce with each other. A society which desires to preserve bilingualism must be assumed to have a different objective. Let us instead assume that the central planner has Rawlsian preferences and thus tries to maximise the utility of the least favoured agents[17].Using (5) and (6), this is given by:

$$\underset{\alpha}{MAX}\ W^R(\alpha) = Min\ \ (A+\alpha I\ ,\ B+(1-\alpha)I)$$

The maximisation of this function is characterised in the following proposition:

[17]As $U_I = \alpha(A + \alpha I) + (1 - \alpha)(B + (1 - \alpha)I) = \alpha U_A^a(\alpha) + (1 - \alpha)U_B^b(\alpha)$, the expected utility of the immigrants is a convex combination of the utility of the a-speakers and of the b-speakers, and thus cannot be lower than the utility of the less favoured of these two groups.

Proposition 3 *With a Rawlsian welfare function, immigrants should choose to learn the language of the minority whenever the native majority constitutes more than half of the total population. Otherwise, immigrants should divide themselves among the two language groups so as to equalize the final sizes of the two language groups.*

Proof. Denote by α^R the Rawlsian allocation of immigrants. If $A > 1/2$, then the b-speakers will always be worse-off than the a-speakers, and thus $\alpha^R = 0$. Symmetrically, if $B > 1/2$, $\alpha^R = 1$. Finally, if $A < 1/2$ and $B < 1/2$, the function is maximised when $A + \alpha I = B + (1 - \alpha)I$ and thus $\alpha^R = \frac{1-2A}{2I}$. ■

In the Rawlsian case, the central planner thus chooses to maximise the production opportunities of the native minority, which leads to the maintenance of bilingualism. Figure 3 represents the Rawlsian optimum: Comparing Figures 1 and 3, it is easy to see that economic incentives push the decentralised equilibrium in the opposite direction to what would be chosen by a Rawlsian planner. More precisely, if group L constitutes more than half of the population, the decentralised equilibrium is such that immigrants learn the majority language l, while the Rawlsian planner would instead choose to allocate them to the minority language. When $A < 1/2$ and $B < 1/2$, the decentralised equilibrium is unlikely to reproduce the Ralwsian optimum as there are multiple equilibria and the interior equilibrium is unstable.

3.2 Bilingual minority members

In this section, we endogenise the language composition of natives by allowing minority members to become bilingual. Empirically, bilingualism is higher among minorities than among majorities. For instance, in Canada, only 9% of the Anglophones consider themselves bilingual whereas 43.4% of the Francophones claim speaking also English. Also, from a theoretical point of view, Church and King (1993) have shown in a game-theoretic framework that the economic incentives for becoming bilingual are stronger among the minority than among the majority, since a minority member learning the majority language gains more potential production partners than a majority member learning the minority language.

Assume that language a is majoritarian among the natives, i.e. $A > B$. We denote by β the proportion of minority members who choose to become bilingual, which will be determined in equilibrium.

3.2.1 Decentralised equilibrium without transfers

Majority language acquisition by minority members Let U_B^{ab} denote the utility of a minority members who chooses to learn language a and who thus becomes bilingual. This individual pays the cost c of learning the language and can produce with everyone, i.e.,

$$U_B^{ab} = -c + 1 \tag{8}$$

If the individual instead decides to remain unilingual, her utility is still given by (6) i.e.$U_B^b(\alpha) = B + (1-\alpha)I$. Subtracting (6) from (8), the net gain associated to becoming bilingual is:

$$\Delta U_B^{ab}(\alpha) = -c + A + \alpha I \tag{9}$$

i.e. the additional partners that can be reached after learning language a (the A natives and the αI immigrants who have learned language a) minus the cost.

Immigrant Language Acquisition Equations (1), (2) and (3) need to be rewritten to take into account the language choices of the minority members. The utility of an immigrant who decides to learn language a is now:

$$U_I^a(\alpha) = -c + A + \alpha I + \beta B \tag{10}$$

i.e. she pays learning cost c and can trade as in the benchmark with the native majority members A and the immigrants who learn language a, and, in addition, with the βB natives that have become bilingual.

$$U_I^b(\alpha) = -c + B + (1-\alpha)I \tag{11}$$

Subtracting (11) from (10) and simplifying, we obtain the net gain for an immigrant to learn language a instead of language b:

$$\Delta U_I^a(\alpha, \beta) = A - B + \beta B + (2\alpha - 1)I \tag{12}$$

Remember that from (3) the net gain of learning language a instead of language b for an immigrant was in the benchmark $\Delta U_I^a(\alpha) = A - B + (2\alpha - 1).I$. The new term in (12) is βB, which shows that the incentives to learning language a are increasing in the number of minority members that become bilingual.

Equilibrium The equilibrium values (α, β) are represented in the space (A, I) in the two figures below. Figure 4 studies the case where $c < A$, while in Figure 5, $A < c < A + I$.(for the derivation of the equilibria, see Appendix 1).

In Figure 4, as $c < A$, it is always optimal from (9) to minority members to become bilingual, i.e. $\beta = 1$. As a result, the equilibrium incentives for immigrants to learn language a become greater. Indeed, when comparing Figure 4 with Figure 3, the area in which $\alpha = 1$ is the unique equilibrium is extended to the area with $A > I$ and $A < 1/2$. In addition, $\alpha = 1$ becomes one of the possible equilibria for $A + I < 1/2$. In other words, as the minority members become bilingual, immigrants may all choose to learn the majority language even if the majority is relatively small and/or the number of immigrants itself is small.

In Figure 5, we assume that becoming bilingual for minority members is more expensive than in Figure 4, i.e. $A < c < A + I$.As a result, $\beta < 1$ in some areas of the parameter space. Still, in Figure 5, we can have $\alpha = 1$ as one of the equilibrium outcomes for $A+I < 1/2$, while in this area the immigrants never chose to learn language a in Figure 2 with an exogenous composition of the native population.

3.2.2 Decentralised equilibrium with subsidies and a heterogeneous minority

Assume now that the government can establish a subsidy s for the immigrants choosing to learn the minority language. Assume also the minority members are heterogeneous in their cost c^{ab} of becoming bilingual, with c^{ab} following a uniform distribution in $[0, 1]$. Then, the payoff of remaining unilingual, being bilingual and the net gain of becoming bilingual are still given respectively by (6), (8), and (9), except that now c^{ab} is individual specific.

As for immigrants, the pay-off associated to learning the majority language is still given by (10), but now learning the minority language is subsidised, i.e.,

$$U_I^b(\alpha) = -c + s + B + (1 - \alpha)I \tag{13}$$

and the net benefit of learning the majority language is also correspondingly lower:

$$\Delta U_I^a(\alpha, \beta) = A - B + \beta B + (2\alpha - 1)I - s \tag{14}$$

In order to keep things simple, assume that group a is twice the size of group b, *i.e.* $B = \frac{A}{2}$. Furthermore, as previously, we impose total immigration to be inferior to the previous population, i.e. $I < A + B \Leftrightarrow I < 1/2$. Then, $B > 1/6$ and $A > 1/3$ combining both assumptions.

The characteristics of the equilibrium are summarised in Proposition 4:

Proposition 4 *Bilingualism among minority members reduces incentives for immigrants to learn the minority language. To learn the minority language, immigrants must be given a larger subsidy the smaller the minority and the higher bilingualism among minority members.*

Proof. To compute β^*, we need to find the threshold cost c^{ab*} corresponding to the marginal b-speaker becoming bilingual. This is given by $\Delta U_B^{ab}(\alpha) = -c^{ab} + A + \alpha I = 0$, i.e. $c^{ab} = A + \alpha I$. As c^{ab} is uniform in $[0, 1]$, $\beta^* = A + \alpha I$.To solve for the equilibrium choices of immigrants, we use $\beta = \beta^*$ in the expression for ΔU_I^a, i.e., $\Delta U_I^a = 2A + (2B + \alpha I)B + 2\alpha I - 1 - c$. Using $B = \frac{A}{2}$, $\Delta U_I^a(\alpha) = (4 - 5\alpha)B + (2 - 3\alpha)B^2 + 2\alpha - 1 - c$. As $0 < B < 1/3$, $\Delta U_I^a(\alpha)$ is monotonically increasing in α. Since $\Delta U_I^a(1) = 1 - B - B^2 - s$, $\alpha^e = 0$ if $s > 1 - B - B^2$. Analogously, $\Delta U_I^a(0) = 4B + 2B^2 - 1 - s$. Hence, $\alpha^e = 1$ if $s < 4B + 2B^2 - 1$. In the case where $\Delta U_I^a(1) > 0$ and $\Delta U_I^a(0) < 0$ we obtain multiple Nash equilibria: two stable corner solutions where α^e can be 0 or 1 and one interior solution,

where the immigrants are indifferent between choosing to learn language a or language b. In that case, $\alpha^e = \widetilde{\alpha} = \frac{1+s-4B-2I^2}{2-5B-3B^2}$. ■

Figure 6 represents the different equilibria of the language learned by immigrants depending on the size of the subsidy and of the immigrant population.
In region (I), i.e. for a relatively small number of immigrants and with a sufficiently small subsidy, all the immigrants choose to learn the language of the majority ($\alpha = 1$). For a given size of the minority group, $\alpha = 0$ cannot be reached as an equilibrium unless the subsidy becomes bigger (i.e. we move to the north). Note also that as the minority becomes larger (the number of immigrants becomes smaller), a larger number of minority members become bilingual[18], and this increases the net incentives of immigrants to learn the majority language. Then, the subsidy necessary to create incentives for immigrants to learn the minority language becomes higher, which explains why the frontier of region (I) is upward sloping. In other words, while becoming bilingual has a positive effect on the minority members who choose to do so (as it increases their set of production partners), their bilingualism increases incentives for immigrants to learn the majority language, which in turn affects the utility of the members of the minority who have stayed unilingual.

To get all immigrants learning the minority language, as in region (III), the subsidy s must compensate immigrants for the decrease in the production opportunities they incur by choosing not to learn the majority language. The frontier of region (III) downward sloping because a larger minority group decreases the size of the required compensation.

Finally, multiple equilibria arise in region (II), i.e. when the number of immigrants is high with respect to the number of natives. With a large number of immigrants, the strategic interactions in their language choices become important, and both an equilibrium in which all immigrants learn the majority language and an equilibrium in which all immigrants learn the minority language arise.

4 Conclusion

(to be added)

References

[1] Barbaud, Philippe (1998) "French in Quebec" in John Edwards (ed.) *Language in Canada*, Cambridge University Press.

[18] Actually, the proportion of minority members that become bilingual decreases, but with our hypothesis concerning the relative size of the minority, this effect is dominated by the effect associated to the larger number of minority members.

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4.1 Appendix

(to be added)

Figure 1: Learning of the majority language by the official language minority

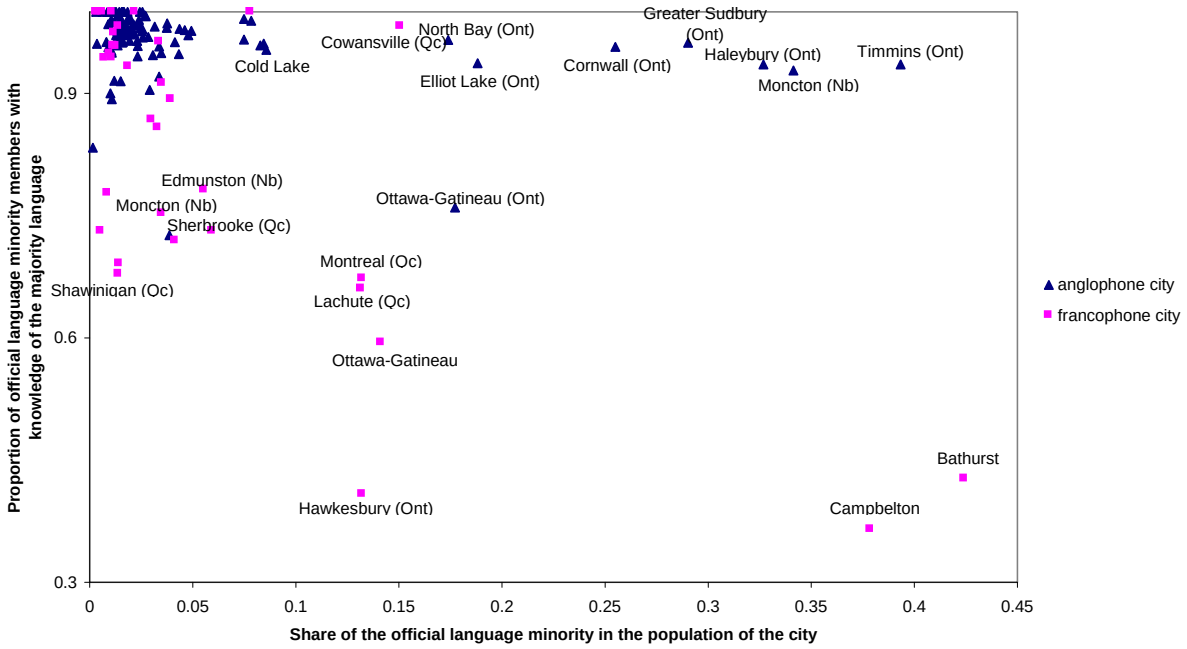


Figure 2: Learning of English by immigrants in anglophone cities

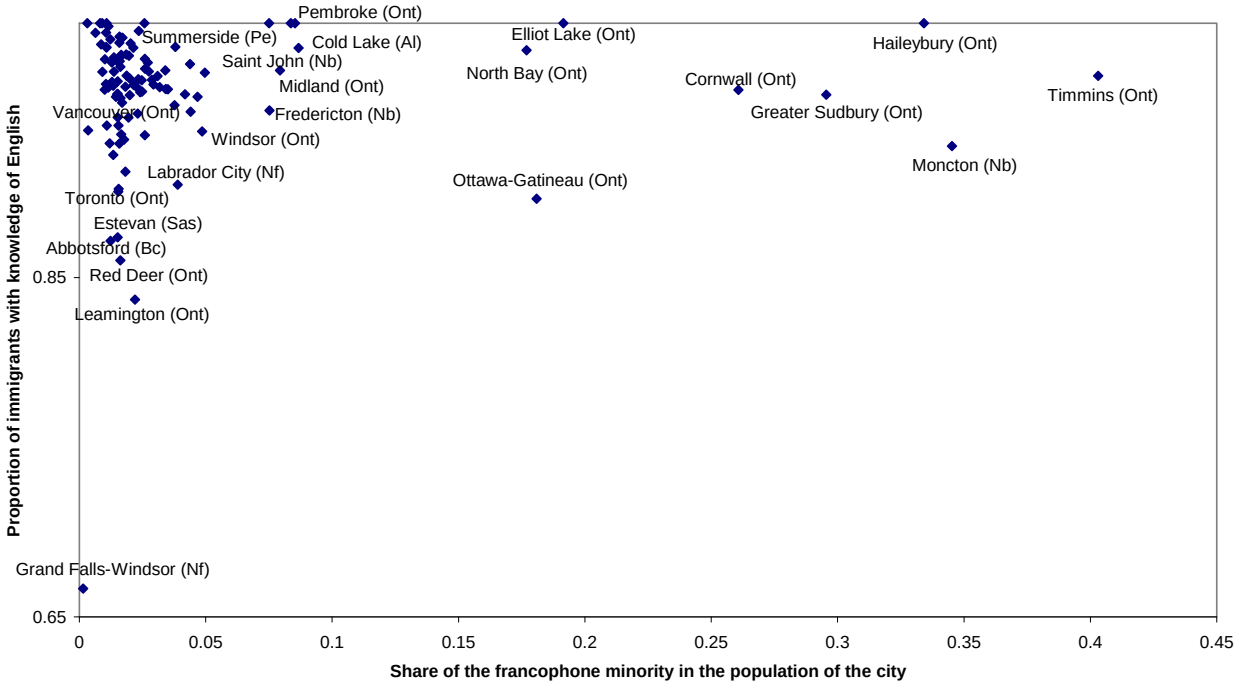
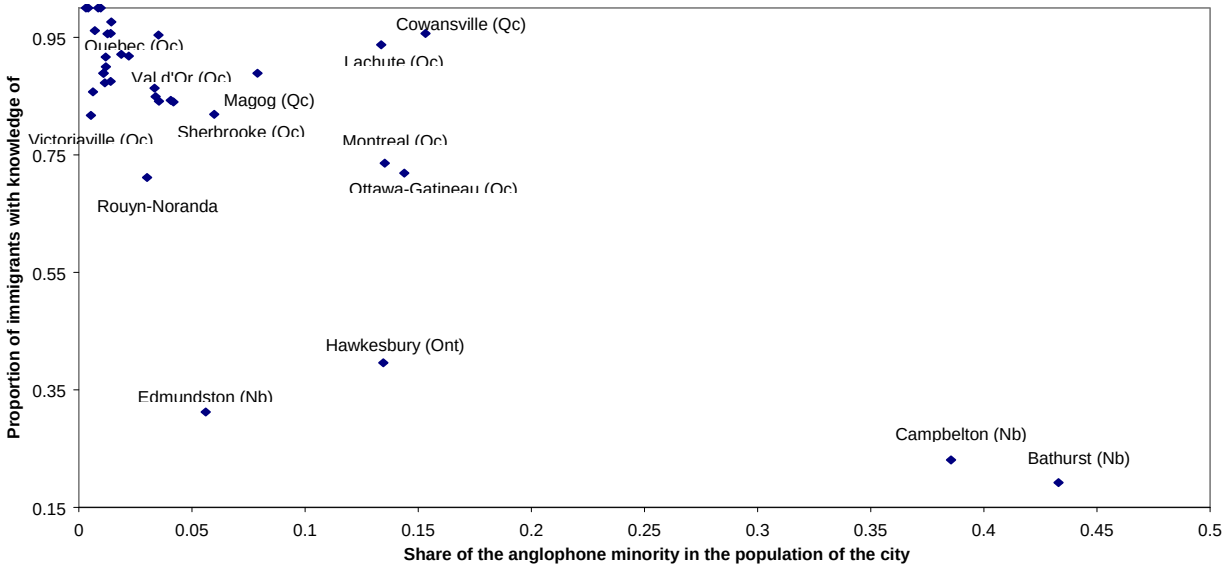


Figure 3: Learning of French by immigrants in francophone cities



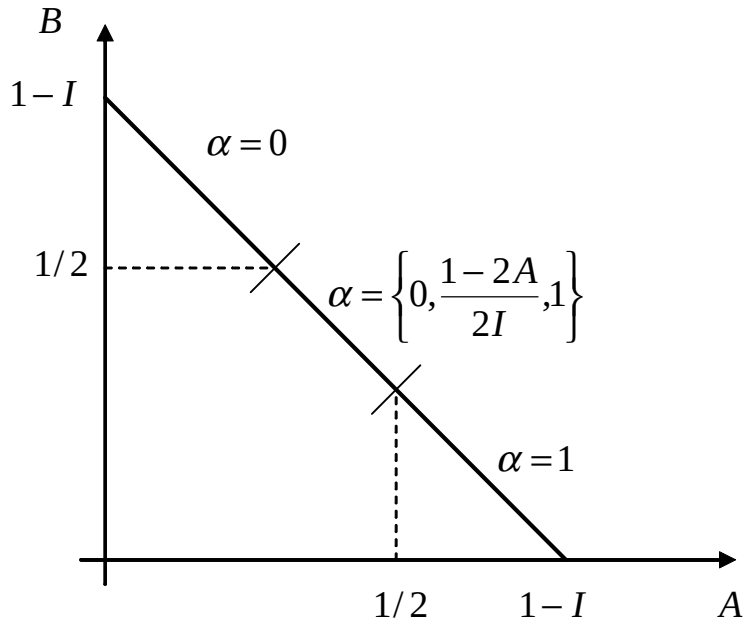


Fig. 4: Language choices of immigrants (exogenous composition of natives)

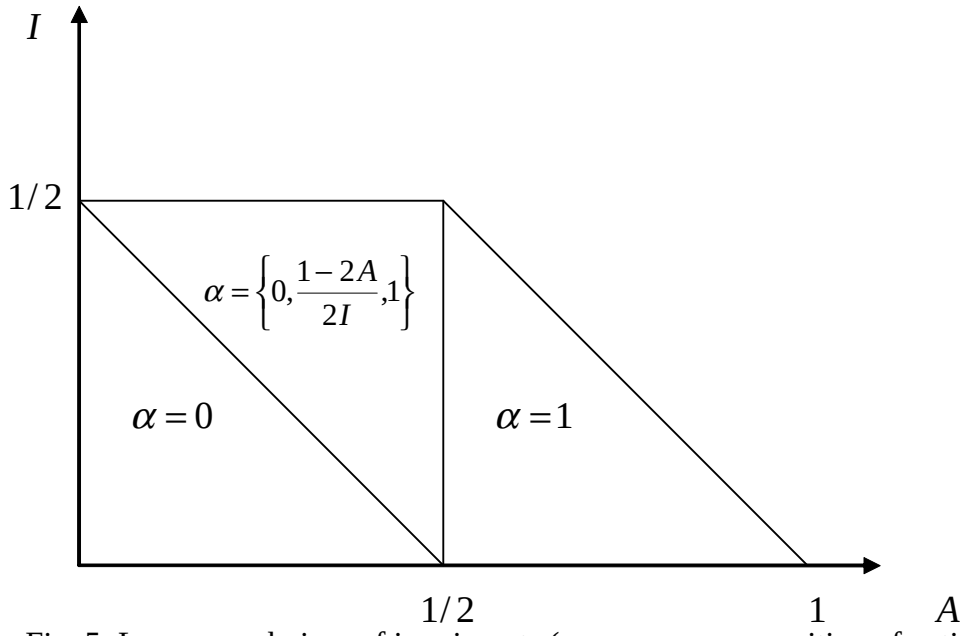


Fig. 5: Language choices of immigrants (exogenous composition of natives)

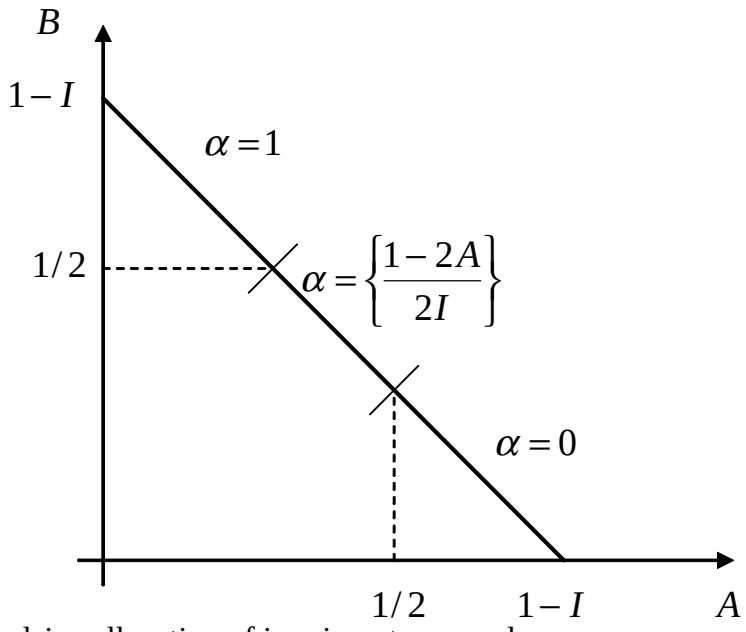


Fig. 6 Rawlsian allocation of immigrants across languages

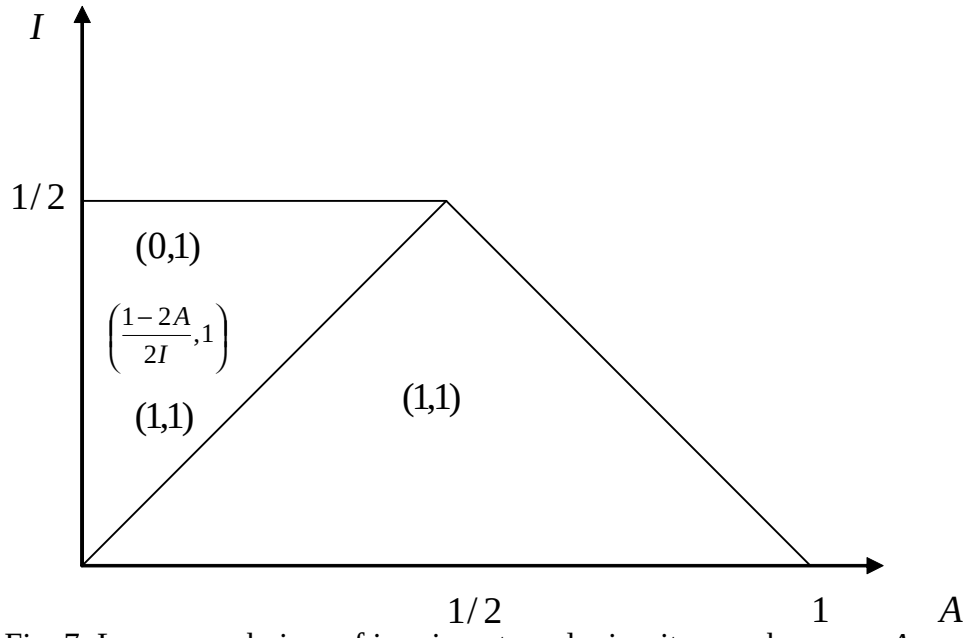


Fig. 7: Language choices of immigrants and minority members, $c < A$

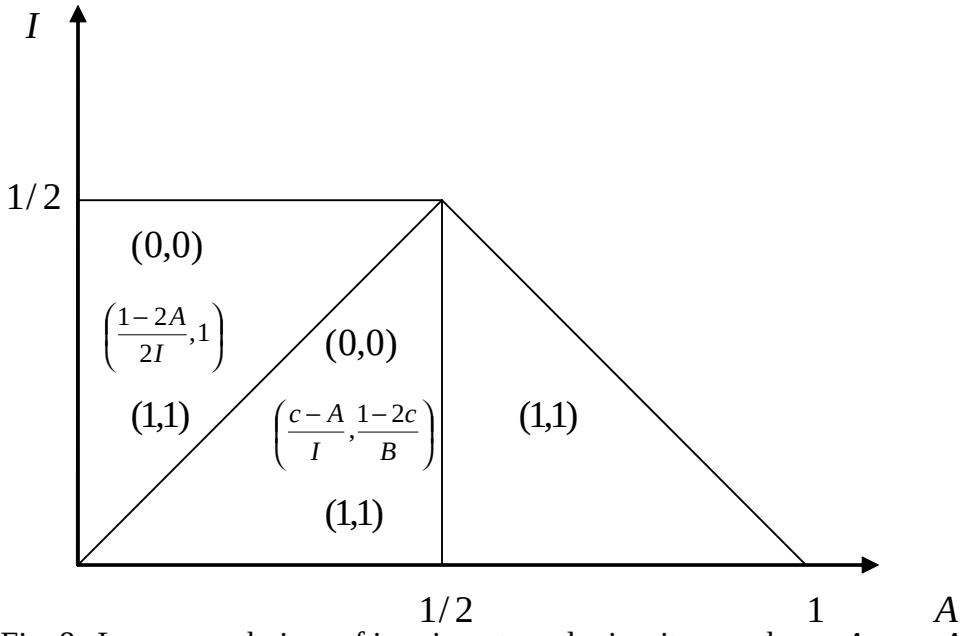


Fig. 8: Language choices of immigrants and minority members, $A < c < A + I$

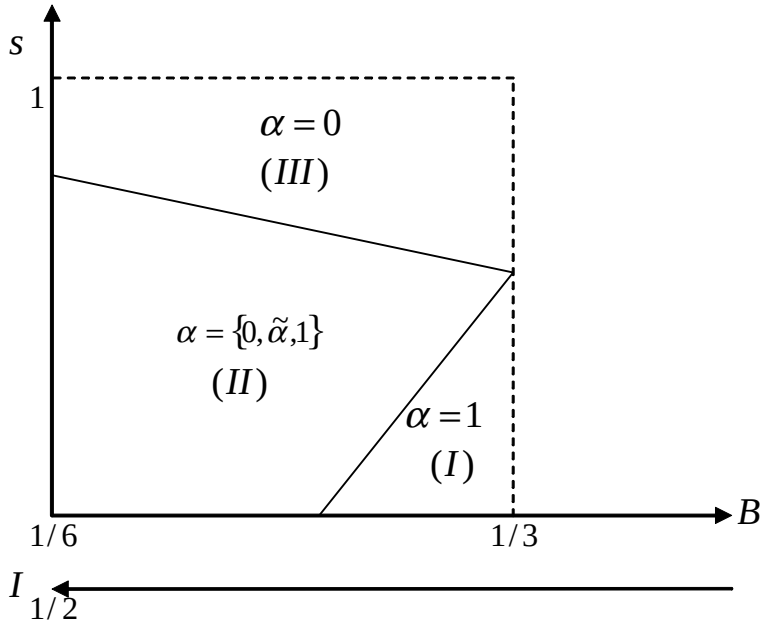


Fig. 9: Decentralised equilibrium with transfers and a heterogeneous minority

Table 1: Mother tongues

	Toronto	Montreal	Vancouver	Ottawa	Calgary	Edmonton	Quebec city
E	57.75	12.07	60.23	50.46	78.18	77.74	1.45
F	1.24	67.30	1.26	32.16	1.56	2.31	96.26
O	39.05	18.49	36.87	15.45	18.95	18.60	1.73
EF	.168	.885	.174	1.07	.20	.21	.40
EO	1.67	.416	1.41	.590	1.05	1.07	.01
FO	.099	.692	.056	.200	.04	.06	.13
EFO	.035	.145	.026	.657	.02	.02	0

E: English; F: French; O: other language; EF: English and French; EO: English and other language; FO: French and other language; EFO: English, French, and other language

Table 2: Proportion of official language minority members with knowledge of the majority language: ranking of CMAs

Kitchener (Ont)	.988	Hamilton (Ont)	.971
Abbotsford (Bc)	.987	Thunder Bay (Ont)	.969
London (Ont)	.987	St. Catherines-Niagara (Ont)	.963
Halifax (Ns)	.982	Greater Sudbury (Ont)	.962
Oshawa (Ont)	.980	St John's (Nf)	.961
Edmonton (Al)	.979	Regina (Sas)	.959
Saskatoon (Sas)	.978	Kingston (Ont)	.958
Winnipeg (Man)	.978	Saguenay (Qc, F)	.944
Victoria (Bc)	.977	Québec (F)	.933
Vancouver (Bc)	.977	Ottawa-Gatineau (Ont)	.760
Saint John (Nb)	.977	Sherbrooke (Qc,F)	.731
Calgary (Al)	.976	Trois Rivières (Qc,F)	.691
Toronto (Ont)	.973	Montréal (F)	.673
Windsor (Ont)	.971	Ottawa-Gatineau (Qc, F)	.594

F: CMA with a French mother tongue majority. Provinces: Al: Alberta, Bc: British Columbia, Ma: Manitoba, Nb: New Brunswick, Nf: Newfoundland, Ns: Nova Scotia, Ont: Ontario, Qc: Quebec, Sas: Saskatchewan

Table 3: Proportion of immigrants with knowledge of the majority language: ranking of CMAs

Trois Rivières (Qc,F)	.976	Windsor (Ont)	.936
Regina (Sas)	.971	Edmonton (Al)	.934
Saint John (Nb)	.971	Hamilton (Ont)	.931
Saskatoon (Sas)	.967	Kitchener (Ont)	.929
Thunder Bay (Ont)	.967	Québec (Qc,F)	.921
Halifax (Ns)	.962	Calgary (Al)	.912
Kingston (Ont)	.961	Toronto (Ont)	.900
Oshawa (Ont)	.960	Ottawa-Gatineau (Ont)	.896
St. Catherines-Niagara (Ont)	.958	Saguenay (Qc, F)	.889
Greater Sudbury (Ont)	.958	Vancouver (Bc)	.874
Winnipeg (Man)	.957	Abbotsford (Bc)	.872
Victoria (Bc)	.944	Sherbrooke (Qc,F)	.819
London (Ont)	.940	Montréal (F)	.738
St John's (Nf)	.937	Ottawa-Gatineau (Qc, F)	.719

Table 4: Assimilation of the official mother tongue minority in Canadian cities (2001)

	Dependent variable: Assimilation of official minority					
	All cities		anglophone cities		francophone cities	
	(1)	(2)	(3)	(4)	(5)	(6)
Minority	-.553***	.193	-.547***	.202	-1.52***	-1.27**
	(.089)	(.176)	(.073)	(.132)	(.520)	(.530)
Minority*F	-1.11***	-1.34***				
	(.179)	(.333)				
Majority	.017	-.001	.014	-.003	.091	-.104
	(.044)	(.040)	(.038)	(.031)	(.258)	(.285)
Minority below 5%		.170***		.171***		.099
		(.036)		(.027)		(.070)
Minority below 5%*F		-.089*				
		(.052)				
CMA (dummy)	-.031**	-.030**	-.026**	-.030***	-.040	-.026
	(.013)	(.012)	(.012)	(.010)	(.040)	(.040)
F (dummy)	-.082***	.026				
	(.020)	(.056)				
Likelihood ratio	233.5	258	49.8	82.4	40.3	42.2

Notes: The figures reported are the coefficients obtained from tobit estimation. Standard errors in parentheses. *, ** and *** denote significance at 10%, at 5%, and 1% levels, respectively. Data are from the 2001 Canadian Census, http://www.statcan.ca/english/census01

Table 5: Assimilation of immigrants in Canadian cities (2001)

	Dependent variable: Assimilation of immigra						
	All cities		anglophone cities				fr
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Minority	.027	.046		.062	.048	.061	
	(.061)	(.062)		(.066)	(.039)	(.041)	
Minority*F	-1.39***	-1.42***					
	(.121)	(.119)					
Majority	.101**	.122***	.225***		.139***	.146***	-.650***
	(.037)	(.038)	(.018)		(.025)	(.026)	(.093)
Years in Canada	.0038***	.004***			.003***	.003***	
	(.0009)	(.001)			(.001)	(.001)	
Years in Canada*F	-.004*	-.003					
	(.0025)	(.002)					
F	.091	.050					
	(.055)	(.057)					
Composition of the recent immigration (2)		.019				.023	
		(.033)				(.021)	
Composition of the recent immigration (2)*F		.378**					
		(.153)					
CMA		.008				-.001	
		(.009)				(.006)	
Likelihood ratio	265	274	94.8	.9	123.3	124.5	30.3

Notes: The figures reported are the coefficients obtained from tobit estimation. Standard errors in parentheses. *, ** and *** denote significance at 10%, at 5%, and 1% levels, respectively. Data are from the 2001 Canadian Census, http://www.statcan.ca/english/census01

Table 6: Assimilation of all minorities in Canadian cities (2001)

	Dependent variable: Assimilation of all r				
	All cities		anglophone cities		fra
	(1)	(2)	(3)	(4)	(5)
Minority	-.264*	.111	-.339***	.064	-1.54**
	(.156)	(.170)	(.122)	(.119)	(.594)
Minority*F	-1.02***	-1.08***			
	(.161)	(.252)			
Majority	.133**	.087	.100**	.074*	-.154
	(.061)	(.057)	(.048)	(.040)	(.362)
Native Americans in all minorities	.014	.037	-.048	-.104	.099
	(.084)	(.078)	(.076)	(.064)	(.221)
Immigrants in all minorities	-.141*	-.175**	-.191***	-.207***	.904**
	(.073)	(.068)	(.058)	(.049)	(.339)
Immigrants in all minorities*F	.174**	.221***			
	(.080)	(.074)			
Years in Canada*Immigrants in all minorities	.003**	.0028*	.004***	.003***	-.038**
	(.001)	(.0015)	(.001)	(.001)	(.015)
Composition of recent immigration *Immigrants in all minorities	.059	.030	.068*	.039	.041
	(.046)	(.043)	(.035)	(.029)	(.704)
Composition of recent immigration *Immigrants in all minorities*F	-.028	.076			
	(.475)	(.439)			
Official minority below 5%		.123***		.123***	
		(.027)		(.019)	
Official minority below 5%*F		-.057			
		(.040)			
CMA	-.005	.010	-.003	-.008	-.107**
	(.011)	(.010)	(.008)	(.007)	(.042)
CMA*F	-.023	.007			
	(.024)	(.023)			
F	-.119***	-.105*			
	(.040)	(.057)			
Likelihood ratio	272.7	295.6	104	139.8	54

Notes: The figures reported are the coefficients obtained from tobit estimation. Standard errors in parentheses. *, ** and *** denote significance at 10%, at 5%, and 1% levels, respectively. Data are from the 2001 Canadian Census, http://www.statcan.ca/english/census01