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English Proficiency and Test Scores of Immigrant Children in the US

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Abstract

This paper explores how much of native-immigrant differences in test scores can be accounted for by a lack of English proficiency. To identify the causal effect of English proficiency on cognitive test scores, I use the fact that language proficiency is closely linked to age at arrival, and that migrant children arrive at different ages from different countries. Using data from the New Immigrant Survey, I find that speaking English very badly or badly can explain 35% of the achievement gap between native and immigrant children in standardized language-related tests. However, I find no significant language effects for math-related tests.

JEL codes: J13, J15, I20

Keywords: standardized tests, English proficiency, immigrant children, age at arrival, English-speaking countries.

I Introduction

There are close to 250 million first and second generation immigrants worldwide (United Nations, 2016). A tenth of them, 25 million, are younger than 14. Social cohesion and ultimately economic outcomes in receiving countries clearly depend on how well immigrant children are able to integrate. Results from the "Programme for the International Assessment of Student Achievements" (PISA) show that in the US, as in most OECD countries, immigrant children tend to perform worse in reading, mathematics, and science compared to native children (OECD, 2015). The current paper addresses the following question: How much of such differences in achievement can be accounted for by a lack of English proficiency? This is an important question because the answer can help to inform policy makers in the debate on optimal education policies for migrant children. In particular, my findings highlight the importance of investing in "English as a Second Language (ESL)" programs to help non-English proficient immigrant children in primary education overcome the difficulties encountered in language-related tests.

There is a large literature documenting that migrant students in the US who are not proficient in English perform worse compared to native students. For instance, Zehler et al. (2003) report that 76 percent of third graders whose command of English is limited, score below (and often well below) grade level on English tests. Findings in Akresh and Redstone Akresh (2011) suggest that at least part of these differences are due to language proficiency. The authors show that foreign-born Latino children achieve higher scores when tests are conducted in Spanish instead of English. Even for economically advantaged immigrant students, Collier (1987), Cummins (1981), and Cummins and Nakajima (1987) report that it takes those students at least four years to catch up with native students in terms of academic English skills. Furthermore, early differences in academic achievement and cognitive test scores seem to translate into differences later on. Latino children whose parents are non-native English speakers are less likely to enroll in postsecondary education, and they are twice as likely to drop out of high school compared to non-Latino whites (Pew Hispanic Center 2002; Fry 2003). Moreover, a sound command of the host country's language has been found to have positive and significant effects for migrants' labor market outcomes, see Bleakley and Chin (2010), Chiswick and Miller (2010), and Dustmann and Fabbri (2003).

Although it seems obvious that low English proficiency would affect cognitive test scores, identifying the exact impact of language proficiency on individuals' academic performance is challenging (Gang and Zimmermann 2000; Frick and Wagner 2001). The fact that immigrant children typically come from less advantageous socioeconomic backgrounds makes it difficult to disentangle language barriers from other effects linked to children's migrant status. Moreover, virtually all tests – with very few exceptions – are conducted in English which makes it hard for researchers to distinguish between errors arising from misunderstandings and lack of English proficiency and those caused by low academic ability (Crawford, 2004).

To identify the causal effect of language proficiency on cognitive test scores, I follow a methodology proposed by Bleakley and Chin (2004, 2010). The authors rely on findings by language-learning theorists indicating that starting age and length of exposure are key factors behind acquiring language proficiency (the "critical period" hypothesis). In particular, I instrument English proficiency by comparing children from English-speaking countries to children from non-English-speaking countries who migrated to the US at different ages. I exploit the fact that both groups present similar levels of English proficiency for children arriving in the US before the age of 6 but present very different levels of English proficiency for children arriving later. For my estimations I use data from the New Immigrant Survey, a rich data set on legal immigrants and their children in the US which contains a large set of demographic and socioeconomic variables. Most importantly, it includes information about children's and parental English proficiency and country of origin, children's age at arrival, as well as results from four standardized tests administrated to children (Letter-Word Identification, Passage Comprehension, Applied Problems, and Calculations). My findings show that speaking English very badly or badly can explain 35% of the achievement gap between native and immigrant children in standardized language-related tests. However, I find no significant language effects for applied mathematics problems or calculations.

The remainder of this paper is organized as follows: The next section provides a detailed description of the data. Section 3 presents the methodology used to estimate the causal effect of English proficiency on cognitive test scores. Section 4 presents the estimation results and robustness checks, and finally Section 5 concludes.

II Data

The New Immigrant Survey (NIS) was conducted among US immigrants who were granted permanent residence between May and November of 2003, including both new arrival immigrants as well as so called adjustee immigrants who were already living in the US on temporary nonimmigrant visas (or, in some cases, illegally). The sample of immigrants asked to take part in the survey was selected based on administrative records from the US Immigration and Naturalization Service (INS) such as to be nationally representative of new arrival and adjustee immigrants. The first wave of the survey was conducted in 2003 (NIS-2003-1) and had a response rate of 69 percent (Jasso et al., 2005). Follow-up interviews took place between June 2007 and December 2009 (NIS-2003-2).[1] The survey asked questions about migrants' education, language skills, and employment history, as well as questions about family composition and characteristics. The language of the interview – English or the respondent's native language– was chosen by the respondent.

Key for my analysis, the survey also administered various cognitive tests to the children of respondents. In particular, I explore results from the four Woodcock Johnson Tests: (i) the Letter Word Identification test which measures symbolic learning and reading identification skills, (ii) Applied Problems which evaluate children's aptitude for solving practical problems in mathematics, (iii) the Passage Comprehension test that assesses reading comprehension and vocabulary knowledge, and (iv) Calculations which determine children's mathematical and quantitative abilities (Woodcock and Johnson, 1989). The first two tests were given to children age 3 to 12 while the last two were given to children age 6 to 12. In order to have homogeneous samples for all tests, I restrict my sample to children age 6-12. All test scores are normalized to have zero mean and standard deviation equal to one for each age. Interviewers also assessed children's English proficiency on the following scale: very bad, bad, good, or very good. Compared to typically available self-reported or mother-reported language proficiency, this measure provided by someone who is not emotionally involved with the child is relatively more objective. I define English proficiency as a dummy variable equal to one if the child speaks English well or very well.

Additionally, mothers (or the main responsible adult if she was absent from the household)

[1] NIS data can be downloaded at http://nis.princeton.edu/. I use the restricted access version of the data which includes detailed information on country of origin and state of residence.

provided information regarding the child's home and school environment. For instance the survey asked questions about home possessions, rules set for the child, language support classes at school, etc. The mother (or the main responsible adult) also provided detailed information on own use and proficiency of English. To assign countries of origin I use the child's country of birth, or for children born in the US the mother's (or the main responsible adult's) country of birth. I define as English-speaking countries those countries where English is an official language as reported by Wikipedia, and I cross-check this data with the list of English-speaking countries in Ethnologue (Lewis, 2009).[2] Age at arrival is computed using the child's current age together with information on year of entry into the US. Age at arrival equals zero for children born in the US.

As mentioned before, I restrict my sample to children age 6 to 12. Furthermore, I only include observations with information on the main variables of interest (scores for the Letter-Word Identification test, English proficiency, age at arrival, current age, and country of origin). For all other variables I define dummy variables to control for missing observations. This leaves me with 1,529 observations. Table 1 shows the corresponding descriptive statistics from NIS. The majority of children in my sample are girls, and they are nine years old and tend to have one younger sibling. Most have lived in the US for around seven years. Slightly more than 40% of children were born in US. Around 82% of children in my sample speak English well or very well. Almost three fourths come from a non-English-speaking country of origin. On average, migrant children in my sample were between 4 and 5 years old when they arrived in the US.

Regarding parental variables, with the large majority of interviews (92%) carried out in 2003, mothers and fathers are on average around 36 and 39 years old. The survey includes the following educational categories: 0 no education, 1 primary education, 2 secondary education, 3

[2]The list of countries classified by spoken and official languages is available at *https://en.wikipedia.org/wiki/List_of_countries_by_spoken_languages*. Wikipedia distinguishes between de jure and de facto official languages while Ethnologue's list of official languages (Lewis, 2009) includes all de jure and some de facto official languages. There are only 5 discrepancies between the two classifications for the countries in my sample. English is de facto official language in Bangladesh, Malaysia, and Sri Lanka according to Wikipedia but not according to Ethnologue. On the other hand, English is official language in Nepal according to Ethnologue but not according to Wikipedia. We follow Wikipedia's classification because it is also consistent with information from the CIA World Factbook (*https://www.cia.gov/library/publications/the-world-factbook/fields/2098.html*). Finally, English is official language in Sudan according to Wikipedia but not according to Ethnologue. We follow Wikipedia because it is consistent with the country's National Constitution of 2005. The list of English-speaking countries in my sample can be found in the Appendix.

high-school diploma, 4 associate's degree, 5 bachelor's degree, 6 master's degree, 7 PhD, 8 Juris Doctor or Medical Doctor, and 9 other degree. Most mothers and fathers in my sample have an associate's or a bachelor's degree. Only half of all fathers and less than a third of all mothers are employed, and average hourly wages are around 20 US$. Regarding parental language use and proficiency, slightly more than half of all parents speak and understand English well or very well, despite the fact that the vast majority, 89%, did not speak English at the age of 10. The exclusive use of English is much more common at the workplace (39%), compared to social contexts with friends (14%) or at home (6%), while other languages tend to be spoken much more frequently at home (60%) or with friends (58%) than at work (36%).

The NIS includes a vast array of variables related to home and school inputs. I carry out a factor analysis to determine the relevant factors for my analysis which are displayed in Table 2. Finally, Table 3 reports descriptive statistics for aggregate and additional controls. I rely on data from the US Census for 2000 to compute average wages, employment and unemployment rates for migrants from each country of origin by US state. I use the same data to also calculate the share of migrants from each country of origin in each US state (network size). For some of my robustness checks I consider data from the Penn World Tables (Feenstra et al, 2015) for the year 2000 for each country of origin on GDP per capita (in international US$) and the human capital index which summarizes information on years of schooling and returns to education.

III Methodology

I estimate the effect of English proficiency on standardized test scores by means of the following linear specification:

$$T_{icst} = \alpha_0 + \alpha_1 E_{icst} + \alpha_2 AA_i + \alpha_3 C_c + \alpha_4 X_{it} + \alpha_5 Z_{cst} + \varepsilon_{icst} \tag{1}$$

where T is one of the four Woodcock Johnson test scores for child i from country of origin c residing in US state s at time t, E denotes English proficiency, AA stands for age at arrival dummies, C includes country of origin indicators, and X is a vector including individual and parental controls as well as home and school inputs. The inclusion of age at arrival dummies allows me to capture potential non-linear effects of age at arrival on cognitive test scores; i.e.

migrating at age 3 versus age 4 might not be comparable to migrating at age 7 versus age 8. Moreover, controlling for parental English proficiency and language use is particularly important in this estimation, because both variables have been shown to influence language proficiency of migrant children (Chiswick, Lee and Miller, 2005). The vector Z includes state and country of origin-specific controls (network size, unemployment rate, employment rate, and average wage). Finally, ε is the error term which is clustered by individual to account for the fact that some, although very few, children participated in the first and second wave of the survey.

However, if I were to estimate Equation 1 by ordinary least squares, the coefficient of interest β_1 would not have a causal interpretation due to: (i) potential reverse causality, e.g. if parents would make an effort to improve their children's English proficiency when their children performed worse at school, and/or (ii) omitted variables; e.g. children's innate abilities. Hence, in order to estimate the causal impact of English proficiency on cognitive test scores, I use the interaction of a function of age at arrival with a dummy variable for non-English-speaking country of origin as an instrument for English proficiency. Graph 1 provides an illustration of my instrument. In line with findings by language learning theorists and Beakley and Chin (2004, 2010), English proficiency for children from English and non-English speaking countries does not differ significantly for those who arrive at early ages, but starts diverging after that.[3] In my sample, mean levels of English proficiency start diverging for children who arrive later than age 5.[4] As a first approximation to the causal effect of interest, I use a Difference-in-Differences model to estimate the different impact of arriving before the age of 6 for children from English and non-English-speaking countries of origin:

$$T_{icst} = \beta_0 + \beta_1 B6_i \cdot NEC_c + \beta_2 B6_i + \beta_3 C_c + \beta_4 X_{it} + \beta_5 Z_{cst} + u_{icst} \qquad (2)$$

where $B6$ is a dummy variable that takes on value one for children who arrived before the age of 6 and NEC is a dummy equal to one for children from non-English-speaking countries. A positive (negative) estimate of β_1 indicates that language proficiency causes improvements

[3] Graph 1 is very similar to those in Beakley and Chin (2004, 2010). They aggregated the data in 3-year groups and display mean English proficiency up to age at arrival 17. I use a lower level of aggregation (2-year groups) because the maximum age at arrival in my sample is 12.

[4] The age at arrival at which children from non-English-speaking countries start to present lower English proficiency differs according to the population studied. Newport (2002) and Birdsong (2006) discuss the evidence from the "critical period" literature by linguists. Beakley and Chin (2010) use 7, 9 and 11 as alternative thresholds in an application to adults.

(reductions) in test scores.

Next, I apply findings from the "critical period" literature and exploit non linearities in the relationship between second language acquisition and starting age of exposure to second language. In particular, I capture how differences in mean English proficiency change with age at arrival by means of the following function:

$$f(AA_i) = \max(0, AA_i - 5) \tag{3}$$

and I estimate the following equation:

$$T_{icst} = \gamma_0 + \gamma_1 f(AA)_i \cdot NEC_c + \gamma_2 AA_i + \gamma_3 C_c + \gamma_4 X_{it} + \gamma_5 Z_{cst} + v_{icst} \tag{4}$$

Given that higher values of $f(AA)$ are associated with lower English proficiency, a positive (negative) estimate of γ_1 indicates that language proficiency causes reductions (improvements) in test scores.

In order to obtain a meaningful estimate of the magnitude of the effect of English proficiency on test scores, I make use of the functional form in (3) to obtain a causal estimate of the effect of English proficiency on test scores in the context of Equation (1) using a two-step IV procedure. The first step estimates:

$$E_{icst} = \delta_0 + \delta_1 f(AA)_i \cdot NEC_c + \delta_2 AA_i + \delta_3 C_c + \delta_4 X_{it} + \delta_5 Z_{cst} + w_{icst} \tag{5}$$

where all other variables are as defined before. The second step of the estimation uses the predicted English proficiency in my main regression

$$T_{icst} = \lambda_0 + \lambda_1 \hat{E}_{icst} + \lambda_2 AA_i + \lambda_3 C_c + \lambda_4 X_{it} + \lambda_5 Z_{cst} + \eta_{icst}. \tag{6}$$

The validity of my instrument – the interaction between $f(AA)$ and an indicator for non-English speaking country of origin– relies on the assumption that language is the only difference between migrant children of similar observable characteristics who arrive at distinct ages from English and non-English speaking countries, and that hence any non-language effects of age at arrival are the same for immigrants from all countries. This is a plausible assumption because

– with the exception of a new language – immigrants from English-speaking countries are faced with the same circumstances upon arrival in the US than immigrants from non-English-speaking countries. Under this assumption, I can compare the gap in test scores between children arriving at younger and older ages from non-English-speaking countries to a similar gap for children arriving from English-speaking countries, and I can attribute any differences between those gaps to language. In other words, considering immigrants from English-speaking countries thus enables me to partial out the non-language effects of age at arrival. Such non-language effects of age at arrival refer to the fact that children who arrive at younger ages might find it easier to make new friends and to better familiarize themselves with US schools as they enroll at earlier stages, aspects which have nothing to do with language per se. Furthermore, families who migrate with younger children from any country of origin may be intrinsically different from those who migrate with older children. My strategy hence requires me to adequately control for children's age at arrival, and as mentioned above, I do so in a very flexible way allowing for potential non-linear effects of age at arrival on cognitive test scores. I also relax my main identifying assumption in a series of robustness checks which are presented in Section IV.A.

IV Results

Table 4 shows the results from the OLS estimation of Equation 1. Panel A presents the estimated coefficients when only controlling for age at arrival dummies, an indicator for non-English-speaking country of origin, and dummy variables for current age. English proficiency presents sizable and highly significant correlations with scores from all four tests. The estimated coefficients indicate that English proficiency is associated with higher test scores of around 0.9 standard deviations, with the exception of scores from the Calculation test which display a much lower correlation with English proficiency of 0.28 standard deviations. Panel B displays results when the full set of controls is included. Coefficients are somewhat smaller but they are still sizable and highly significant. The size of the coefficients is slightly larger than 0.7 for all but the Calculation test which again display a much lower correlation of 0.26 standard deviations.

In order to obtain a first approximation to the causal effect of English proficiency on cognitive test scores, I estimate Equation (2) by OLS. The results of this exercise are shown in Table 5.

The effect of English proficiency on Letter-Word Identification test scores is positive while the effect is negative for Calculation test scores.[5] The estimates for Passage Comprehension and Applied Problems tests are positive but not significantly different from zero. Estimates for the more parametric specification presented in Equation (4) are displayed in Table 6 and are consistent with those in the previous table. The interaction of the function of age at arrival and an indicator variable for non-English speaking country of origin displays a negative and significant relationship with language-related test scores while there is no significant relationship with math-related test scores (with the exception of the Calculation test which presents a positive and significant coefficient in the specification without controls). Graphs 2-5 visualize these results. Differences in language-related test performance between children form English and non-English-speaking countries are positive and increasing with age at arrival. They start being significant for children arriving in the US at age 6 or later. Regarding math-related test scores, differences are positive and increasing starting at age 6 but they are not significantly different from zero for Applied Problems. For Calculation test scores, differences in results are even decreasing from age 6 on.

I use the two-step instrumental variable approach described by Equations (5) and (6). Table 7 shows the results from the first stage regression as specified in Equation (5). In all cases, estimated coefficients for the instrument are negative and highly significant as predicted by theory and as visualized in Graph 1. Children who arrive at older ages from non-English speaking countries are less likely to be proficient English speakers compared to children who arrive at younger ages from these same countries. The F-statistic of the excluded instrument (reported at the bottom of the tables) is around 14.5 in the regressions without controls and around 12.5 when all controls are included. This shows that in the context of my specifications the instrument is strong.

Table 8 displays the results from the second step, i.e. when estimating Equation 6. The estimated coefficient of interest does not change significantly when I include all controls, which indicates that the instrument is exogenous, even in the absence of controls. English proficiency has a positive and significant effect on scores in the Letter-Word and Passage Comprehension tests. In particular, English proficiency increases scores by 1.85 and 1.88 standard deviations in Letter-Word and Passage Comprehension tests respectively. A back-of-the-envelope calculation

[5] A negative coefficient could be due to low English proficiency students making additional effort in mathematics to compensate for their weak performance in language-related tests.

shows that these effects imply that speaking English very badly or badly can explain 35% of the native-migrant achievement gap in language-related tests.[6] However, I estimate no significant effect of English proficiency on test scores in Applied Problems or Calculations. Estimated coefficients for Applied Problems are small and insignificant while the effect for Calculations is insignificant and even negative. Estimated coefficients for all other control variables are displayed in Table A.1 in the Appendix.

When comparing the differently estimated coefficients for English proficiency, we observe that those from the two-step IV estimation are higher compared to those from the OLS estimation. Studies on the impact of English proficiency on labor market outcomes find similar negative biases in OLS estimations (Beakley and Chin, 2004). As discussed before, in principle reverse causality and omitted variables can lead to biased estimations using OLS. However, at least in the context of a univariate OLS estimation, omitted measures of innate ability would imply a positive bias. The negative bias could hence only be due to omitted variables (i) if the presence of other controls somehow turned the omitted variable bias negative or (ii) if there was measurement error in English proficiency (see Beakley and Chin, 2004, for how not only classical but also non-classical measurement error can lead to a negative bias in OLS estimations). Finally, the negative bias could also be due to reverse causality, in particular if as mentioned before children or parents reacted to lower (higher) results on similar cognitive tests at school by reinforcing (discouraging/undermining) children's English skills. However, note that my full set of controls already includes variables such as language use at home and language support classes.

A Robustness

The group of English-speaking countries in my sample includes Canada, Australia, New Zealand, Ireland, and the United Kingdom, five developed countries with high quality education systems which are potentially quite similar to the one in the US. This implies that integration could be much easier for immigrant children from these countries, potentially violating the assumption that non-language effects of age at arrival are the same for immigrants from all countries of origin. In order to make sure that immigrant children from these five countries are not driving

[6] The average native-immigrant achievement gap in the 2016 PISA reading score in the US was 40 points (502 for natives vs. 462 for immigrants, std. 7.6). Increasing the immigrants' average score by 1.85 standard deviations implies a reduction of 14 points in the gap, representing 35%

my results, I repeat the IV estimation for a sample without children from Canada, Australia, New Zealand, Ireland and the United Kingdom. Results displayed in Table A.2 are similar to those in Panel B of Table 8.

I also check the robustness of my results to the exclusion of migrant children from Mexico who constitute the most numerous group in my sample (almost 19%). Results in Table A.3 show that immigrant children from Mexico are not driving my results. If anything, regarding Passage Comprehension the effect of English proficiency on cognitive test scores is larger.

Finally, I perform three additional robustness checks to make sure that other potential differences between migrant children from English-speaking and non-English-speaking countries of origin are not driving my results. First, parents could be aware of the influence of their children's age at arrival on future outcomes, and thus when deciding when to migrate they could take into account the age of their children. However, this would only be a concern if migration decisions of parents from English and non-English speaking countries were differently affected by their children's ages. Moreover, the extent to which parents take their children's age into account may change over time. To account for this possibility, I weight observations such as to construct the same distribution of age at arrival for the two groups of countries and for each year of entry. In particular, I compute the proportion of children by age at arrival and age at time of the survey for non-English-speaking countries and use these proportions to weight the entire sample. Results of this exercise are displayed in Table A.4, and they are in line with those from my main specification, although the estimated coefficients for language-related tests are somewhat smaller.

In the spirit of the first robustness check, if English-speaking and non-English speaking countries differ strongly in terms of economic and educational development, the type of migrant from each group of country might also be very different. I carry out two different robustness checks to address this concern. First, I add an interaction term of age at arrival and GDP per capita in the country of origin as well as uninteracted GDP per capita to my controls. Results displayed in Table A5 remain arguably unchanged. If anything, the estimated effects of English proficiency on language-related test scores become stronger. The interaction of age at arrival and GDP per capita is not significant or only significant at the 10% level in the specifications for language-related tests. Second, I include as additional controls an interaction term of age at arrival and the human capital index as well as the uninteracted human capital index. Results displayed in Table A6 show that my main results are not driven by differences in educational system between English-speaking and non-English-speaking countries. Estimated coefficients on the interaction are never significant for language-related tests.

V Conclusion

Previous literature has shown that speaking the language of the host country has positive and significant effects on immigrants' social and economic outcomes (Bleakley and Chin, 2004 and 2010). A large part of the effect of language proficiency – 90% in case of the language effect on wages – appears to operate through improvements in education as measured by years of schooling. However, the effect of low English proficiency on years of schooling does not need to operate through lower academic performance and can also be due to aspects such as self-selection of non-English proficient children into the unskilled labor market or teacher discrimination (see e.g. Gershenson et al, 2017).

In order to estimate the causal effect of English proficiency on academic outcomes I make use of the New Immigrant Survey which includes scores of migrant children on standardized cognitive tests similar to the ones used by schools to assess their students. I show that English proficiency has a sizable effect on language-related tests but I find no effect for math-related tests.

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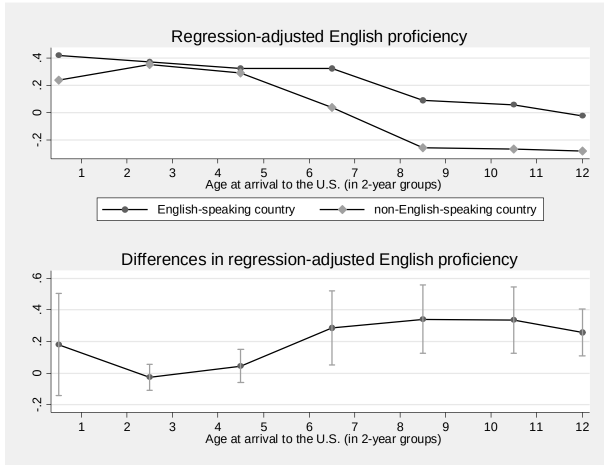
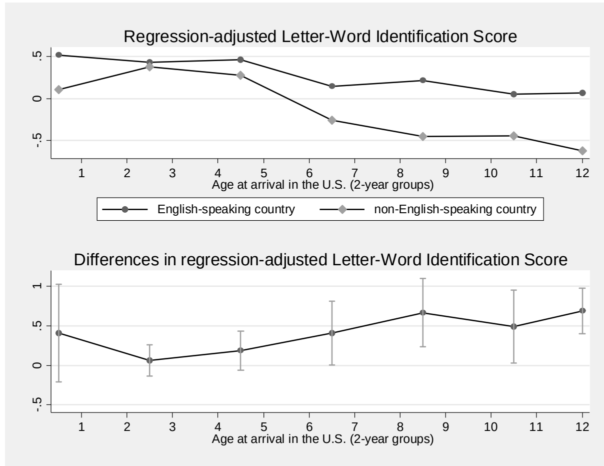
Graphs

Graph 1: English proficiency and age at arrival



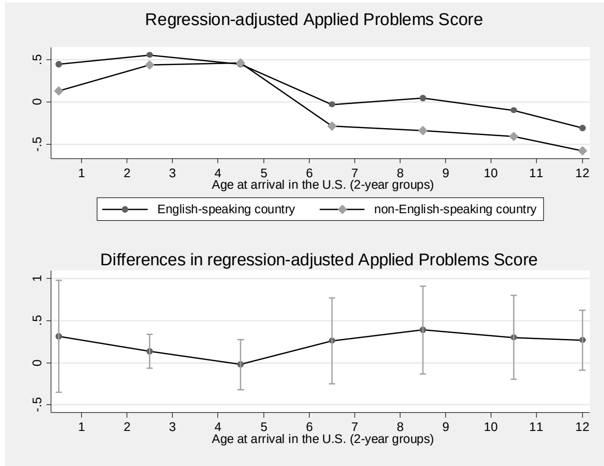
Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test scores. English proficiency is a dummy equal to one if the child speaks English well or very well. The list of English speaking countries is detailed in the Appendix. Means have been regression-adjusted using gender and age dummies.

Graph 2: Letter-Word Identification Score and age at arrival



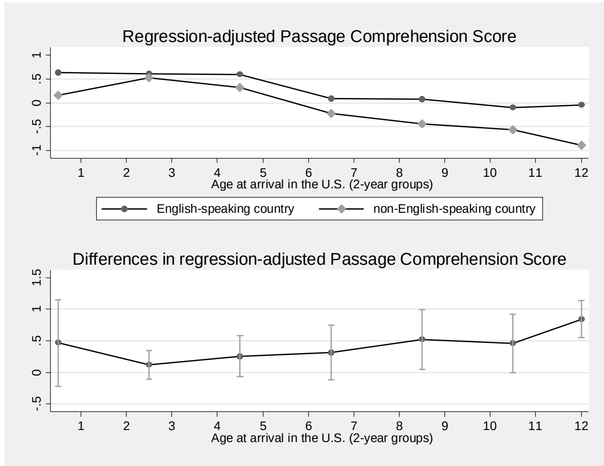
Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test scores. Test scores are normalized to have zero mean and standard deviation equal to one. The list of English speaking countries is detailed in the Appendix. Means have been regression-adjusted using gender and age dummies.

Graph 3: Applied Problems Score and age at arrival



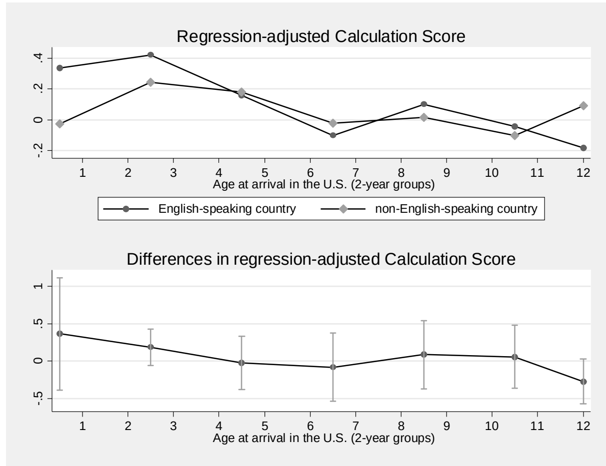
Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test scores. Test scores are normalized to have zero mean and standard deviation equal to one. The list of English speaking countries is detailed in the Appendix. Means have been regression-adjusted using gender and age dummies.

Graph 4: Passage Comprehension Score and age at arrival



Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test scores. Test scores are normalized to have zero mean and standard deviation equal to one. The list of English speaking countries is detailed in the Appendix. Means have been regression-adjusted using gender and age dummies.

Graph 5: Calculation Score and age at arrival



Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test scores. Test scores are normalized to have zero mean and standard deviation equal to one. The list of English speaking countries is detailed in the Appendix. Means have been regression-adjusted using gender and age dummies.

Tables

Table 1: Descriptive statistics NIS

Variable	Mean	Std. Dev.	Min.	Max.
Individual characteristics of children				
Male	0.366	0.482	0	1
Age	9.032	2.008	6	12
Only child	0.084	0.277	0	1
Number of siblings	1.286	0.829	0	7
Mean age siblings	7.411	3.444	0	18
Years in US	7.708	3.171	0	12
Born in US	0.397	0.489	0	1
English proficiency	0.822	0.383	0	1
From non-English-speaking country	0.723	0.447	0	1
Age at arrival	4.591	4.432	0	12
Cognitive Test Scores				
Letter-Word Identification	0.024	0.877	-3.616	2.645
Passage Comprehension	0.024	0.97	-3.267	3.255
Applied Problems	-0.007	0.983	-3.642	3.82
Calculation	0.069	0.937	-4.07	4.935
Parental characteristics				
Wave 2	0.08	0.271	0	1
Father year of birth	1964.142	5.171	1921	1981
Mother year of birth	1967.05	4.952	1947	1982
Father educational degree	4.767	0.864	1	9
Mother educational degree	4.409	0.929	0	9
Father absent from household	0.338	0.473	0	1
Mother absent from household	0.275	0.447	0	1
Father employed	0.485	0.309	0	1
Mother employed	0.291	0.306	0	1
Father unemployed	0.064	0.161	0	1
Mother unemployed	0.111	0.217	0	1
Father looking for a job	0.054	0.15	0	1
Mother looking for a job	0.091	0.198	0	1
Father wage	20.514	28.372	2.13	122.75
Mother wage	20.392	28.231	2.75	97.5
Parents coming from different countries	0.052	0.223	0	1
At least one parent is from US	0.029	0.167	0	1
Parental language use and proficiency				
Parent understands English	0.573	0.345	0	1
Parent speaks English	0.501	0.352	0	1
Parent spoke English and other language at age 10	0.085	0.203	0	1
Parent spoke English at age 10	0.014	0.084	0	1
Parent spoke only other language at age 10	0.889	0.2	0	1
Parent speaks English and other language at home	0.407	0.347	0	1
Parent speaks only English at home	0.064	0.162	0	1
Parent speaks only other language at home	0.591	0.345	0	1
Parent speaks English and other language at work	0.325	0.33	0	1
Parent speaks only English at work	0.386	0.341	0	1
Parent speaks only other language at work	0.358	0.334	0	1
Parent speaks English and other language with friends	0.351	0.335	0	1
Parent speaks only English with friends	0.135	0.236	0	1
Parent speaks only other language with friends	0.584	0.346	0	1

Data source: New immigrant survey. Sample: 6-12 years old immigrant children included in the IV estimations of the Letter-Word test score. There are 1,529 observations.

Table 2: Descriptive statistics - selected home and school inputs

Variable	Mean	Std. Dev.	Min.	Max.
Home and School inputs				
Parents show interest in school	0.024	0.466	-2.546	1.459
Reading material at home	-0.006	0.501	-5.916	1.438
Technology at home	0.005	0.506	-1.716	2.497
Language assistance program at school	0.014	0.537	-1.028	4.556
Schools attended in the US	0.011	0.379	-6.361	1.727
Parents impose limits	0.012	0.512	-3.317	2.066
Calculator and dictionary at home	-0.017	0.494	-3.294	6.518
Repeated grade	0.02	0.463	-6.802	1.943
School outside US	-0.006	0.554	-6.452	3.153

Data source: New immigrant survey. Sample: 6-12 year old immigrant children included in the IV estimations of the Letter-Word test score. There are 1,529 observations. Factor analysis allows me to summarize variables related to school inputs (grade attending, country where child attended school last year, years attended school outside the US, days of school missed, time spent on homework), family inputs (family receives daily newspaper, family receives regular magazine, possessions: encyclopedia, computer, more than 50 books, vcr, dvd player, place to study for child), and parental inputs (attended school meeting, phoned or spoken to teacher or counselor, visited child's classes, volunteered to help at school, how often parent checked done homework, how often required child do chores, how often limited tv use, how often limited time out with friends, child attends language assistance classes, years child attending language assistance classes, child attends other language classes).

Table 3: Descriptive statistics - aggregate and additional controls

Variable	Mean	Std. Dev.	Min.	Max.
US Census Data				
Network size	0.023	0.039	0	0.118
Unemployment rate	0.081	0.034	0	0.199
Employment rate	0.497	0.086	0.321	0.873
Average wage	645.886	278.946	259.615	2986.502
Penn World Table				
GDP per capita, international US$	9164.324	9324.722	521.779	42612.344
Human capital index	2.301	0.552	1.17	3.57

Data source: 2000 US Census Data extracted from IPUMS (https://www.ipums.org). Data from the Penn World Table (Feenstra et al, 2015) are for 2000.

Table 4: Test scores on English proficiency. OLS.

Panel A. No Controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	0.836	0.892	0.924	0.282
	(0.066)***	(0.082)***	(0.068)***	(0.073)***
Obs.	1,654	1,611	1,626	1,639
R^2	0.399	0.321	0.388	0.195

Data source: New immigrant survey. OLS estimation controlling only for age at arrival dummies, country of origin indicators, and age dummies.

Panel B. Controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	0.746	0.737	0.778	0.258
	(0.073)***	(0.088)***	(0.073)***	(0.079)***
Obs.	1,570	1,529	1,543	1,556
R^2	0.505	0.443	0.524	0.332

Data source: New immigrant survey. OLS estimation controlling for age at arrival dummies, country of origin indicators, age dummies and the list of controls included in Tables 1-3.

Table 5: Test scores on English proficiency. Difference-in-Differences.

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
Arrived before 6 by	0.246	0.066	0.139	-.245
non-English-speaking country	(0.113)**	(0.132)	(0.13)	(0.136)*
Arrived before 6	0.336	0.504	0.557	0.292
	(0.092)***	(0.108)***	(0.109)***	(0.12)**
Obs.	1,701	1,658	1,673	1,685
R^2	0.281	0.215	0.263	0.178

Data source: New immigrant survey. Difference-in-Differences estimation controlling only for age at arrival dummies, country of origin indicators, and age dummies.

Table 6. Test scores on a function of age at arrival by non-English-speaking country of origin

Panel A. No controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
max(0, age at arrival-5) by	-.052	-.013	-.050	0.043
non-English-speaking country	(0.023)**	(0.026)	(0.025)**	(0.025)*
Obs.	1,701	1,658	1,673	1,685
R^2	0.296	0.226	0.289	0.185

Data source: New immigrant survey. OLS estimation of test scores over a function of age at arrival by non-English speaking country dummy, controlling only for age at arrival dummies, country of origin indicators, and age dummies.

Panel B. Controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
Age at arrival by NEC	-.064	-.021	-.058	0.041
	(0.023)***	(0.028)	(0.025)**	(0.027)
Obs.	1,614	1,573	1,586	1,599
R^2	0.428	0.378	0.455	0.323

Data source: New immigrant survey. OLS estimation of test scores over the instrument age at arrival by non-English speaking country dummy, controlling only for age at arrival, country of origin indicators, age dummies, and the set of controls listed in Tables 1-3.

Table 7: English proficiency on a function of age at arrival by non-English-speaking country of origin. First stage

Panel A. No controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
max(0, age at arrival-5) by	-.035	-.033	-.033	-.034
non-English-speaking country	(0.009)***	(0.009)***	(0.009)***	(0.009)***
Obs.	1,654	1,611	1,626	1,639
R^2	0.368	0.365	0.363	0.366
F-stat of excluded instrument	15.7	14.09	13.53	15.34

Data source: New immigrant survey. OLS estimation of the First Stage (Equation 5) controlling only for age at arrival dummies, country of origin indicators, and age dummies.

Panel B. Controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
max(0, age at arrival-5) by	-.036	-.034	-.034	-.036
non-English-speaking country	(0.01)***	(0.01)***	(0.01)***	(0.01)***
Obs.	1,570	1,529	1,543	1,556
R^2	0.475	0.477	0.474	0.474
F-stat of excluded instrument	13.89	11.45	11.54	13.71

Data source: New immigrant survey. OLS estimation of the First Stage (Equation 5) controlling for age at arrival dummies, country of origin indicators, age dummies and the list of controls included in Tables 1-3.

Table 8: The impact of English proficiency on test scores. IV

Panel A. No controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.748	0.682	1.958	-.876
	(0.624)***	(0.702)	(0.704)***	(0.765)
Obs.	1,654	1,611	1,626	1,639
R^2	0.3	0.317	0.283	0.052

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling only for age at arrival dummies, country of origin indicators, and age dummies. English proficiency is instrumented by the interaction of max(0, age at arrival-5) and non-English-speaking country of origin.

Panel B. Controls

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.852	0.734	1.880	-.899
	(0.662)***	(0.805)	(0.867)**	(0.799)
Obs.	1,570	1,529	1,543	1,556
R^2	0.383	0.443	0.424	0.214

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival, country of origin indicators, age dummies, and the set of controls listed in Tables 1-3. English proficiency is instrumented by the interaction of max(0, age at arrival-5) and non-English-speaking country of origin.

Appendix

Table A.1. IV with coefficients of controls displayed

	(1)	(2)	(3)	(4)
English proficiency	1.852 (0.662)***	0.734 (0.805)	1.880 (0.867)**	-.899 (0.799)
Years in US	0.012 (0.018)	-0.027 (0.021)	-0.014 (0.02)	-0.041 (0.022)*
Network size	1.532 (2.263)	-0.944 (2.474)	2.465 (2.123)	0.597 (2.671)
Unemployment rate	-2.603 (1.527)*	-3.057 (1.808)*	-2.985 (1.634)*	-2.158 (2.112)
Employment rate	-1.414 (0.737)*	-1.838 (0.782)**	-1.911 (0.759)**	-2.346 (0.902)***
Average wage	0.0002 (0.0002)	0.0004 (0.0002)**	0.0003 (0.0002)*	0.0005 (0.0002)**
Male	-0.031 (0.052)	-0.049 (0.057)	-0.152 (0.056)***	-0.107 (0.064)*
Number of siblings	-0.022 (0.039)	0.043 (0.04)	0.03 (0.043)	0.068 (0.054)
Only child	-0.061 (0.132)	0.113 (0.145)	-0.019 (0.145)	0.119 (0.183)
Mean age of siblings	-0.020 (0.012)*	-0.002 (0.013)	-0.007 (0.013)	0.002 (0.015)
Born in US	-0.686 (0.202)***	-0.719 (0.273)***	-0.918 (0.212)***	-0.804 (0.31)***
Wave 2	-0.067 (0.188)	0.344 (0.202)*	0.253 (0.196)	0.294 (0.238)
Parent spoke English and other language at age 10	0.149 (0.218)	-0.011 (0.242)	-0.050 (0.22)	-0.061 (0.296)
Parent spoke English at age 10	-0.109 (0.452)	-0.446 (0.586)	-0.051 (0.477)	-0.276 (0.564)
Parent spoke only other language at age 10	-0.031 (0.282)	-0.101 (0.339)	-0.167 (0.305)	-0.289 (0.404)
Parent speaks English and other language at home	0.486 (0.556)	-0.486 (0.563)	0.064 (0.556)	-0.046 (0.575)
Parent speaks only English at home	0.523 (0.544)	-0.403 (0.558)	0.092 (0.531)	-0.218 (0.565)
Parent speaks only other language at home	0.487 (0.572)	-0.525 (0.581)	-0.043 (0.579)	-0.204 (0.604)
Parent speaks English and other language at work	0.14 (0.518)	0.608 (0.581)	0.015 (0.58)	0.525 (0.575)
Parent speaks only English at work	0.132 (0.525)	0.778 (0.597)	0.017 (0.596)	0.716 (0.59)
Parent speaks only other language at work	0.03 (0.52)	0.553 (0.593)	-0.051 (0.588)	0.492 (0.588)
Parent speaks English and other language with friends	0.246 (0.455)	0.56 (0.467)	0.701 (0.474)	0.223 (0.522)
Parent speaks only English with friends	0.312 (0.427)	0.6 (0.425)	0.881 (0.437)**	0.548 (0.495)
Parent speaks only other language with friends	0.415 (0.476)	0.793 (0.491)	0.867 (0.495)*	0.581 (0.549)
Parent understands English	0.131 (0.115)	0.256 (0.134)*	0.271 (0.132)**	0.195 (0.134)
Parent speaks English	-0.018 (0.113)	-0.148 (0.129)	-0.129 (0.129)	-0.039 (0.138)

	(1)	(2)	(3)	(4)
Father employed	-0.072 (0.14)	0.149 (0.158)	-0.065 (0.142)	0.056 (0.172)
Father unemployed	0.034 (0.299)	0.285 (0.3)	0.415 (0.338)	0.496 (0.303)
Father looking for a job	-0.122 (0.335)	-0.371 (0.343)	-0.566 (0.368)	-0.566 (0.361)
Father wage	0.006 (0.005)	0.004 (0.005)	0.007 (0.005)	0.008 (0.007)
Mother employed	0.082 (0.106)	0.236 (0.114)**	0.202 (0.112)*	0.268 (0.136)**
Mother unemployed	-0.025 (0.311)	-0.135 (0.249)	-0.016 (0.276)	-0.577 (0.297)*
Mother looking for a job	0.105 (0.308)	-0.027 (0.262)	0.016 (0.275)	0.193 (0.299)
Mother wage	0.003 (0.008)	0.001 (0.009)	0.003 (0.01)	-0.011 (0.011)
Father educational degree	0.037 (0.031)	0.046 (0.036)	0.043 (0.034)	0.003 (0.041)
Mother educational degree	0.052 (0.029)*	0.005 (0.037)	0.035 (0.035)	-0.016 (0.034)
Parents show interest in school	0.048 (0.055)	0.084 (0.063)	0.076 (0.061)	0.157 (0.075)**
Reading material at home	-0.030 (0.057)	0.102 (0.065)	0.033 (0.055)	0.114 (0.073)
Technology at home	0.019 (0.054)	-0.009 (0.063)	0.051 (0.06)	0.191 (0.068)***
Language assistance program at school	0.042 (0.037)	0.036 (0.045)	0.065 (0.038)*	0.008 (0.054)
Schools attended in the US	0.044 (0.051)	0.034 (0.062)	-0.007 (0.071)	0.031 (0.071)
Parents impose limits	0.01 (0.046)	0.027 (0.051)	-0.053 (0.048)	0.029 (0.061)
Calculator and dictionary at home	0.018 (0.048)	0.034 (0.057)	0.019 (0.05)	0.064 (0.063)
Repeated grade	0.031 (0.043)	0.032 (0.051)	0.035 (0.04)	0.052 (0.063)
School outside US	-0.034 (0.033)	0.006 (0.037)	-0.011 (0.036)	-0.054 (0.042)
Parents coming from different countries	0.108 (0.111)	0.177 (0.122)	0.111 (0.121)	0.126 (0.138)
At least one parent is from US	19.504 (37.274)	4.137 (1.602)***	0.342 (0.569)	-3316.678 (2245.003)

Table A.2. IV omitting Canada, Australia, New Zealand, Ireland, and United Kingdom as countries of origin

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.665	0.375	1.623	-1.359
	(0.668)**	(0.816)	(0.756)**	(0.894)
Obs.	1,511	1,472	1,485	1,497
R^2	0.413	0.428	0.443	0.082

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival dummies, country of origin indicators, age dummies and the set of controls listed in Tables 1-3. Observations with Canada, Australia, New Zealand, Ireland and United Kingdom as country of origin are omitted from the sample.

Table A.3. IV omitting Mexico as country of origin

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.676	0.818	2.400	-.871
	(0.734)**	(0.856)	(0.931)***	(0.881)
Obs.	1,270	1,233	1,244	1,256
R^2	0.474	0.476	0.391	0.283

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival dummies, country of origin indicators, age dummies, and the set of controls listed in Tables 1-3. Observations with Mexico as country of origin are omitted from the sample.

Table A.4. IV with age at arrival with distribution weights

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.570	0.174	1.259	-1.162
	(0.544)***	(0.673)	(0.588)**	(0.689)*
Age at arrival	-0.073	-0.096	-0.102	-0.114
	(0.026)***	(0.032)***	(0.026)***	(0.035)***
Non-English-speaking country	-2.751	-0.307	-0.822	-1.562
	(0.)	(248.924)	(0.527)	(0.561)***
Obs.	1,567	1,526	1,540	1,553
R^2	0.428	0.424	0.502	0.144

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival dummies, country of origin indicators, age dummies and the set of controls listed in Tables 1-3. Observations are weighted such as to equalize the proportion of children of a certain age who arrived at each age from English-speaking countries to those from non-English-speaking countries of origin.

Table A.5. IV including the interaction of age at arrival and GDP pc of the country of origin

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	1.997	1.127	2.214	-.112
	(0.71)***	(0.861)	(0.818)***	(0.773)
max(0, age at arrival) by GDP pc	2.85e-07	2.27e-06	1.24e-06	2.71e-06
	(6.82e-07)	(7.85e-07)***	(7.49e-07)*	(7.44e-07)***
GDP per capita	0.00002	0.003	-.0001	0.00002
	(0.)	(0.013)	(0.00003)***	(0.003)
Obs.	1,498	1,459	1,472	1,485
R^2	0.349	0.441	0.371	0.313

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival dummies, a binary indicator for non-English speaking country of origin, age dummies and the set of controls listed Tables 1-3. It also includes the interaction of max(0, age at arrival-5) and GDP per capita in the country of origin and the uninteracted GDP per capita as controls.

Table A.6. IV including the interaction of age at arrival and human capital in the country of origin

	Letter-Word	Applied Problems	Passage	Calculation
	(1)	(2)	(3)	(4)
English proficiency	2.062	0.954	1.975	0.062
	(0.688)***	(0.857)	(0.782)**	(0.777)
Age at arrival by human capital index	0.008	0.025	0.016	0.038
	(0.012)	(0.013)*	(0.012)	(0.014)***
Human capital index	-.621	-104.059	-1.984	0.924
	(15.721)	(0.)	(27.100)	(211.343)
Obs.	1,459	1,420	1,433	1,446
R^2	0.338	0.452	0.42	0.319

Data source: New immigrant survey. IV estimation of Equations 5 and 6 controlling for age at arrival dummies, country of origin indicators, age dummies, and the set of controls listed in Tables 1-3. It also includes the interaction of max(0, age at arrival-5) and the human capital index in the country of origin and the uninteracted human capital index as controls.

A.1. List of English-speaking countries

The list of English-speaking countries of ancestry of the children in my sample is:

- Australia
- Bangladesh
- Bermuda
- Cameroon
- Canada
- Ethiopia
- Ghana
- Grenada
- Guyana
- Hong Kong
- India
- Ireland
- Jamaica
- Kenya
- Liberia
- Malaysia
- New Zealand
- Nigeria
- Pakistan
- Philippines
- Sierra Leone
- South Africa
- Sri Lanka
- St. Lucia
- Sudan
- Trinidad and Tobago
- United Kingdom

This list includes all countries in our sample where English is an official language according to Wikipedia: https://en.wikipedia.org/wiki/List_of_territorial_entities_where_English_is_an_official_language.