DISCUSSION PAPER SERIES

IZA

IZA DP No. 6072

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October 2011

Forschungsinstitut
zur Zukunft der Arbeit
Institute for the Study
of Labor

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Discussion Paper No. 6072
October 2011

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ABSTRACT

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The successful acquisition of a language is often characterized in terms of critical periods. If this is the case it is likely that children who migrate face different challenges in attaining high school credentials depending upon their age at immigration. This paper examines the education outcomes of a cohort of immigrants who arrived in Canada as children. The 2006 Census is used and it is found that there is in fact a distinct change in the chances that children will hold a high-school diploma according to the age at which they arrived in the country. The chances of being a high-school dropout do not vary according to age at arrival up to about the age of nine, with children arriving after that age facing a distinct and growing increase in the chances that they will not graduate from high school. The findings suggest that public policy addressing the long run success of immigrant children needs to be mindful of the variation in risks and opportunities by age, and the role of both early childhood investment and the structure of the education system faced by young adolescents in determining them.

JEL Classification: I29, J13

Keywords: children, immigration, education

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* Earlier versions of this chapter were presented to a research seminar at Statistics Canada, the Research Seminar on Child Migration in Comparative Perspective supported by the Princeton Institute for International and Regional Studies at Princeton University in August 2009, and the Jacobs Foundation Conference 2009 conference on Capitalizing on Migration, The Potential of Immigrant Youth held at Schloss Marbach, Germany in April 2009. The comments and feedback of participants at these seminars, and also the detailed comments by Ann Masten, Karmela Liebkind, and Marta Tienda, is acknowledged with thanks, as is the support of the Jacobs Foundation. The research assistance of Ive Delahousse, who was responsible for the data development, is also acknowledged with appreciation.

Age at immigration and the education outcomes of children

1. Introduction

There is no simple or single answer to the question of how migration influences the well-being of children. The answer will very much depend upon the counterfactual state that represents the basis for any causal comparison. Would the child have been better off: if the parents had decided not to migrate; the parents had migrated to a different country; if the parents had migrated at a different point in the child's life cycle; or if the parents had given birth in the new country? Each question presupposes a different counterfactual, all of them being relevant to an assessment of the child's well-being.

Even this series of questions does not exhaust the possible dimensions of the issue. But to keep the counterfactual question explicitly in mind does help to structure analysis, keep its relevance in perspective, and ultimately to highlight the possible public policy mechanisms that can be both addressed and evaluated. The analysis in this paper focuses on only one of these questions, and on a particular measure of child well-being: how would the education outcomes of the child differ if he or she had migrated at a different point in the life cycle? Focusing on this question is one way of allowing the concerns of child migrants to be informed by the research on child development. This growing literature underscores the importance of the early years in determining adult social and economic success. The suggestion that the full development of a child's social and cognitive competencies passes through a series of stages, or sensitive periods, in which competencies at one stage build the foundation for subsequent development, implies the need to give distinct attention to child migrants. Children, in a way different from adults, face important transitions in their lives, and migration during these particularly critical periods may have long lasting impacts on their capacities to become successful and self-reliant adults, impacts that may be much more costly and difficult to remedy at a later stage.

The next section of the paper briefly sketches this literature in a manner that emphasizes policy implications, and motivates an analysis of the relationship between education outcomes, in particular high school graduation, and age at arrival in the destination country. The objective of the analysis in this paper is to uncover the extent and nature of distinct periods during which there is a greater risk of not completing high school. Is there a critical period after which the likelihood of high school graduation falls? What is its nature? When does it occur?

This is an exercise in description and there is a certain caution required in ascribing a causal interpretation to the findings. As such this research is the first step in answering the question of whether a particular child would have been better off if his or her parents had changed countries when he or she was younger or older. Causal inference is difficult to make because we do not observe the same child in two different states, and we cannot rely on a randomized experiment. The analysis is based upon observational data potentially subject to selection problems that make a clear causal inference difficult without convincingly controlling for the unobserved influences that may vary with the child's age at arrival in the destination country. This said, our analysis of Canadian Census data, which is described in section 3, offers a very large and representative sample to document high school graduation by age at arrival, but also according to the country of origin and its linguistic distance from English or French, Canada's two official languages.

The findings are presented in sections 4 and 5, and suggest that there is in fact a critical age beyond which child migrants experience a greater risk of not completing high school, that its presence is associated in a predictable way with the extent of the challenges faced in learning English and French, and that it is likely no older than the age of nine. This point in the child's life cycle is associated with the acquisition of a second language during the period that elementary school aged children are also making the transition from "learning to read" to "reading to learn." It is not possible to distinguish the separate role of the social and learning environments of schools in determining this outcome from the maturational changes children go through during this period in their lives. As such the threshold we uncover could well reflect critical "social" periods reflecting the structure of the education system and public policy choices as much as they reflect critical or sensitive "learning" periods in the child's development.

2. Overview and motivation

The importance of the early years on the development of the adult capacities of children is studied and acknowledged in a large growing literature from a number of different disciplines. Knudsen *et al.* (2006) offer a particularly clear and succinct summary of the major findings, but just as importantly they sketch out the logic of an argument stressing the relevance for public policy. Their discussion begins with the observation that early experiences seem to have long-lasting consequences, influencing adult competencies as well as social and labour market success. How and why this occurs has important implications, in their view, for the future productivity of society, and raises a need for public policy to invest in the development of young children from disadvantaged backgrounds. Their policy recommendations rest on the claim that the returns to social investments in children during the early years, exceed those offered to school age children, which in turn are greater than remedial training offered to adults: “the most cost-effective strategy for strengthening the future of the American workforce,” the authors state, “is to invest greater human and financial resources in the social and cognitive environments of children who are disadvantaged, beginning as early as possible. The greatest return derives from investing in disadvantaged children because their home environments are impoverished.” (p. 10161)

Early experiences influence social, emotional, and cognitive capacities in a way that impacts upon adulthood because learning is hierarchical, and because it progresses through a series of so-called “sensitive” periods. The early development of skills influences the ability to master related and other skills, and ultimately determines competencies at later stages in life. “Skills beget skills,” meaning that capabilities at a particular point in life are based upon foundations set at earlier points. The development of the capacities of the child occurs through a recursive process with the opportunities and challenges at a point in time being dependent upon the nature and extent of development at earlier stages in the child’s life. This learning is subject to sensitive periods during which specific skills can be mastered with greatest ease and productivity. This refers to early experiences shaping temperament and social development, but it also refers to perceptual and cognitive skills. Knudsen *et al.* (2006) make a point of citing language acquisition as illustrating this hierarchical process subject to sensitive periods, and in particular highlighting second language acquisition. “Learning a second language as an adult requires far greater effort than learning it as a child, and the result is never complete” (Knudsen *et al.* 2006, p. 10158). They make note of Johnson and Newport (1989), a study of 46 Chinese and Korean immigrants who came to the United States as children and whose English proficiency was tested in adulthood after at least ten years since arrival. They claim that this study shows that proficiency does not vary with Age at Arrival up to the age of seven, and then deteriorates with each subsequent year. By late adolescence language proficiency is no better than for those who arrived as adults in their 20s and 30s.

This hierarchical pattern with sensitive periods occurs because the expression of genes is triggered by environmental influences, and neural circuits in the brain are more susceptible to the influence of experience during sensitive periods in their maturation. The molecular and cellular mechanisms that mediate neural plasticity are more active during sensitive periods, after which they operate less effectively. It is easier to form connections in a neural circuit that is not already established since experience reinforces and strengthens already existing patterns, stabilizing them, and making it more difficult for subsequent experiences to change the initial configuration. As such early experiences have the greatest influence on the architecture of the brain because they influence connectivity in the absence of already established patterns.

> In the hierarchies of neural circuits that support complex behaviour, sensitive periods for circuits at lower levels in the hierarchy, which perform more fundamental computations, tend to close before those for circuits at higher levels. ... The sensitive periods for most lower-level circuits end relatively early in life. In contrast, sensitive periods for more high-level circuits remain open until the individual approaches adulthood. (p. 10159)

In other words, learning occurs in the way it does because the structure of the brain is influenced by both experience and genes. This influence leads to a recursive pattern in the development of competencies since it occurs through a series of sensitive periods with successively decreasing plasticity of the neural network.

The fact that “skills begets skills” in both cognitive and non-cognitive functions of the child has implications for adult labour market success and societal productivity. The authors suggest that the emotional and temperamental development of the child occurs this way, making social skills in adulthood, and hence relative success in the labour market, dependent upon the experiences—particularly the nature of the mother-child bond—during the early years. While they note that these non-cognitive skills are important for labour market success, they also point to the impact of the early year environments on cognitive skills and school success, factors traditionally associated with human capital and earnings. In particular, language acquisition is claimed to progress through a series of sensitive periods, each building upon the next. Children first learn to distinguish similar sounds that convey different meanings, which supports the next stage of development involving the skill to segment sounds into words, then to attach meaning to words, and finally to use syntax and grammar in a meaningful way. Experiencing a deprived environment during any of these periods raises the risks that subsequent skills will not be successfully or fully developed. Though not all aspects of language acquisition are subject to sensitive periods, studies of children who have lived through deprived circumstances or who have never experienced language suggest a strong correlation between early experience and later outcomes: if the appropriate foundations are not laid subsequent learning is impeded not withstanding intensive training.

This in part explains the interest of social scientists in the acquisition of a second language by immigrants, who in some sense experience a sharp depreciation in the value of competencies obtained with the language in their country of origin. The fact that their competencies may not be suited to the language in their country of destination, and that language acquisition must start anew at an older stage in life, offers a test of the relevance and importance of sensitive periods in the learning process. This is an important aspect of why the study of child migrants deserves distinct attention. Children are likely to experience migration differently than adults, with distinct opportunities and challenges because of how the learning process occurs. Further, if the logic of the public policy argument put forward by Knudson *et al.* (2006) is accepted, they also represent a group for which public policy, for better or worse, can make a difference in long term outcomes that have broad social implications.

In fact, second language acquisition has long been motivated by the idea of "sensitive" or "critical" periods. For example, Penfield and Roberts (1959) is an often cited reference putting forth the idea that language acquisition is subject to a critical period, the end of which is associated with a neurological change associated with maturation. Birdsong (2006) and many of the essays in Birdsong (1999) offer an overview of this literature. The theoretical research in this area often associates critical periods with puberty, though there does not appear to be a consensus on this. Some theoreticians place the critical period as early as 5 or 6 years, others as old as 12 to 15. Further, in some perspectives puberty is associated with the stage at which declines in second language competencies end, but in others with the stage at which it begins (Birdsong 2006, pp. 18-19).

The empirical literature is addressed to the exact timing of any discrete changes in the relationship between the Age at Arrival and second language competence. In fact, Johnson and Newport (1989), who focus on a test of grammatical judgment, is only one of many empirical studies adopting this research design. Flege (1999) and Flege, Munro, and MacKay (1995) are of particular interest as they describe results from a sample of 240 Italians who came to Canada as children or young adults, and had been in the country for an average of 32 years when studied. Their focus, like that of much of this literature, is on the degree to which the second language is spoken with a foreign accent. In this research the capacity to speak English with a native-like accent declines linearly with age, and no distinct thresholds are apparent in the data. Chiswick and Miller (2008) and Hakuta, Bialystok and Wiley (2003) are also of interest in that the US Census is used to study the self-reported language abilities of a large sample of immigrants. Hakuta *et al.* (2003) study 2.3 million immigrants of Spanish and Chinese backgrounds who had been in the country at least ten years. They find a linear decline in language ability, and no evidence of discontinuities that would lend support to a critical period. Their analysis, however, does not focus specifically on children and is restricted to examining possible discontinuities at ages 15 and 20 years. Chiswick and Miller (2008) offer a more comprehensive use of the data, but reach broadly similar conclusions. In fact, the reviews by Birdsong (2006, 1999) suggest that the evidence for a distinct critical period is not clear, in part reflecting methodological differences associated with different outcomes and disaggregation of the data across studies. These studies are often based on relatively small samples of specific groups, often with little control for possible other influences, Hakuta *et al.* (2003) and Chiswick and Miller (2008) being notable exceptions.

In general second language competencies deteriorate for immigrants with age at arrival, so that younger is better, but it is not clear that there is an empirical consensus on the presence and nature of distinct thresholds in these patterns. This is a somewhat more ambiguous picture than that painted by Knudsen *et al.* (2006) and other analysts and advocates of the importance of the early years for public policy, but it should be noted that the focus is on a limited set of outcomes which may be associated in varying degrees with social and economic success in adulthood depending upon the context. Accordingly the outcome we focus upon is not on foreign accent or language skills, but one that is more directly tied to socio-economic outcomes in adulthood—high school graduation—though perhaps less informative about the specific mechanisms at work. Educational attainment is directly related to future productivity, but in addition to being associated with maturational changes associated with language competencies it also highlights the role of social competencies. In addition, public policy determines the structure of the school environment, both as a learning and a social environment, and is also likely to be associated with outcomes. Even if there are no critical or sensitive periods in language acquisition they may be evident in eventual education attainment because of the development of social competencies and the structure of the schooling system, which may accentuate or alleviate the challenges migration implies for children.

3. Data and measurement

Our analysis uses the 2006 Canadian Census. The Census is administered to all households, but a random sample of 20 per cent of the population is required to complete the so-called “long form” version of the questionnaire, offering detailed socio-economic information on a very large number of respondents. This is the source of our analysis because it offers information on educational attainment, but also on immigration background including country of origin and Age at Arrival. The potentially very large sample size makes this data one of the more important sources of information on immigrants to Canada, supporting a large number of studies but surprising few on child migrants.[1]

The file for analysis is based upon all adults between the age of 35 and 55 in 2006, a sample of about 2.1 million representing a population of 10.2 million. We use a number of restrictions to ensure accuracy and consistency of the data, but principally to restrict the respondents to those who report they are immigrants who arrived in the country before the age of 18. These restrictions lead to a sample size of 111,302. The details of this sample selection process are described in the appendix.

We focus the analysis on what we call Age at Arrival (AaA). This is what is measured in our data. It is calculated from information on the year the individual recalls arriving in Canada.[2] It should be distinguished from a number of concepts used in the second language acquisition

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[1] Aydemir, Chen, and Corak (2009a,b) use the 2001 version of these data to study second generation Canadians, while Ferrer and Riddell (2008), and Schaasfma and Sweetman (2001) use similar public use versions on earlier years to offer evidence of earnings and age at arrival. Ferrer, Green, and Riddell (2006) also examine issues associated with age at arrival from other surveys. See also Ornstein (2006a,b) for the use of the full version of the long-file respondents, though he does not focus on age at arrival. Böhlmark (2009, 2008) and Gonzalez (2003) are examples of studies from other countries using large samples of representative data to study education and earnings outcomes. Both authors find that education outcomes deteriorate for those children migrating after the age of nine. Böhlmark (2009, 2008) examines child migrants to Sweden with administrative data and finds that this is the case for GPA and final grades but not necessarily for level of education attainment, while Gonzalez using US Census data finds that the negative impact of arrival after about the age of nine to 12 is strongest for those coming from Mexico. Böhlmark (2009) is a notable reference since particular attention is paid to selection biases that may make causal inference difficult. The author uses sibling differences to identify a causal impact, and finds that the results are in fact similar to cross sectional regressions controlling for country of origin and parental education.

[2] Strictly speaking this is the age at landed immigrant status, but it is not apparent that respondents answer the question in this way. Further, it should be noted that individuals who recently entered the country as refugees are not included in the analysis. These individuals do not have a value for the year at arrival because they do not have landed immigrant status. This also implies that it is not possible to know whether a given immigrant initially came as a refugee, and then subsequently received landed immigrant status and even citizenship. For all immigrants who came as refugees, the age at arrival variable in our analysis will in a sense overstate the true age at arrival if the respondents do in fact report on the year landed immigrant status was obtained. This would not capture any time spent in the country prior to becoming a landed immigrant.

literature, which are likely to be more conceptually relevant measures. The most studied measure, and the one considered the most strongly predictive of second language competencies, is Age of Acquisition (AoA). This refers to the age at which the individual is immersed in the new language context. AoA may not be the same thing as AaA if, for example, a child arrived in the country during the pre-school years and was not exposed to English or French until starting school. Both of these measures are also distinct from Age of First Exposure (AoE), which indicates when the individual first became exposed to the second language. This could well be before AaA as a result of the language of instruction in formal schooling in the country of origin, visits to other countries, or contact with relatives or other speakers of the second language. AaA will often coincide with AoA but obviously this is not an experience that will characterize all migrants from the many different source countries to Canada, or even within the same source country.[3] Further, there will be a potential bias using the data to uncover a critical period to the extent that AaA differs from AoE.

Figure 1 illustrates that our sample size is sufficiently large to support an analysis by Age at Arrival. The figure presents the unweighted sample frequencies by Age at Arrival and gender, with a total sample size of 55,016 men and 56,286 women. On average there are 3,056 observations at each Age at Arrival for men, and 3,127 for women. The analysis is restricted to individuals who arrived before the age of 18 in part to focus on individuals considered to be children according to the UN Convention on the Rights of the Child. But it also reflects the fact that there is a sharp rise in the number of individuals who arrive in the country between the ages

[3] See Birdsong (2006, pp. 11-12) for a more detailed discussion, and who also offers Length of Residence (LoR) as another distinct measure.

of 18 and 20.[4] Though individuals under the age of 21 may be admitted to the country with their parents and considered as children, this increase suggests that this population likely also has a significant number of individuals who arrived as independent migrates.[5]

We make use of the information that respondents offer on their country of origin to classify each origin county into broad categories according to the linguistic distance of the dominant language spoken in the country from English, as well as adding a classification for English speaking and French speaking countries. In order to do this we use the linguistic distance measure developed by Chiswick and Miller (2005), making some minor corrections and adaptations to the Canadian case.

Our categorization focuses on the dominant language in the country of origin, and it begins by creating a correspondence between the language codes in Chiswick and Miller (2005) for the US census to those in the Canadian Census. Not all of the languages they use are found in the Canadian Census but we established the correspondence by aggregating languages if necessary. This permits us to characterize all the languages into three categories: Low, Medium, and High. The Low category collects languages that are the farthest from English, having a score lower than 2.00 in Chiswick and Miller's terms; the Medium category of languages that are a medium distance to English, having a language score equal to 2.00; and the High category refers to languages that are closest to English, having linguistic scores of more than 2.00. [6]

[4] This is particularly the case at ages 18 and 19 when 4,005 and 4,392 men report arriving in the country, and 4,686 and 5,872 women do so. These numbers fall at age 20 to the range depicted in Figure 1.

[5] This said, it should also be noted that children may arrive in the country independently. These individuals may be as young as 16 and 17 who come for short periods to study in Canadian high schools as a part of student exchanges. To the extent that they stay in the country or emigrate as adults from their origin country at a later date they may also play a part in influencing the patterns in these data.

[6] In the process of creating this language to language score mapping, some discrepancies were discovered in Chiswick and Miller's table. For example, Burmese appeared in two separate sections with a different language

The next step in categorizing the over 100 countries of origin that appear in our data is done using the full sample of immigrants from the Census data (not just the immigrant children and young adults, who are 35 to 55 years old in 2006). If over 75% of the people coming from a particular country spoke a language that fell into one of the five categories—Low, Medium, High, English, French—then the origin country was assigned that category. Not all individuals in our sample can be categorized with confidence because more than one language is spoken in their country of origin. This ambiguity affects about 10% of our sample, with the result that over 90% of the individuals in our analytical sample are assigned a language category. This leads to a smaller sample of 101,884, made up of 50,253 men and 51,631 women that we use when linguistic distance forms part of the analysis.

We further sub-divide the sample into particular source countries to the extent permitted by sample size. On this basis the English Speaking source regions are: the United Kingdom, the United States, and the Rest of the World in which English is spoken. Those with a High linguistic similarity to English are also divided into three groups: Italy, Portugal, and the Rest of the World. The groups with a Low linguistic similarity are: Hong Kong, India, and the Rest of the World. Two remaining groups include those in which the language of the origin country is

score assigned to it in each instance. Fortunately, Burmese was not a language that appeared in the Canadian Census code set, so this turned out not to be problematic. However, in the case of Thai and Laotian, the discrepancy was important. In one instance, Laotian was listed as the primary language having a language score of 1.50, with Thai listed as being in the same group. And, in the second instance, the reverse is listed (Thai being primary, and Laotian being in the same group) but with a language score of 2.00. With the language scores being so different, the language group assigned to these languages would change depending on which score is used. To handle this issue, the two languages were considered to be independent with the primary language having the "correct" score assigned to it. So, Laotian was given a score of 1.50 putting it in the Low category, while Thai was given a score of 2.00 putting it in the Medium category.

French, and those with an intermediate distance from English, which we refer to as Medium. A detailed listing of the countries that fall into these groups is offered in the Appendix.

A summary of the sample sizes and proportions by region of origin classified into these eleven groups is offered in Table 1. Immigrants from the United Kingdom represent just over one-fifth of the entire sample, and as a group those from English speaking countries represent about 40% of the sample. Immigrants from countries with a high similarity to English are the next largest group, collectively representing about one-third of the sample. The smallest group are those from French speaking regions, with just under three percent of the total sample.

4. Overall descriptive results and some cautions

While the frequency distributions in Figure 1 shows that roughly 3,000 individuals arrived in the country at each age between newborn and 17, they also show that (with the possible exception of the oldest category) the largest fraction of children arrive in the country between the ages of one and five. This pattern raises the possibility that some parents time their migration decision with the welfare of their children in mind. If parents consider possible Age at Arrival effects on their children's welfare when timing the emigration decision then it is possible that the distribution of unobserved parental characteristics may vary across the Age at Arrival distribution. More motivated or altruistic parents who are more inclined to invest effectively in their children may be over-represented in the early Age at Arrival groups. Their children will perform better than a randomly selected group of children because of the enriched environment in which they were raised, making comparisons and causal inferences across Age at Arrival thresholds suspect. At the same time it should also be noted that generally parents do not have complete discretion as to when they will emigrate, the application being subject to administrative rules and delays, and therefore the scope for selection biases of this sort may be constrained.

The weighted averages of individuals not having a high school diploma for each Age at Arrival are calculated using these data, and offered in Figure 2 along with a local polynomial smooth of the data.[7] This is the major descriptive finding of our analysis, motivating more in depth analysis. There is a clear and distinct variation in the chances of high school graduation. At the broadest level this is in accord with the hypothesis of a sensitive or critical period: there are no changes in the proportion of high school drop-outs during the earliest years, then a distinct change in the slope with the proportion increasing practically linearly with each additional year beyond seven or eight. At age eight or younger 14.7 per cent of men will on average not have obtained a high school diploma, but after that 19.7 percent. For women these averages are 11.3 and 18.2 respectively. A linear least squares regression model fit to these data in a way that permits a break in the constant and slope of the relationship at the turning points of the local polynomial smooth in Figure 2 suggests that the chances of being a high school dropout rise by 1.2 percentage points for every year that a boy arrives in the country after age eight, and by 1.5 percentage points for every year a girl arrives after age seven.[8]

These thresholds may be associated with maturational changes related to the onset of puberty. This said, it is difficult to associate a distinct age marking the onset of puberty across

[7] The smooth is meant only as a descriptive device to aid visualization of the patterns in the data. It is not the correct tool to identify a discrete change in these patterns, and is used only to highlight a possible turning point worthy of more detailed analysis.

[8] These weighted regressions explain 97% of the total variation in the data for men, and 95.1% for women. Using a turning point of age eight for men also leads to the highest R-squared among all possible thresholds between age five and twelve. For women this happens at age ten.

time, and ethnic group. This timing is, however, in accord with the transition children must make upon the completion of the earliest years of primary education, that from “learning to read, to reading to learn.” This said, the results in Figure 2 do support the possibility of other breaks, particularly after 14 for men. This is likely associated with the institutional structure of the Canadian education system, which at the time appropriate for the sample of individuals under study had a minimum school leaving age of 16. If a boy arrived in the country at the age of 15 or higher he was much more likely to not obtain a high school diploma than if he had arrived at 13 or 14. A similar jump in the chances of being a high school drop-out also occurs for girls of the same age, but in addition there is a distinct increase after the age of 12, an age often associated with the onset of puberty and in some views the closing of a window of opportunity for language acquisition.

There are at least three cautionary issues that need to be addressed before we can adopt this causal interpretation of the findings. The first is the issue of self-selection that has already been noted. If, in some sense, unobserved family characteristics vary across the Age at Arrival distribution in a way that implies children who arrive earlier are raised in a family environment more favourable to their long run success, then the results in Figure 2 overstate the relative success rates during the early years compared to a randomly selected group of individuals. The sharp distinction at the age of seven or eight may not be as clear, and the overall level of dropping out not as low, depending upon how these unobserved influences vary over the age distribution during these earlier years. A similar reasoning but opposite in direction applies to the findings at older ages.

Second, there could very well be heterogeneity along other dimensions such as country of origin. Immigrants to Canada come from a wide range of countries, and therefore previous exposure to English and French varies significantly. It could well be that the similarity of the language in the country of origin to English or French—and hence the difficulties that must be overcome in learning the new home country language—also varies across the distribution of Age at Arrival. If those arriving at younger ages are disproportionately from English or French speaking countries, or countries with a language close to English or French so that it is easier to learn one of the official languages, then a similar bias could result.

Finally, and related to both of these factors, prior exposure to one of the official languages, even if the source country is not an English or French speaking country, could vary. As mentioned Age at Arrival should not necessarily be equated with Age of Acquisition or Age of First Exposure, which could depend on country of origin, formal schooling in the source country context, parental investments, or exposure to relatives or visits to English or French speaking countries. If those who arrive at a young age are more likely to have been exposed to one of the official languages before arriving to Canada then their outcomes would be more favourable than otherwise, and bias the findings toward the type of non-linear pattern displayed in Figure 2. This could very well be the case if some parents are preparing their children for migration to the country, or chose the country of destination according to where they expect their children will be more likely to succeed.

5. Results by country and language of origin

We address these cautions by examining the patterns in high school graduation by language of origin and mother tongue. The sample frequencies by Age at Arrival for the 11 groups of origin countries according to their linguistic distance from English are displayed in Figure 3a for men, and Figure 3b for women. There do not appear to be notable differences in the patterns across gender. These raw sample sizes make clear, for example, that the patterns observed in Figure 1—namely a greater tendency for children to arrive between the ages of one to five—are due in large measure to immigrants from just two regions: the United Kingdom and those countries linguistically close to English (particularly those countries other than Portugal and Italy). The suggestion is that the overall group of individuals who arrived in the country at a particularly young age are disproportionately from an English-speaking country and countries where the linguistic challenge in learning English is lowest. As such if they are less likely to drop out of high school because they have no or lower linguistic challenges in learning the dominant language they will contribute to an overstatement of the educational attainment—relative to a randomly chosen child of the same age—for the group of children actually observed in our sample. This selection effect combined with an opposite tendency at the other end of the Age at Arrival distribution, namely an over-representation of children from countries with languages that are not similar to English, could produce the pattern depicted in Figure 2. Children arriving in the country at the oldest ages, however, are somewhat more representative of the entire population of children. It is the case that those from countries with languages least like English have an overall tendency to arrive at a later age, but this is also the case for children arriving from countries other than the UK or the US in which the language spoken is English.

There are perhaps three messages from this information. First, all other things equal it should be expected that any patterns in the likelihood of being a high-school dropout across Age at Arrival should be muted for those from English speaking countries of origin, and if present due to factors other than language, or to more subtle language effects associated for example with accent.

Second, the causal role of language should be clearest for those countries with the greatest distance from English, subject to some control being made for non-language effects. It should also be clearest for those individuals who came from Portugal (and possibly Italy) as the frequency distribution does not appear to vary by Age at Arrival and hence the selection problem is likely to be less of a problem. The best comparison group by which to judge the causal impact of Age at Arrival and to net out these other effects is most likely to be those immigrants from English speaking countries other than the UK or the US. The reason for this is that the pattern in the frequency distribution by Age at Arrival is roughly similar for these countries as it is for countries that are least like English, those with a low linguistic distance score.

Third, the possible selection bias needs to be addressed by controlling for variations in the degree of parental investments in children across the Age at Arrival distribution. One way to do this with the available data is to attempt to measure Age of First Exposure. The Canadian Census contains a number of indicators of language ability. The closest measure that can possibly speak to the Age of First Exposure is the so-called "Mother Tongue." Question 16 of the Census asks: "What is the language this person first learned at home in childhood and still understands?" The possible responses are: English, French, and Other. Figure 4a and 4b graph for each gender and for each of the 11 source regions the proportion, by Age at Arrival, answering "Other." The fraction of individuals whose first language was not one of the two official languages is, as might be expected, low among those from English speaking origin regions, and relatively high among non-English speaking regions. But in some of these later cases it also varies systematically by Age at Arrival, and somewhat more so for men. In particular, 74.7% of men and 80.2% of women from countries (other than Italy and Portugal) with a high similarity to English have a language other than English or French as their mother tongue. But only 67.4% of men who arrived at the age of eight or younger do so compared to 87.8% of those who arrived after eight years of age. For women these proportions are 74.9% and 89.4%.

Just as importantly the figures also show a systematic rise in the proportion with a non-official language as a mother tongue for countries that have the lowest similarity to English, particularly so for men. The proportion of those with a non-official mother tongue increases on average by more than one percentage point for each additional year for those from French speaking countries, those with a high linguistic score (other than Italy and Portugal), Hong Kong, India, and for men from countries with a low and medium linguistic score. There is only a very shallow positive gradient for both men and women from Italy and Portugal.[9]

These patterns suggest that the linguistic challenges that a cohort of young immigrants faces varies not just according to their region of origin, but also within region of origin. More

[9] The weighted least squares estimates of the gradient between the proportion with a non-official language as mother tongue and Age at Arrival for each of the source regions are:

	English ROW	UK	US	French	Italy	Portugal	High ROW	Hong Kong	India	Low ROW	Medium
Men	**-0.003**	-0.000	**-0.001**	**0.011**	**0.008**	**0.006**	**0.022**	**0.014**	**0.023**	**0.010**	**0.011**
Women	**-0.003**	-0.000	**-0.002**	**0.015**	**0.006**	**0.005**	**0.016**	**0.010**	**0.018**	**0.006**	**0.008**

Boldface indicates statistical significance with a marginal significance level of at least 0.05, using robust estimates of the standard errors. The relatively sharp gradients for those from Hong Kong and India may reflect not only the English-related history of these regions, but also the emigration of ex-patriots, ethnicity not being controlled for in these regressions.

importantly it does so in a way that suggests those arriving at younger ages will likely find it easier to learn English because it was more likely to be the language they first learned.

At the same time it should be noted that to some degree these patterns may overstate the potential for this selection problem. The mother tongue question refers to the language first learned and still understood, not simply to the language first learned. So some fraction of individuals may have had a first exposure in a non-official language, subsequently lost the ability to understand, and answered the Census question by responding accordingly. The outcomes for those from Italy and Portugal are in this sense likely to be among the groups least affected by a selection problem as the gradient between Age at Arrival and mother tongue being a non-official language is the flattest, and will therefore likely be even flatter if the question truly captured first exposure. In other cases it will be important to control for mother tongue in the hope of capturing a more accurate estimate of the impact of Age at Arrival on schooling success.

Table 2 offers estimates from a series of least squares models that attempt to address these issues by controlling for mother tongue and region of origin. The results presented are for the choice of threshold maximizing the adjusted R-squared among all possible thresholds from Age at Arrival of five to twelve. The preferred model is the last one presented for each gender, indicating that the best fitting model uses a threshold of age eight. For men this is not a significant change from what visual inspection of Figure 1 would suggest. For women a threshold at age ten maximizes the adjusted R-squared when mother tongue is controlled for as well as when it is not. But the suggestion in the last column of the table, which also controls for region of origin, suggests this is due to compositional changes in the underlying sample.

These results continue to hold when a more detailed analysis is undertaken by Region of Origin. There are no clear patterns by age at arrival for English speaking regions, with the results being driven by the non-English speaking countries. Further, in almost all of these cases the threshold that best fits the data is at an age that is distinctly younger than puberty, in some cases as young as five or six.

The results for children who were born in the United Kingdom, the United States, and other countries in which English is the language spoken are presented in Figure 5a for men and Figure 5b for women. Table 3 represents the results of least squares regressions for the threshold between five and twelve that best fits these data, again in the sense of maximizing the R-squared. Two sets of results are presented for each region, one controlling for the proportion with a non-official language as a mother tongue, and another without such a control. With one possible exception, the use of this additional control variable does not change the choice of threshold. But the preferred model is that controlling for mother tongue, the simpler model being included for completeness.

The major finding from this information is that there is at best a weak relationship between Age at Arrival and educational attainment. For those from countries other than the UK or the US the break point does occur at age 11 as a step function, the change in slope not being statistically significant at a marginal significance level of 10%. On average for men the chances of being a high school drop are 4.3 percentage points higher if a child arrives after 11 than at or before, and for women just over one percentage point. But the models have low explanatory power, explaining only between 28 and 40 percent of the total variation in the data. The models for the UK have higher explanatory power, but suggest that not having high school credentials is actually higher for those arriving at younger ages. For men from the US the preferred model does not involve a threshold, but rather a linear increase in the chances of dropping out. For women there is a break, but it occurs very early, at age five. All this said, the overall the chances of not having a high school diploma are relatively low, never over 15 percent (with the major exception being men who came to Canada from the United States after the age of 10).

This contrasts sharply with the results for those from countries not speaking English. Figures 6a, 6b, and Table 4 present the findings for countries in which the language has a high resemblance to English. The break point is at ages five or six, the exception being Italy where it is nine for men and eleven for women. But it is not even clear that this model is the best fitting. A model in which there is no threshold but age is expressed as a quadratic—a specification also suggested by the pattern displayed in Figure 6b—would have a slightly higher adjusted R-squared (0.971 versus 0.969). This said, the least squares models fit the data very tightly explaining up to 97% of the variation in the Italian and Portuguese data, and more than 70% for the remaining countries. In large measure it is the data from this group of countries that drives the overall results depicted in Figure 2.

The high school drop-out rates are particularly high for those from Portugal, reaching over 60% for those who arrived after the age of 15. This high overall level is well known, as described by Nunes (2008) and studied in more detail in Ornstein (2006a,b,c). This is a community that began its migration to Canada in the 1950s and continued into the 1990s. Nunes notes that these migrants were predominantly from poor, rural regions of Portugal with relatively very low levels of education. In this sense they are a self-selected group, and the very low overall rate of attaining high school relative to other immigrant groups is not a new finding. What is new and particularly relevant in the current context is that this pattern varies markedly according to Age at Arrival, being two to three times lower for those who arrived as pre-schoolers compared to those who arrived as adolescents. A roughly similar story can be told for those from Italy.

Even if the levels of high school graduation are lower, the pattern across Age at Arrival is similar for countries whose languages have the least resemblance to English, depicted in Figures 7a, 7b, and Table 5. With the single exception of women from countries other than Hong Kong or India the threshold that maximizes the R-squared occurs at ages nine or younger, with values always higher than 0.75 and as high as 0.98.

Finally, Figures 8a, 8b and Table 6 offer the findings for those who came from French speaking regions or from countries with a mid-ranging linguistic distance score. These results also indicate a relatively young threshold but, as the figures would lead one to suggest, not in a manner that is strong. For the French speaking regions there is, as might be expected, no strong effect. When a threshold is statistically accepted it actually has a weak negative sign.

6. Conclusion

This analysis of the education outcomes of a large sample of adults who came to Canada as child migrants suggests the following three conclusions. First, there is a distinct pattern in the chances of not obtaining a high school diploma that varies with Age at Arrival in a way that is consistent with a sensitive or critical period. The chances of not being a high school graduate do not vary with Age at Arrival for those who came to the country before nine years of age, but increase by over a percentage point for every year past this age. There are also discrete increases in this risk at around the age of 14 or 15 that likely reflect the fact that during the relevant period the legal school leaving age was 16 years, but also a discrete increase for women at after 12 years of age. These results are robust to controls for the linguistic distance between the language spoken in the migrant's country of origin and one of Canada's two official languages, as well as for the possibility that first exposure to English or French occurred before migration.

Second, these patterns have something to do with the challenges children face in learning a second language as they vary in a predictable way according to the linguistic distance of the language in the country of origin from English. There is no discernable pattern between high school graduation and Age at Arrival for those who came to Canada from English or French speaking countries. Though the overall levels in high school graduation vary significantly across other origin countries, the nature of the pattern is the same: no change in the early years, followed by a distinct change in slope. The threshold for this change corresponds to the first years of primary school, being reasonably estimated to be as young as five for some regions and likely no older than nine in all the others.

Third, the underlying reasons for these findings require further study. Our research has the benefit of using a large and diverse sample of immigrants, and controls for some of the more important aspects of the underlying heterogeneity. We focus on education outcomes because of the policy relevance of the issue, but the patterns we uncover are distinct and robust in a way that cannot be described of previous research that has focused specifically on language proficiency. More detailed analysis is necessary to discern the degree to which the results are due to maturational changes in the cognitive capacities of children to learn a second language, sensitive periods in their social development, or to institutional features of the education system that are not sufficiently attune to the needs and challenges of children in the senior primary or young adolescent age groups.

Future research, particularly in a comparative context, would be helpful to discern the relative roles of these factors, particularly that of institutional design. It may well be that education systems that track students into different streams at a very early age may reinforce or aggravate pre-existing risks associated with cognitive and social integration. This would be a particularly policy relevant issue to focus upon, and underscores the need to appreciate the distinct challenges confronting child migrants.

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Appendix Table A1

Sample selection rules used in the creation of the analytical file from the 20% file of the 2006 Census

Sample Selection Rules	Sample Count	Population Total
Total adult population 35 to 55 years of age (inclusive)	2,137,809	10,225,084
1. Exclusions for out of scope or anomalies		
Institutional residents	53,111	53,111
Refugees	15,610	69,766
Cases with rare characteristics[1]	5,908	28,534
Residing in one of the three territories	20,333	31,408
Total population after exclusions	2,042,847	10,042,265
2. Exclusions for immigrant status		
Canadian born with Canadian born parents	1,315,123	6,321,972
Canadian born with Foreign born parents	258,099	1,302,630
Foreign born, Age at Arrival older than 20 years	332,559	1,717,506
Total population after exclusions	137,066	700,157
3. Exclusions for outlying values[2]		
Foreign born, Age at Arrival 20 years or younger with employment income of outlying or of negative value	1,053	5,347
4. Analytical Sample with Age at Arrival of 20 years or younger	136,013	694,810

Note: the analysis in the text is based upon a sample of 111, 302 individuals less than 18 years of age at arrival. Further, the analysis using region of origin classified according to linguistic distance from English and French is based upon a sample of 101,884. This latter sample restriction reflects the fact that more than one language is spoken in some countries. When the proportion of all immigrants in 2006 from a particular country reporting more than one language exceeds 25% the country is not assigned a language and individuals from that country excluded from the analysis.

1. Some individuals are coded as Canadian-born with respect to the age at immigration variable but at the same time coded as being born in Canada. Similarly, some others are coded in the Census as both Canadian-born and as having an age at immigration. This can occur in some rare situations. For example, a mother giving birth to her baby in Canada can move back to her country of origin shortly after. Then, if the child immigrates at a later date, he or she would legitimately have an age at immigration despite having been born in Canada.

2. Employment income is considered as outlying when greater than three standard deviations from the mean employment income for the overall population of immigrants. Individuals whose employment income was negative are also removed from the sample since this is probably a reflection of temporary losses for self-employed individuals.

Appendix Table A2

Categorization of countries of origin according to distance of language spoken from English

English

Anguilla
Antigua and Barbuda
Bahamas
Barbados
Bermuda
Cayman Islands
Dominica
Grenada
Jamaica
Montserrat
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and Grenadines
Trinidad and Tobago
British Virgin Islands
Guyana
Ireland
Republic of South Africa
Australia
New Zealand

United States and United Kingdom are categorized separately

French

Saint Pierre and Miquelon
Guadeloupe
Haiti
Martinique
France
Réunion
Gabon

Medium Score

Bulgaria
Czech Republic
Slovakia
Hungary
Poland
Estonia
Finland
Bosnia and Herzegovina
Croatia
Macedonia
Serbia and Montenegro
Slovenia
Yugoslavia n.o.s.
Eretria
Afghanistan
Iran
Turkey
Philippines

High Score: Lowest linguistic distance from English

Costa Rica
El Salvador
Guatemala
Honduras
Mexico
Nicaragua
Panama
Cuba
Dominican Republic
Puerto Rico
Argentina
Bolivia
Brazil
Chile
Colombia
Ecuador
Paraguay
Peru
Uruguay
Venezuela
Austria
Germany
Liechtenstein
Netherlands
Romania
Belarus
Republic of Moldova
Russian Federation
Ukraine
USSR n.o.s.
Denmark
Iceland
Norway
Spain
Angola
Kazakhstan
Kyrgyzstan
Tajikistan
Uzbekistan

Italy and Portugal are categorized separately

Low Score: Highest linguistic distance from English

Greece
Palestine / West Bank / Gaza
Peoples' Republic of China
Macau
Japan
North Korea
South Korea
Taiwan
Brunei Darussalam
Laos
Vietnam
Fiji

Hong Kong and India are categorized separately

Table 1
Sample sizes and proportions by Regions of Origin classified according to linguistic distance from English and French: Men and Women

	Men		Women	
	Unweighted Sample Size	Percent	Unweighted Sample Size	Percent
English				
Rest of World	5,131	10.2	5,946	11.5
United Kingdom	10,693	21.3	10,916	21.1
United States	3,899	7.8	4,510	8.7
French	1,285	2.6	1,477	2.9
High Similarity to English				
Italy	5,687	11.3	5,518	10.7
Portugal	3,803	7.6	3,866	7.5
Rest of World	7,039	14.0	6,957	13.5
Low Similarity to English				
Hong Kong	1,786	3.6	1,774	3.4
India	2,004	4.0	1,973	3.8
Rest of World	4,841	9.6	4,510	8.7
Medium Similarity to English	4,085	8.1	4,184	8.1
Total	50,253	100	51,631	100

Table 2
Least squares regression results for most likely thresholds of Age at Arrival impacts on not having graduated from High School: Men and Women

	Men			Women		
	T = 7	T = 7	T = 8	T = 10	T = 10	T = 8
Age at arrival	0.000105	-0.00183	-0.000805	0.00223	0.00124	-.000532
T	-0.0138	-0.00805	0.00250	-0.0123	-0.0100	-0.0107
T x Age at Arrival	**0.0112**	**0.0106**	**0.0127**	**0.0168**	**0.0152**	**0.0163**
Mother Tongue		**0.112**	**0.143**		**0.112**	**0.220**
Region of Origin	none	none	eleven	none	none	eleven
Constant	**0.150**	**0.0930**	**0.0592**	**0.131**	**0.0725**	0.0218
R-squared adjusted	0.0980	0.284	0.790	0.168	0.358	0.733
F test – p value	0.0010	0.000	0.000	0.000	0.000	0.000

Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest adjusted R-squared among all possible thresholds from 5 to 12 years. Sample size is 198 observations by Age at Arrival from zero to 17 for each gender, representing 50,253 men and 51, 631 women. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with shading indicating the marginal significance level: **less than or equal to 0.05**; greater than 0.05 and less than or equal to 0.10; greater than 0.10. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English speaking countries other than the UK or the US. P value for the F test refers to the null hypothesis that all regressors except the constant equal zero.

Table 3
Least squares regression results for most likely thresholds of Age at Arrival impacts on High School and University Attainment: Men and Women for English Speaking Regions of Origin

	Rest of World		United Kingdom		United States	
1. Men	T = 11	T = 11	T = 5	T = 5	T = none	T = none
Age at arrival	-0.00141	-0.00215	0.00363	0.00417	**0.00367**	**0.00353**
T	**0.0403**	**0.0427**	-0.0218	**-0.0209**		
T x Age at Arrival	-0.00448	-0.00546	-0.00417	**-0.00539**		
Mother Tongue		-0.297		-0.636		-0.101
Constant	**0.0907**	**0.104**	**0.139**	**0.163**	**0.122**	**0.128**
R squared	0.244	0.279	0.384	0.498	0.396	0.401
F test – p value	0.0467	0.0705	0.0306	0.0389	0.006	0.0193
2. Women	T = 11	T = 11	T = 9	T = 8	T = 5	T = 5
Age at arrival	-0.00003	0.000573	**-0.00226**	**-0.00296**	-0.00806	-0.00573
T	-0.0261	-0.0259	**0.0312**	0.0158	0.00884	0.0120
T x Age at Arrival	**0.0111**	0.0107	-0.00392	0.000655	**0.0156**	**0.0135**
Mother Tongue		0.147		**-0.661**		0.443
Constant	**0.0711**	**0.0663**	**0.0931**	**0.116**	**0.0593**	**0.0404**
R squared	0.392	0.396	0.548	0.760	0.629	0.662
F test – p value	0.0036	0.0051	0.0049	0.000	0.000	0.0001

Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. Mother Tongue refers to the proportion of an age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with shading indicating the marginal significance level: **less than or equal to 0.05**; greater than 0.05 and less than or equal to 0.10; greater than 0.10. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English speaking countries other than the UK or the US. P value for the F test refers to the null hypothesis that all regressors except the constant equal zero.

Table 4
Least squares regression results for most likely thresholds of Age at Arrival impacts on High School and University Attainment: Men and Women from countries with a high resemblance to English, by age at arrival

	Italy		Portugal		Rest of World	
1. Men	T = 5	T = 9	T = 5	T = 6	T = 6	T = 6
Age at arrival	0.00784	**-0.0111**	**-0.0100**	0.00280	0.00403	0.0140
T	**-0.0738**	**0. 0799**	**0. 0479**	**0.0644**	**-0.0493**	**-0.0522**
T x Age at Arrival	**0.0170**	**0.0302**	**0.0393**	**0.0256**	0.00685	0.000116
Mother Tongue		**0.875**		-0.270		-0.243
Constant	**0.205**	-0.648	**0.255**	0.531	**0.213**	**0.405**
R squared	0.937	0.951	0.974	0.969	0.724	0.743
F test – p value	0.000	0.000	0.000	0.000	0.0001	0.0001
2. Women	T = 9	T = 11	T = 5	T = 5	T = 6	T = 6
Age at arrival	**0.00979**	0.00672	0.00520	0.00317	**-0.00411**	-0.00191
T	-0.0158	0.0369	0.000390	-0.00469	**0.0464**	0 .0482
T x Age at Arrival	**0.0342**	**0.0399**	**0.0293**	**0.0309**	**0.00786**	0.00577
Mother Tongue		0.536		0.205		0.0606
Constant	**0.198**	-0.290	**0.222**	0.0318	**0.124**	0.175
R squared	0.973	0.976	0.965	0.966	0.716	0.717
F test – p value	0.000	0.000	0.000	0.000	0.000	0.0001

Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. Mother Tongue refers to the proportion of an age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with shading indicating the marginal significance level: **less than or equal to 0.05**; greater than 0.05 and less than or equal to 0.10; greater than 0.10. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English speaking countries other than the UK or the US. P value for the F test refers to the null hypothesis that all regressors except the constant equal zero.

Table 5
Least squares regression results for most likely thresholds of Age at Arrival impacts on High School and University Attainment: Men and Women from countries with a low resemblance to English, by age at arrival

	Hong Kong		India		Rest of World	
1. Men	T = 5	T = 5	T = 8	T = 7	T = 11	T = 7
Age at arrival	**-0.00589**	**-0.00766**	-0.00765	-0.0160	-0.000992	0.00826
T	**0.0221**	0.0193	0.0118	-0.0121	0.0184	**-0.0490**
T x Age at Arrival	**0.0122**	**0.0136**	**0.0360**	**0.0377**	**0.0341**	**0.0225**
Mother Tongue		0.0516		0.267		**-0.598**
Constant	0.00422	-0.0389	**0.0302**	-0.163	**0.114**	**0.635**
R squared	0.865	0.868	0.879	0.892	0.954	0.962
F test – p value	0.000	0.000	0.000	0.000	0.000	0.000
2. Women	T = 8	T = 9	T = 8	T = 8	T = 11	T = 11
Age at arrival	0.00532	**-0.00744**	-0.00309	-0.00292	0.000744	0.00146
T	**-0.0510**	**-0.0502**	-0.0218	-0.0224	**0.0336**	**0.0349**
T x Age at Arrival	0.00706	**0.0188**	**0.0369**	**0.0371**	**0.0364**	**0.0356**
Mother Tongue		**0.707**		-0.0161		0.0826
Constant	**0.0564**	**-0.605**	**0.0188**	0.0309	**0.107**	0.185
R squared	0.618	0.752	0.952	0.952	0.987	0.987
F test – p value	0.0057	0.000	0.000	0.000	0.000	0.000

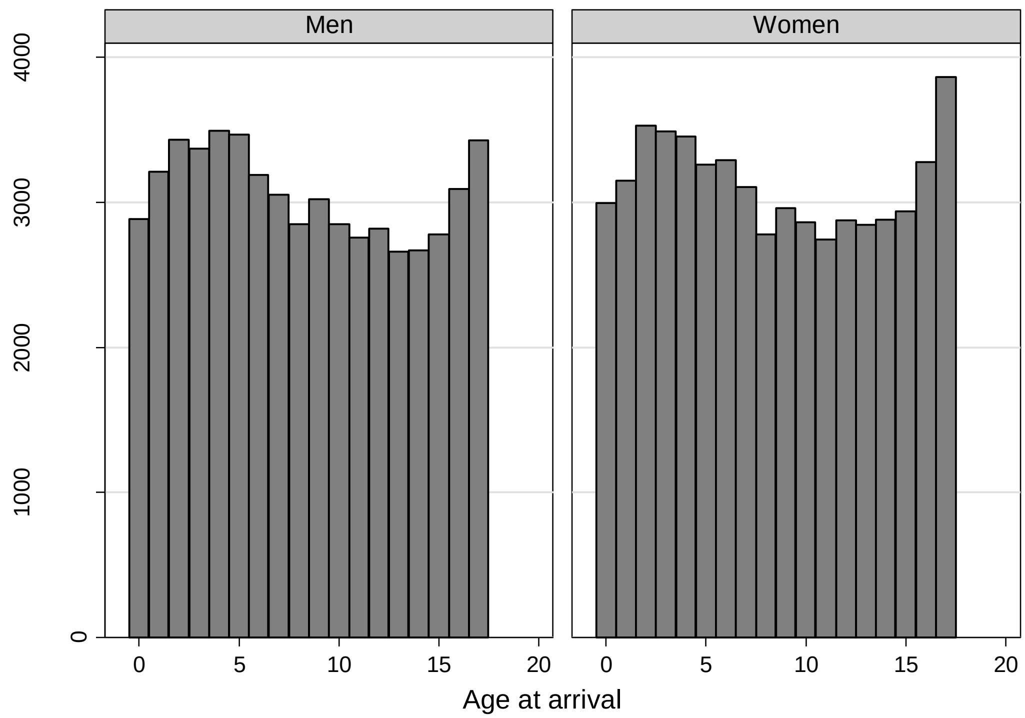
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. Mother Tongue refers to the proportion of an age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with shading indicating the marginal significance level: **less than or equal to 0.05**; greater than 0.05 and less than or equal to 0.10; greater than 0.10. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English speaking countries other than the UK or the US. P value for the F test refers to the null hypothesis that all regressors except the constant equal zero.

Table 6
Least squares regression results for most likely thresholds of Age at Arrival impacts on High School and University Attainment: Men and Women from countries with a medium resemblance to English and countries speaking French, by age at arrival

	French		Medium linguistic distance from English	
1. Men	T = 6	T = 6	T = none	T = none
Age at arrival	-0.00249	-0.00387	**0.00361**	0.00466
T	**0.109**	**0.120**		
T x Age at Arrival	-0.00371	-0.00782		
Mother Tongue		**0.303**		-0.100
Constant	**0.0835**	0.001454	**0.0823**	0.159
R squared	0.634	0.745	0.523	0.532
F test – p value	0.0018	0.0003	0.0002	0.0005
2. Women	T = 11	T =12	T = 5	T = 5
Age at arrival	-0.00138	-0.00150	**0.00420**	**0.00401**
T	**0.0817**	0.0694	**-0.0438**	**-0.0448**
T x Age at Arrival	-0.00581	-0.0143	**0.00456**	**0.00428**
Mother Tongue		0.196		0.0613
Constant	**0.0817**	0.0292	**0.0837**	0.0325
R squared	0.465	0.495	0.877	0.878
F test – p value	0.0127	0.0147	0.000	0.000

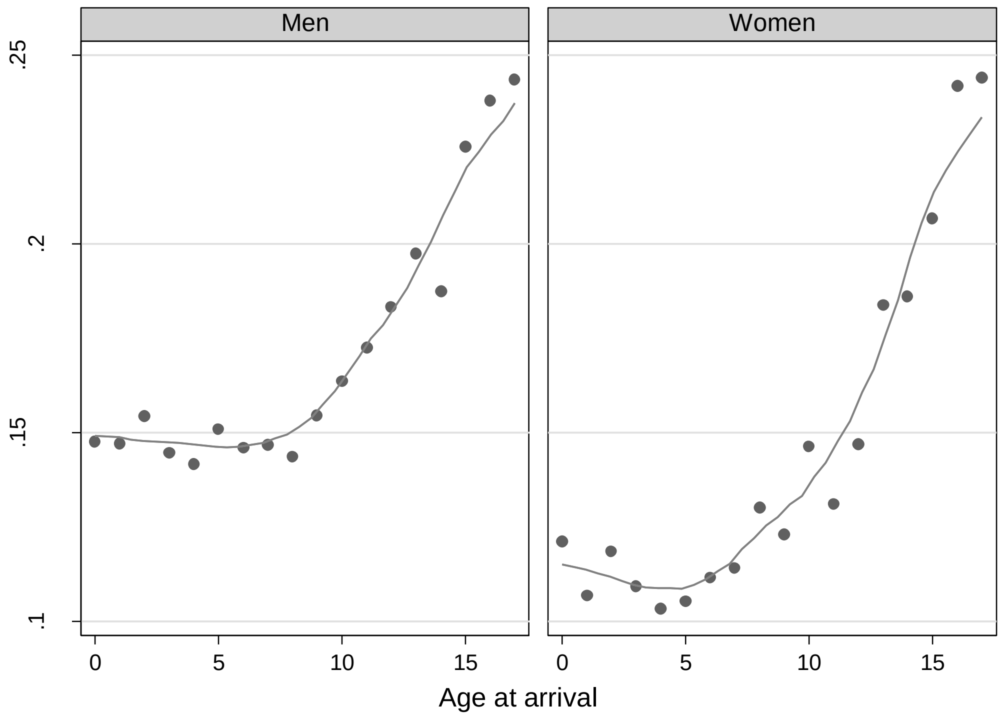
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. Mother Tongue refers to the proportion of an age group not having English or French as a mother tongue. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with shading indicating the marginal significance level: **less than or equal to 0.05**; greater than 0.05 and less than or equal to 0.10; greater than 0.10. Region of origin controls refer to indicator variables for the eleven regions categorized by linguistic distance from English and French as described in the text, with the omitted category for the sake of the regression analysis being the group of English speaking countries other than the UK or the US. P value for the F test refers to the null hypothesis that all regressors except the constant equal zero.

Figure 1
Frequency distribution of individuals arriving in Canada before the age of eighteen by age at arrival and gender



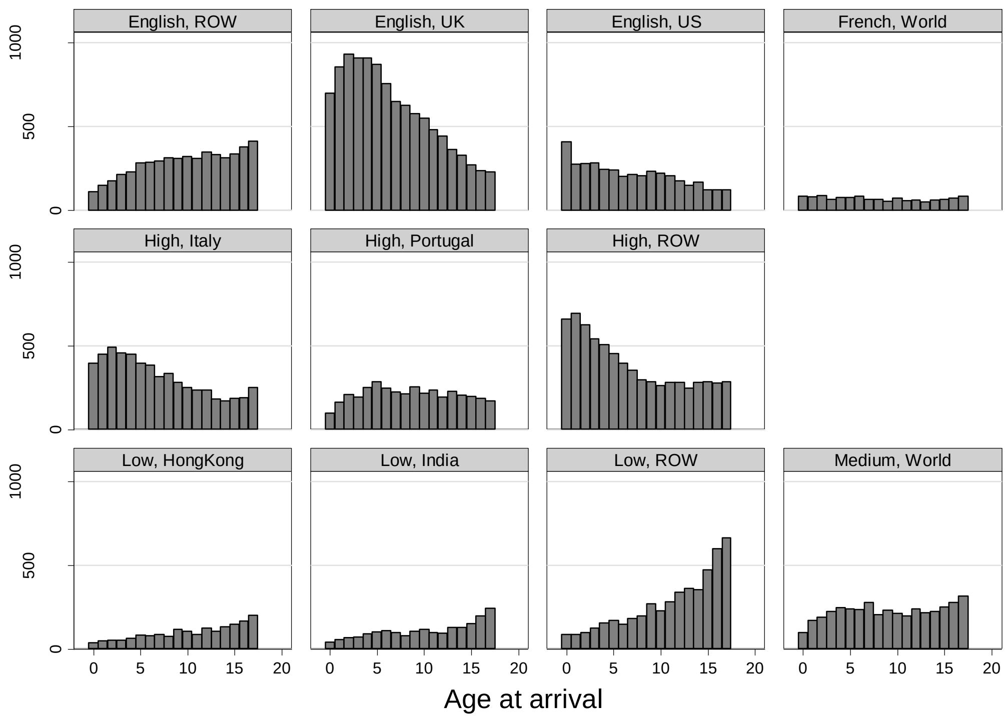
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
Figures represent unweighted sample sizes.

Figure 2
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: by age at arrival and gender



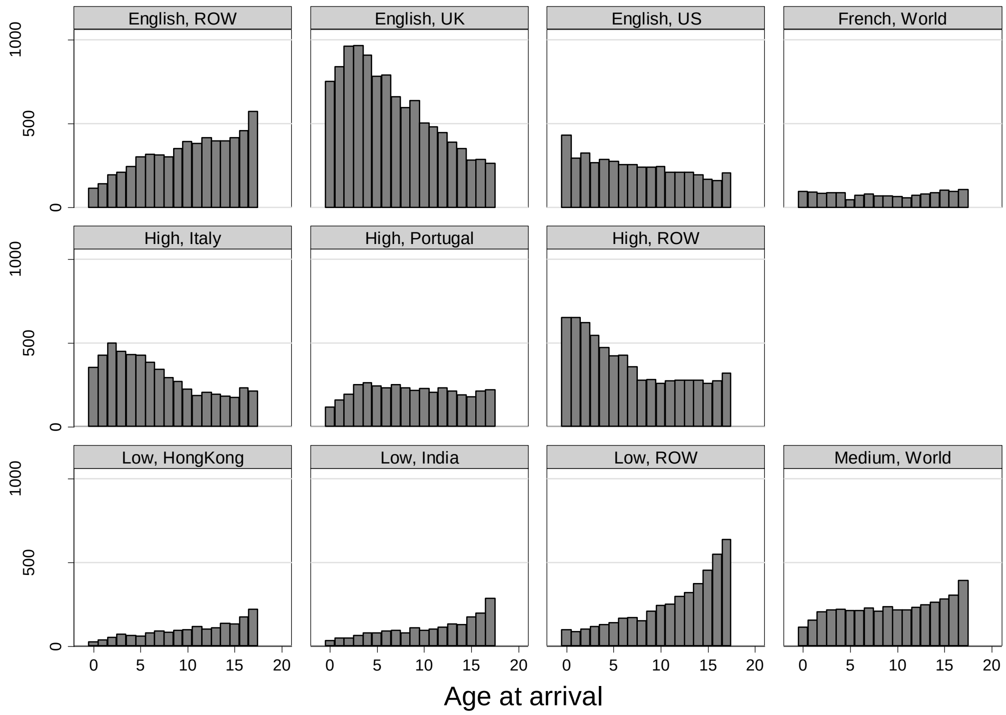
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text. Each data point represents the proportion of individuals by Age at Arrival without a High School Diploma who are 35 to 55 years of age in 2006. The continuous line is an estimated local polynomial smooth based upon weighted data, and calculated using a linear smooth and an epanechnikov kernel.

Figure 3a
Sample frequency distribution by language and region of origin: men by age at arrival



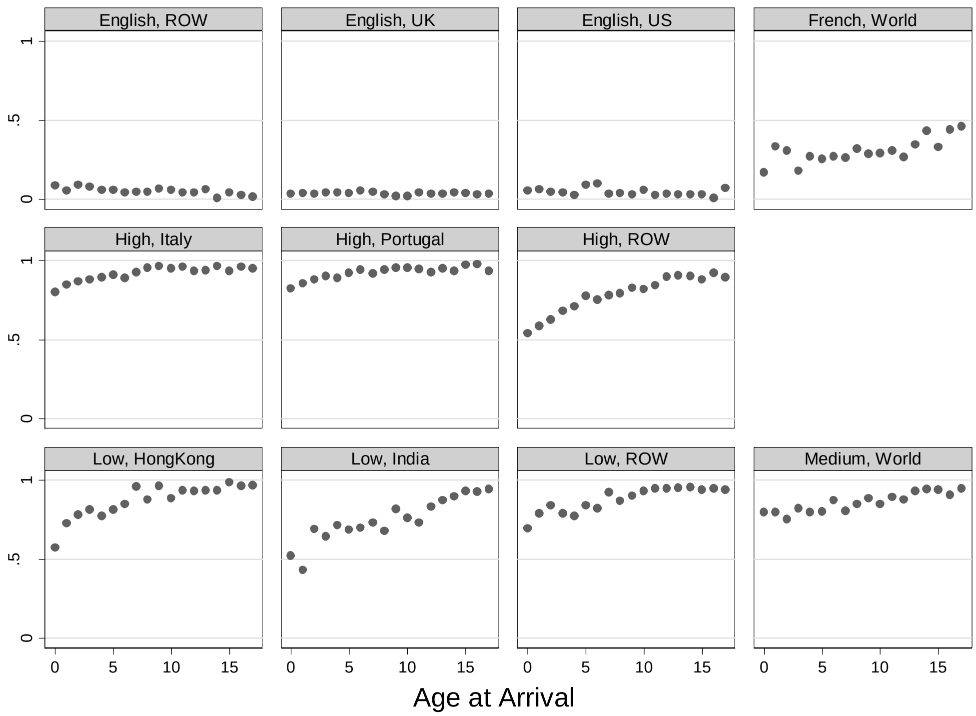
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.

Figure 3b
Sample frequency distribution by language and region of origin: women by age at arrival



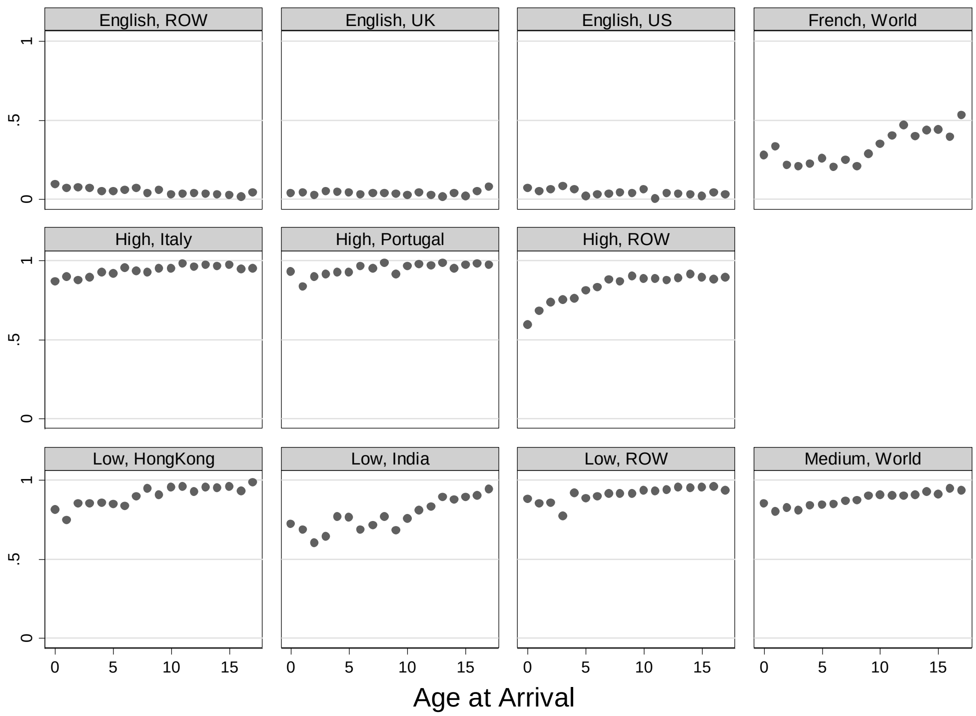
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.

Figure 4a
Proportion with a language other than English or French as a mother tongue:
men by age at arrival



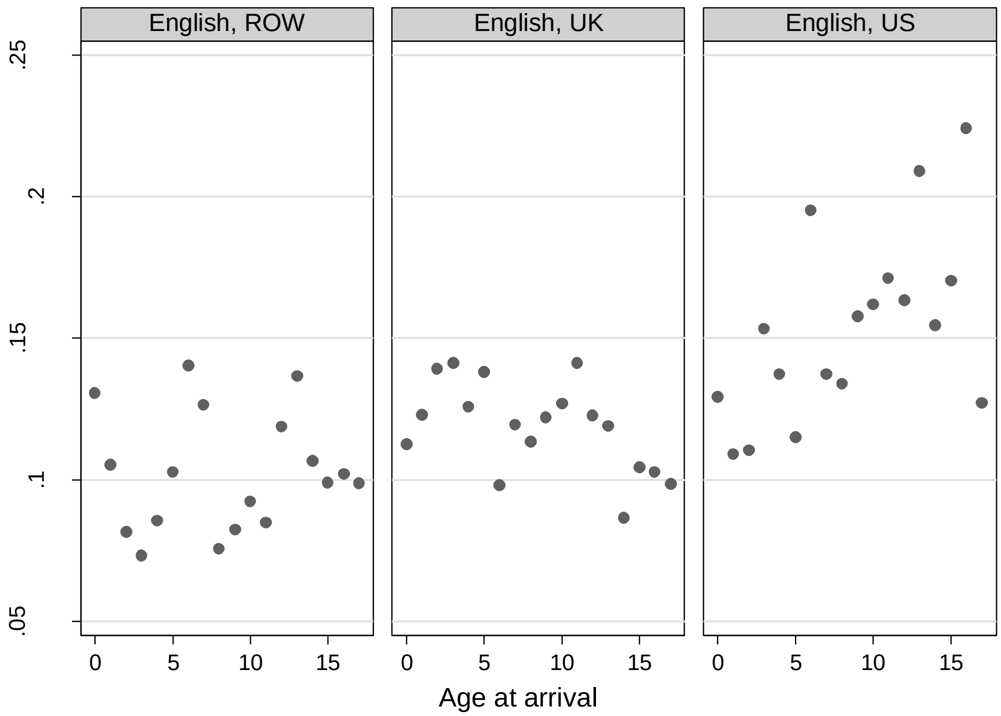
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.

Figure 4b
Proportion with a language other than English or French as a mother tongue:
Women by age at arrival



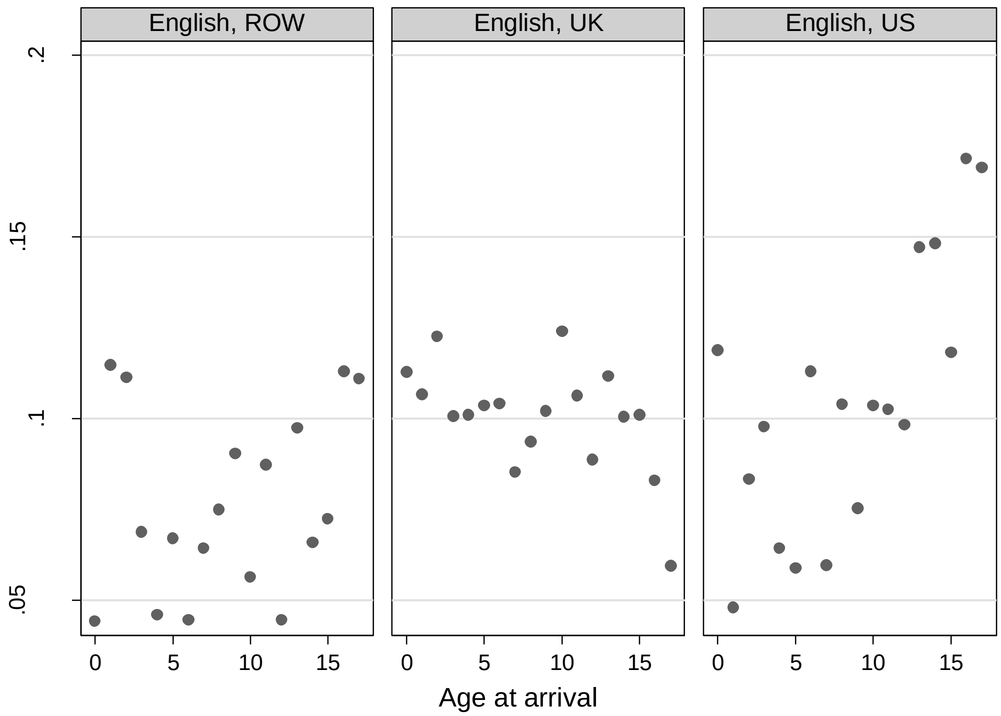
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.

Figure 5a
Proportion of individuals without a high school diploma in adulthood:
Men from English speaking countries, by age at arrival



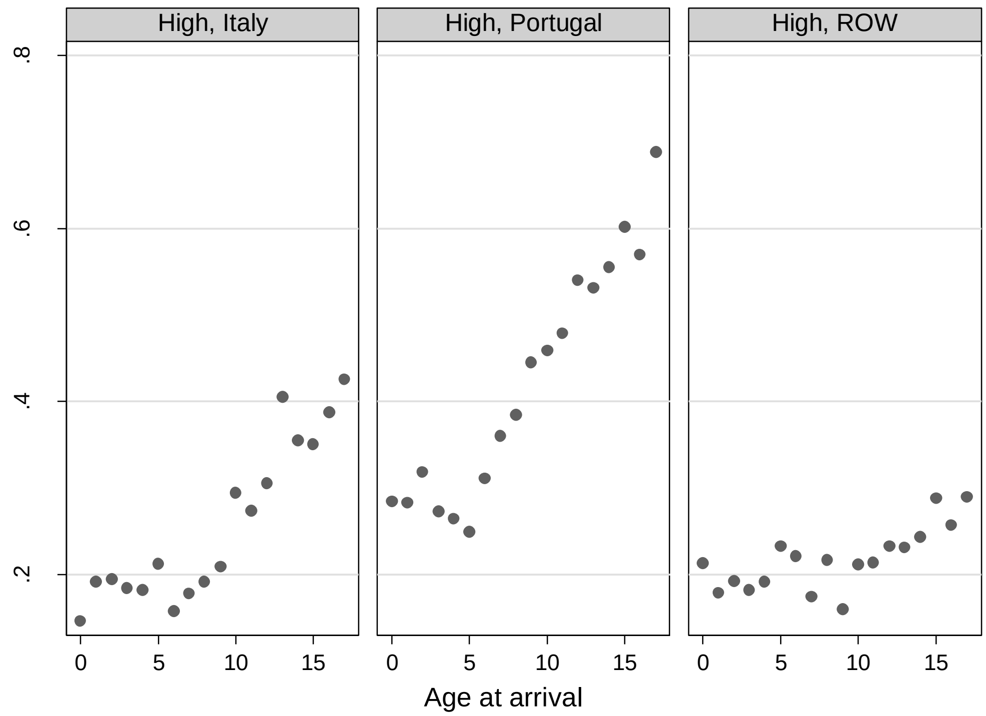
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

Figure 5b
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Women from English speaking countries, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

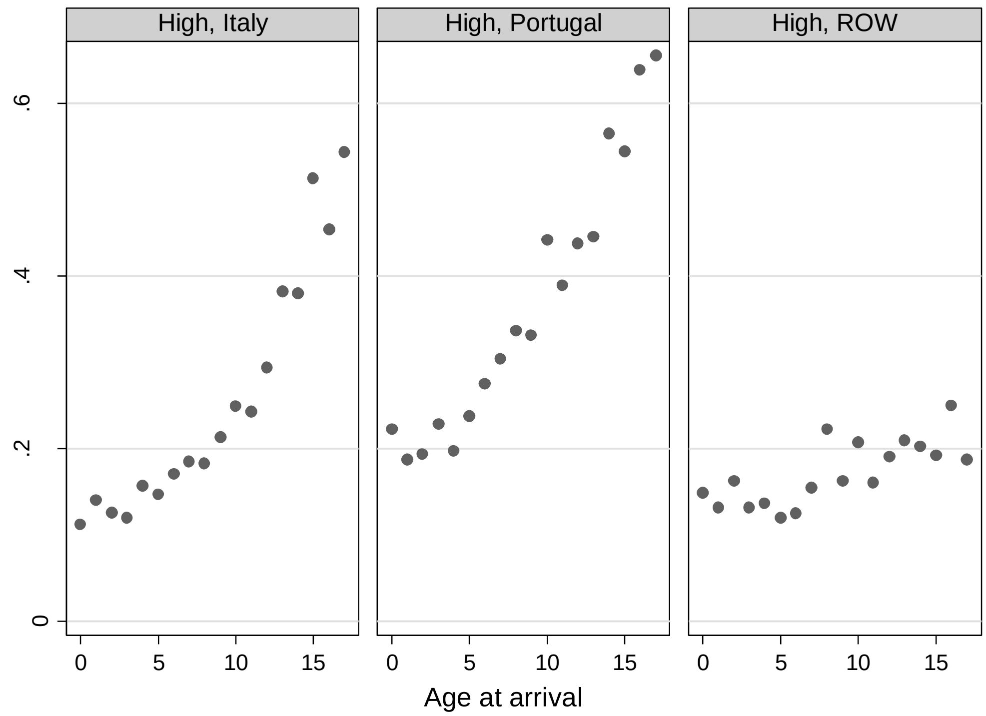
Figure 6a
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Men from countries with a high resemblance to English, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

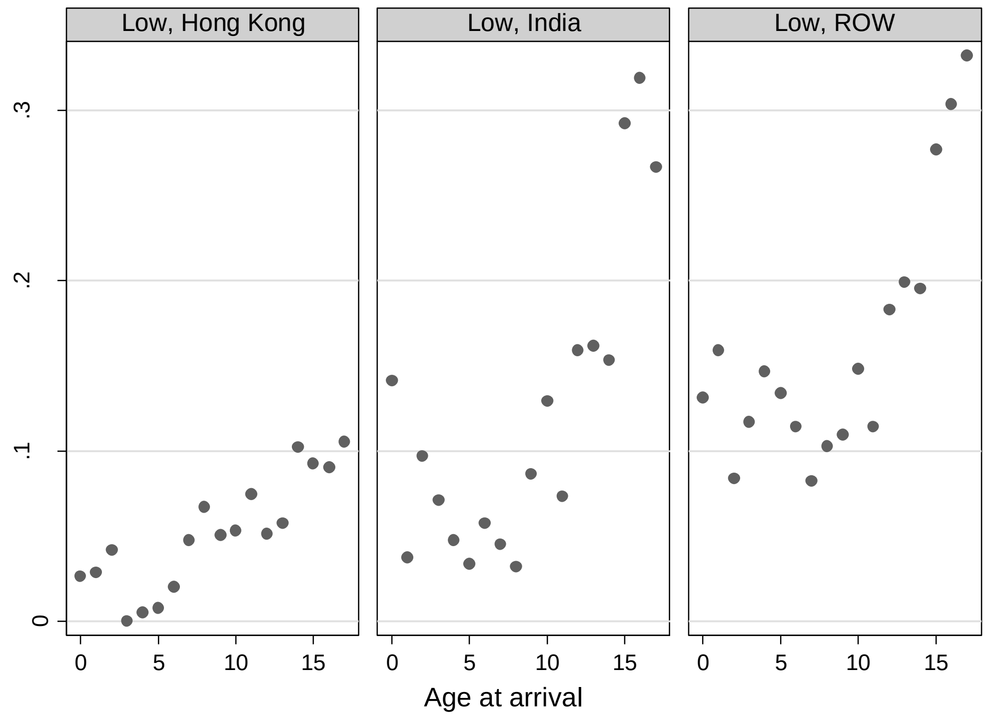
Figure 6b

Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Women from countries with a high resemblance to English or French, by age at arrival



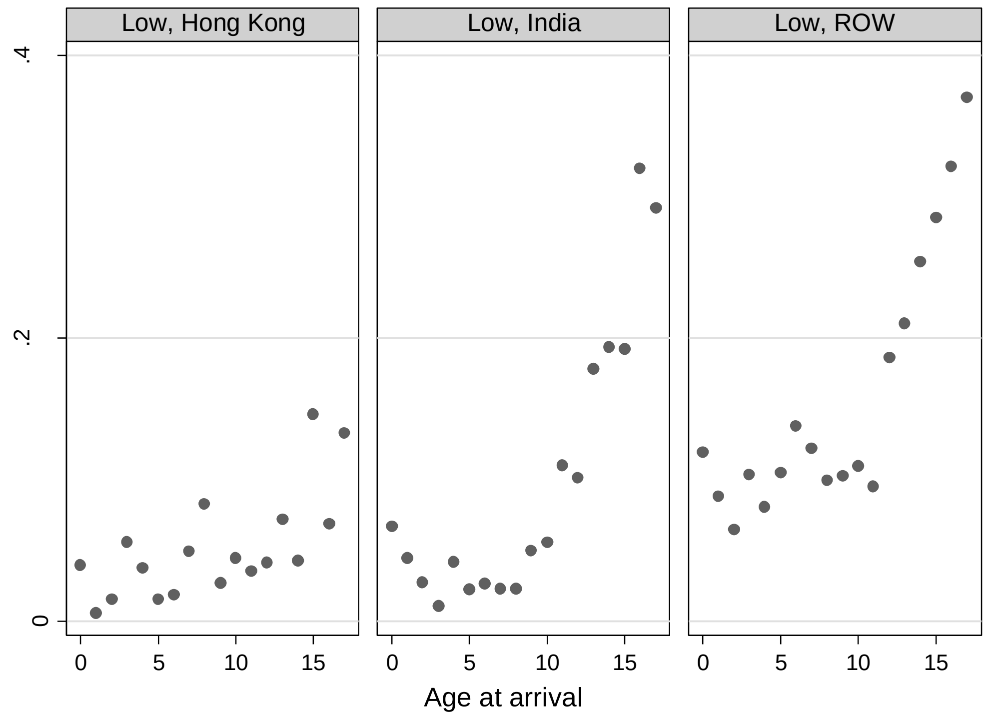
Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

Figure 7a
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Men from countries with a low resemblance to English or French, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to heteroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

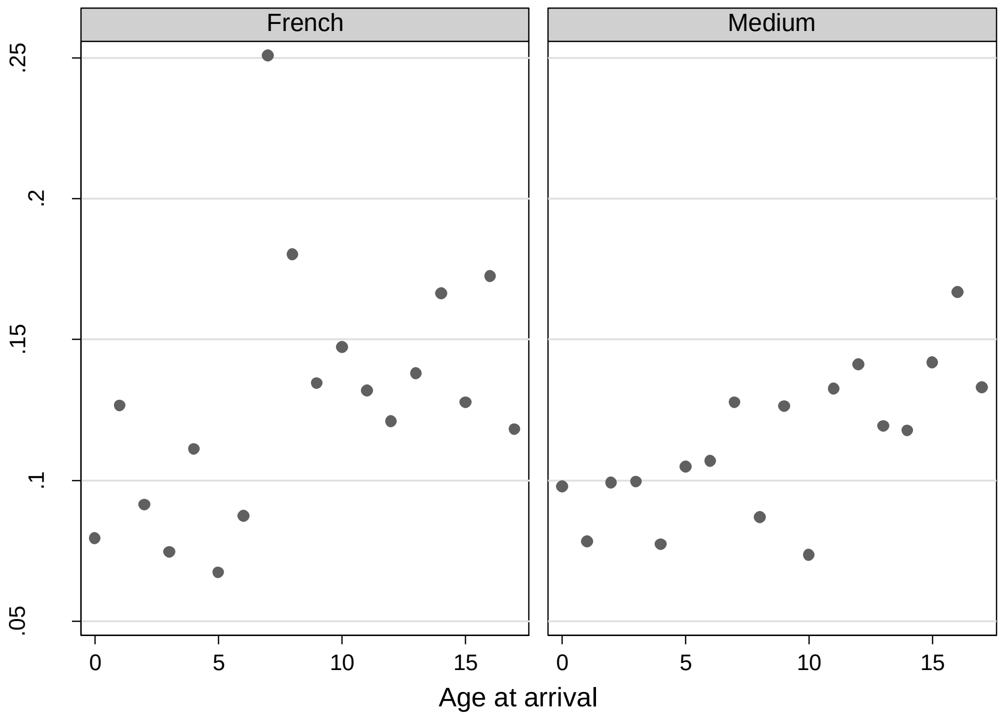
Figure 7b
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Women from countries with a low resemblance to English or French, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to hetroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

Figure 9a

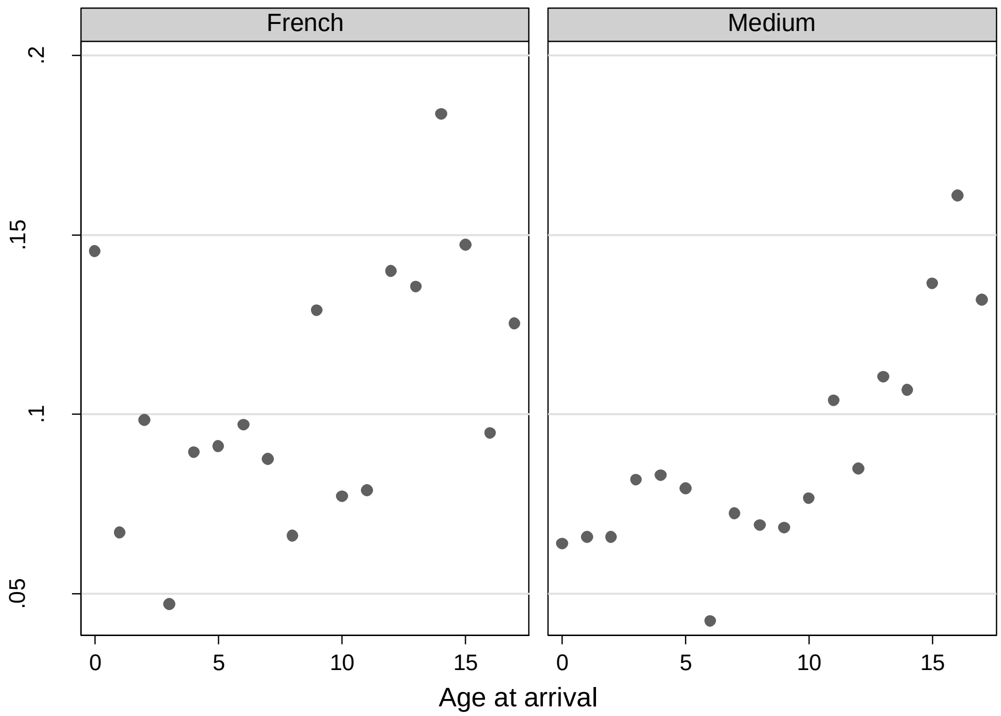
Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Men from French speaking countries and countries with a Medium resemblance to English or French, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to heteroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.

Figure 9b

Proportion of individuals arriving in Canada before the age of eighteen without a high school diploma in adulthood: Women from French speaking countries and countries with a Medium resemblance to English or French, by age at arrival



Note: Derivation by author from Statistics Canada, Census 2006 using analytical files described in the text.
T refers to the threshold used in the estimation of a piece-wise linear least squares model. Results presented are those for models with highest R-squared among all possible thresholds from 5 to 12 years. Sample size is 18 observations on average attainment by Age at Arrival from zero to 17. All regressions use analytical weights. Standard errors are robust to heteroscedasticity, with **boldface** indicating marginal significance levels of less than 0.05.