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ABSTRACT

Between 1898 and 1948, English was the language of instruction for most post-primary grades in Puerto Rican public schools. Since 1949, the language of instruction in all grades has been Spanish. We use this policy change to estimate the effect of English-intensive instruction on the English-language skills of Puerto Ricans. Although naive estimates suggest that English instruction increased English-speaking ability among Puerto Rican natives, estimates that allow for education-specific cohort trends show no effect. This result is surprising in light of the strong presumption by American policymakers at the time that instruction in English was the best way to raise English proficiency. This has implications for medium of instruction policy in former colonies as well as U.S. education policy toward immigrant children.

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On the morning of January 2, 1949, the first elected governor of Puerto Rico took office. In the afternoon, he appointed Mariano Villaronga as the Commissioner of Education. Villaronga had been appointed to the same post by President Truman in December 1946, but resigned in June 1947 because the U.S. Senate refused to confirm his appointment. The Senate had stalled Villaronga's confirmation indefinitely because he had said that if confirmed, he would make Spanish the medium of instruction in Puerto Rican public schools. Philleo Nash, an advisor to President Truman on issues related to U.S. territories, recalled that "all previous incumbents [in the Commissioner of Education post] had had a condition set on them that they would have English be the language in the schools, or they wouldn't get confirmed by the United States Senate. The Senate was standing firm, at least the Senate committee [on Territories and Insular Possessions] was, and was refusing to approve Villaronga" (Hess 1966, p. 320). Upon returning as Commissioner of Education in 1949, Villaronga made Spanish the language of instruction in all grades in public schools, with English taught as a subject. The Villaronga policy remains in effect today.

In this paper, we use Puerto Rico's 1949 reform to gauge the importance of English-intensive instruction for Puerto Ricans' ability to speak English. The 1949 language reform required universal Spanish-only instruction after a half century of instruction in English in post-primary grades. To identify the effect of the switch to Spanish, we take advantage of two sources of variation. On one hand, among individuals growing up in Puerto Rico, cohorts educated in the post-reform period were schooled in Spanish. At the same time, the reform changed the language of instruction only for those completing five or more years of schooling because lower grades were taught in Spanish even before the 1949 reform. The extent of an individual's exposure to English-intensive instruction was therefore determined by interactions between his year of birth and years of schooling. Use of these interactions to capture language

policy effects leads to a difference-in-differences-type identification strategy across cohort and schooling groups.

To validate this strategy and provide an additional source of control for omitted variables, we use comparison groups that never experienced a change in language of instruction, such as earlier and later cohorts of Puerto Ricans and immigrants from former Spanish colonies. Our statistical analysis exploits the fact that the U.S. Census covers Puerto Rico as well as the U.S. mainland. Thus, we can analyze samples of island-born individuals regardless of where they choose to live. In particular, we use data from the 1980 and 1990 U.S. Census of Population and Housing Public Use Microdata Samples (PUMS) for Puerto Rico and the mainland.

As far as we know, ours is the first rigorous evaluation of the 1949 language reform.[1] An assessment of the consequences of this reform should be of interest for a number of reasons. First, some observers see the 1949 reform as contributing to relatively low levels of English proficiency among Puerto Ricans today, and favor bringing back English-language instruction in some grades and subjects in order to raise English proficiency. Cohort data on the English proficiency of the Puerto Rican-born provide some support for the view. Figure 1, which plots cohort trends in English proficiency as observed in the 1980 and 1990 PUMS, shows a continuous increase in English proficiency that flattens after the last cohort (born 1933) to receive English-intensive instruction. Among cohorts born 1934 and later, there is a persistent "language gap," in that one-third of these cohorts do not speak English at all. Since the language gap stopped narrowing after Spanish-only schooling was introduced, it is natural to ask whether the school policies regarding language of instruction explain this.

In addition to the implications of language reform for Puerto Ricans themselves, the

[1] Osuna (1949) and Pousada (1999) describe early studies of the effectiveness of English instruction in Puerto Rico. The general finding is that Puerto Rican students were less proficient in English than the evaluators thought they should be, or compared with students on the mainland. These studies do not address the counterfactual question of what English proficiency would have been without the English-intensive instruction then in use.

Puerto Rican experience should also be of more general interest. Many former European and American colonies have struggled with language policy (see, e.g., *Human Development Report 2004*; Tollefson and Tsui 2004). Some former colonies have chosen to use native language instruction in public schools (e.g., Morocco, Malaysia, Pakistan, India) while others continue using the colonial language (e.g., much of sub-Saharan Africa, the Philippines). On one hand, native language instruction might reinforce national identity and make schooling more accessible. On the other, since top jobs in government and business often continue to use the colonial language, native language instruction might reduce economic opportunities for the poor (see, e.g., Angrist and Lavy 1997; Munshi and Rosenzweig 2005).

The Puerto Rican experience may also be relevant for contemporary U.S. education policy. The proper extent and timing of English-only instruction for non-native English speakers remains highly controversial. Over eight percent of students enrolled in U.S. public schools are classified as limited-English-proficient (LEP), of whom three-quarters are Hispanic.[2] From 1980 to 1999, enrollment of LEP students doubled but total enrollment grew by only 25%. Recent years have seen a move away from bilingual instruction for LEP students towards English-only instruction and a "sink or swim" approach (Zehler et al. 2003). Although a large literature attempts to evaluate programs for LEP students, few of these studies have convincing research designs. In particular, few studies address the endogeneity of program participation or other sources of omitted variables bias.[3] The variation in exposure to English-intensive instruction used in this paper arises from a sharp policy change, thereby facilitating evaluation.

[2] Zehler et al. (2003), using data provided by school districts, estimate that there were 4.0 million LEP students in grades K-12 in U.S. public schools in the 2001-02 school year. Different school districts have different standards for classifying a student as LEP, but all LEP students are deemed to have inadequate English skills.

[3] See, for example, Baker and de Kanter (1981), Willig (1985), Rossell and Baker (1996), and Greene (1998) for reviews. An exception is Matsudaira (2004), who uses a regression-discontinuity design to estimate the impact of participating in bilingual education and English as a Second Language (ESL) programs compared to a mainstream, English-only classroom. Matsudaira finds no effect of bilingual and ESL program participation on math scores, and weak positive effects on reading scores.

The paper is organized as follows. Section I provides some background on the 1949 language reform and outlines our main identification strategy. Section II describes the data sources and presents some descriptive statistics. Section III discusses the empirical results. Section IV presents estimates of the effects of English-intensive instruction using an alternative identification strategy that relies on comparisons with immigrants. The paper concludes in Section V with a discussion of possible explanations for the findings.

I. Background and Identification Strategy

A. Background

After four hundred years as a Spanish colony, Puerto Rico became an American possession in 1898 as a result of the Treaty of Paris which ended the Spanish-American War. The U.S. took an active role in the island's administration, particularly in education.[4] One American goal was to expand the public school system. Under Spanish rule, educational opportunities had, for the most part, been reserved for the elite. A second goal was to teach Puerto Ricans English as part of a process of Americanization.

The American administration set up a U.S.-style school system providing free education through 12th grade.[5] Schooling was compulsory for those aged 8-14, though in practice the compulsory schooling law was of little consequence since many rural communities had no school offering grades beyond 4th. To increase access, the number of public school teachers was increased from 897 in 1900 to 9101 in 1948 (Osuna 1949, p. 607, Table II). Nominal spending on public education increased from half a million dollars to $21.4 million over the same period

[4] This subsection provides only a brief description of education in Puerto Rico. For more detail, see Osuna (1949) and Solís (1994).

[5] Elementary education consisted of four years of primary and four years of middle school. Beginning with the 1941-42 school year, Puerto Rico switched to a 6-year elementary school + 3-year junior high school + 3-year high school system, mirroring changes in the U.S. mainland.

(Osuna 1949, p. 607, Table II). Figure 2 documents the rise in public school enrollment in Puerto Rico among children aged 6 to 18. In 1900, only 8% of the population aged 6 to 18 (i.e., 26,204 children) was in school; enrollment rates in public schools exceeded 50 percent by the time of the 1949 language reform and continued to climb thereafter, peaking at almost 80 percent in 1980.[6]

The growth in enrollment generated dramatic increases in educational attainment. Individuals born 1914-23 had an average of 6.4 years of schooling, but those born 10, 20 and 30 years later had 7.9, 9.3 and 10.7 years of schooling, respectively. Much of the increase in attainment came from a shift in the distribution of years of schooling from four or fewer to more than four years. This can be seen in Figure 3, which plots the cumulative distribution of educational attainment for the Puerto Rican-born population by cohort. Forty-two percent of those born 1914-23 had zero to four years of schooling, compared with 29% of those born 1924-33, 16% of those born 1934-43, and 8% of those born 1944-53.

The effort to increase English proficiency proved to be at least as much of a challenge as increasing access to public education. One difficulty was the lack of consensus over the appropriate pedagogical method for achieving this goal. Some educators favored the use of English as the only language of instruction in all grades, but others favored Spanish in the early grades and English in later grades. Between 1898 and 1948, language policy changed several times, reflecting the views of different Commissioners of Education. These shifts are summarized in Table 1, which shows that a common feature of public education during this

[6] Children not attending public school were more likely to be out of school than attending a private school until 1990. In Puerto Rico, most private schools are Catholic schools. Although the private school share of total enrollment has risen in recent decades—according to Census data for Puerto Rico, 10% of enrolled students aged 6-18 were attending private schools in 1980 and 15% were in 1990—it was low and fairly stable during the time the cohorts analyzed in this paper would have attended school. For example, the share of grade K-12 enrollment in private schools was 3% in the 1919-20 school year, 4% in 1940-41, and 5% in 1945-46 (Osuna [1949], pp. 475-476 and Appendix VI).

period was English-language instruction in at least the post-primary grades.

A second difficulty was a shortage of teachers who knew English. As a result, teachers were recruited from the mainland and in-service training courses were used to prepare island teachers to teach in English (Osuna 1949, Chapter IX). Also, the University of Puerto Rico was established in 1903 to generate a supply of new island-born teachers who could teach in English. These strategies increased the number of English-proficient teachers so that compliance with English-only instruction policies became feasible.

Given the logistical effort and additional personnel required to expand instruction in English, it is worth documenting the success of this effort and the extent to which the 1949 language-policy reversal was meaningful. High schools appear to have had instruction in English from their founding in the early 1900s to 1949. Describing high schools around 1920, Osuna (1949) observes: "With the exception of Spanish, which was taught as a subject, the official language of the high school was English" (p. 248). Similarly, the *Report of the Commissioner of Education* for the 1947-48 school year states that English "is the medium of instruction in the senior high school in all classes except the Spanish class and the class in Puerto Rican history" (p. 25). The report for the 1948-49 school year, halfway through which Villaronga began serving as the Commissioner of Education, mentions plans for "the introduction of Spanish as the medium of instruction…in the senior high schools in the following year" (p. 24).

Even in grades below the high school level, instruction in English did take place. By the 1911-12 school year, 98% of 771 urban elementary schools and 17% of 1097 rural elementary schools used only English (Osuna, 1949, p. 346).[7] As the supply of teachers capable of teaching

[7] Among other rural elementary schools, 22% had part-time English instruction, 61% offered English as a subject, and only 0.5% used no English. Various issues of the *Report of the Commissioner of Education* support the view

in English increased and with the elimination of English-only instruction in grades 1-4 in 1916, it also became increasingly practicable to comply with the language of instruction policies listed in Table 1 even in grades below the high school level. Even if rural areas had ignored English-only instruction, the proportion of pupils instructed in English would have been high since most of the post-primary enrollment was in urban areas. For example, in 1940, 57% of 5th graders, 77% of 8th graders and 100% of 10th graders were attending schools in urban areas.[8]

B. Identification Strategy

The effect of English-intensive instruction on English proficiency is identified here using a difference-in-differences-type strategy that exploits variation in exposure to English-intensive instruction across cohorts and schooling levels. This variation is documented in Table 2, which shows potential years of exposure to English-intensive schooling by year of birth and years of completed schooling. Thus, variation in exposure arises from differences in the timing and amount of school attendance. It is worth emphasizing that Table 2 reflects *potential* exposure since some children start school at different ages, repeat grades, or withdraw temporarily. The

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that English continued to be used in all schools in urban areas, not just in high schools. Since the Falkner policy, English training had been a prerequisite to teach in urban elementary schools; the report for the 1926-27 school year notes: "The preparation now required for an elementary urban-school teacher is a two-year normal course after graduation from high school. These teachers hold an English graded license issued by the Department of Education, which is also attainable through free examination and University summer courses by experienced rural teachers who have attained a high standing in the profession" (pp. 24-25). The report for the 1920-21 school year states: "The regular teachers not only teach English but in English…In the first four grades Spanish is used as the medium of instruction and English is taught as a special subject but by Porto Rican teachers. The fifth and sixth are the transition grades; some subjects are taught in Spanish, others in English. In the grammar grades and in the continuation and high schools English is used as a medium of instruction and Spanish is taught as a special subject." (p. 377). The reports for the 1919-20 and 1930-31 note that English was used to teach arithmetic in grades five and up. In the 1941-42 report, which describes changes in curricula in concert with the shift to a 6-3-3 school system, English instruction is noted for urban junior high schools and grade 9 of rural junior high schools. The 1947-48 report mentions the end of English instruction in junior high, beginning with the 1948-49 school year.

[8]Authors' calculations based on enrollment data by year, grade and urban/rural status from Osuna (1949), pp. 624-25, Appendix VIII, Table 1. In 1930, schools offering post-primary grades were even less prevalent in rural areas and thus the percentage of students attending schools in urban areas was even higher: 66% of 5th graders, 93% of 8th graders and 100% of 10th graders. Even by the 1951-52 school year (the last year for which we managed to get the commissioner's annual report), there were no public senior high schools in rural areas.

results discussed below are unchanged when the exposure variable is coded allowing for modest levels of delayed school entry and grade repetition.

The identification strategy we use resembles the one used by Angrist and Lavy (1997) to estimate the effects of a change in language of instruction from French to Arabic in Morocco. The empirical analysis below allows the effect of English-intensive instruction to vary by years of potential exposure to English-intensive instruction. Among the cohorts studied here (born 1914-63), treatment intensity varied from 0-8 years. We report estimates of the coefficients on eight treatment dummies, denoted β_m; $m = 1, \ldots, 8$; in the following equation:

$$(1) \quad y_{ijk} = \alpha + \sum_{m=1}^{8} \beta_m I(E_{jk} = m) + \theta_j + \rho_k + \varepsilon_{ijk}$$

for individual i born in year j with k years of schooling where $I(\cdot)$ is the indicator function. The dependent variable, y_{ijk}, is a measure of English proficiency and E_{jk} is years of potential exposure to English-intensive instruction. The parameter θ_j is a cohort effect, controlling for cohort trends common across schooling groups, while ρ_k is an educational attainment-specific effect, controlling for the fact that less-educated people probably have weaker English-language skills.

The interpretation of β_m as the causal effect of receiving m years of English-intensive instruction rests on the assumption that the coefficients for interactions between birth cohort and years of schooling would be zero without the 1949 language reform. However, the cohort trend in English proficiency may differ across schooling groups for various reasons. The empirical analysis therefore uses various groups of non-exposed controls to test and modify the basic identification strategy. We also estimate specifications that explicitly allow for differential cohort-specific trends across schooling groups.

II. Data and Descriptive Statistics

The empirical analysis pools individual-level data from the U.S. Census of Population and Housing for 1980 and 1990 for Puerto Rico and the mainland.[9] Similar questionnaires have been fielded in both places so we can assemble a data set of consistently-defined variables for Puerto Ricans regardless of whether they live on the island or the mainland. Most importantly, self-reported information on English-speaking ability has been solicited on Puerto Rico's census form for decades and was added to the mainland census form in 1980. Although the language question is asked differently on the two forms, we are able to construct a uniform set of dummy variables indicating English-speaking proficiency.[10]

A natural concern is the extent to which self-reported English-speaking ability is a meaningful measure of English-language skills. The Census language question has been validated in two ways, both described by Kominski (1989). First, the English Language Proficiency Study, conducted in 1982 by the Census Bureau for the Department of Education, incorporated standardized tests of English-language skills. The results on this test were shown to be highly correlated with Census self-reported English-speaking ability; for example, those responding "speaks English very well" in the census questionnaire had standardized test scores similar to a native English-speaking control population, while score levels fell markedly when self-reported English-speaking ability was lower. A second validation effort compared Census

[9]For 1980, we have a 6% sample for both Puerto Rico and mainland residents (the 5% A + 1% B PUMS samples). For 1990, we also have a 6% sample for each (5% State + 1% Metro PUMS samples). Data files for U.S. residents were obtained from the IPUMS website, while data files for Puerto Rico residents were obtained from the ICPSR.

[10]The Puerto Rican census form asks: "Do you know how to speak English?" with three possible responses: "yes, with ease", "yes, with difficulty" and "no, I do not speak English". This question is asked of every respondent. The 1980 and 1990 mainland census form asks: "How well does this person speak English?" with four possible responses "very well", "well", "not well" and "not at all". This question is asked only of those responding affirmatively to "Does this person speak a language other than English at home?" We coded mainland residents speaking only English as speaking English very well. Our indicator for speaking English well is 1 for Puerto Rican residents who speak English with ease or mainland residents who speak English well or very well. Our indicator for speaking English is 1 for Puerto Rican residents who speak English with difficulty or mainland residents who speak English not well or anyone for whom speaking English well is 1.

self-reported English-speaking ability with other measures of English-language skills taken from the National Content Test administered by the Census Bureau in 1986. These results showed Census self-reports to be highly correlated with functional measures of language skills such as English reading and writing skills and whether respondents used English at work.

Most of our analysis uses samples of people born in Puerto Rico. Since passage of the Jones Act in 1917, which granted U.S. citizenship to all Puerto Ricans, islanders have been able to travel freely and settle anywhere in the U.S. mainland and possessions. Significant migration to the mainland began in the 1950s, and by 1970 approximately one-third of those born in Puerto Rico lived on the mainland. Because virtually all Puerto Ricans live either in Puerto Rico or on the mainland, the combination of mainland and Puerto Rican census data provides a representative sample of all people born in Puerto Rico. This allows us to sidestep the problem of selective migration when examining the impact of the language reform.

Our main analysis uses cohorts born 1924-43.[11] This yields a narrow window that contains sufficiently many observations; a longer window would likely make the need to control for education-specific cohort trends even more acute. We think of those born 1924-33 as the treatment cohorts (i.e., exposed to English-intensive instruction) since they would have been schooled in the pre-reform period with at least one year of English-intensive instruction. The 1933 cohort caught the tail end of English-intensive instruction, exposed for one-third of a year in 3rd grade, 3 years in junior high school, and one year in high school (since this cohort was in 10th grade in 1948). The control cohorts begin with those born in 1934 because this cohort entered first grade in 1940, just missing English-intensive instruction in primary grades as required by the Gallardo policy. Moreover, the 1934 cohort entered junior high school (grades

[11] Because we pool 1980 and 1990 data, the sample includes those aged 37-56 in 1980 and 47-66 in 1990. The results are invariant to modest changes in these age ranges.

7-9) in 1946, when the officially condoned though still unofficial policy was to phase out English. Finally, this cohort would have entered senior high school (grades 10-12) in 1949, when the 1949 language reform eliminating instruction in English took effect.

Appendix Table 1 shows descriptive statistics for the treatment cohorts and control cohorts born 10 years later than the treatment cohorts, as well as for three additional cohorts (born 10 years earlier, and 20 and 30 years later than the treatment cohorts) used for specification testing. For the treated cohort, the average potential years of exposure to English-intensive instruction was 2.85 years. Those completing five or more years of schooling had on average four potential years of English-intensive instruction and those completing four or fewer years of schooling had none.

III. Results

A. Difference-in-Differences Estimates

Table 3 reports ordinary least squares estimates of equation (1) using the sample born 1924-43.[12] Although only the coefficients for the treatment dummies are reported, the regressions used to construct these estimates also control for a full set of schooling, year of birth, age and sex dummies, as well as for potential experience and year of observation. The results indicate that those who received English-intensive instruction were significantly more likely to speak English. For example, the effect of receiving six years of English-intensive instruction on the probability of speaking English is 3.54% (column 1). Those receiving more than one year of treatment are more likely to speak English than those receiving only one year, however, the treatment effects do not increase monotonically with years of treatment. Column 2 shows that

[12]The corresponding logit marginal effects are reported in Appendix Table 2. These estimates differ little from the linear probability model estimates.

those who received English-intensive instruction are also significantly more likely to speak English well. The estimates in this case roughly increase with years of exposure, consistent with the notion that stronger English-language skills take time to develop.

Control for mainland residence has little effect on the results. This can be seen in columns 3 and 4, which report results from models that include a dummy for mainland residence. The robustness to inclusion of the control for residence is encouraging since, although residence is potentially endogenous (with language skills affecting the decision to migrate), the fact that the island and mainland language questions differ is a potential concern in pooled island/mainland samples. We would therefore like to look at estimates for island residents only. As it turns out, estimates using Puerto Rico residents only, reported in columns 5 and 6, resemble the estimates generated using the sample of all Puerto Rican-born.

B. Controlling for Differential Trends

The estimates in Table 3, which point to better English-language skills for those who were schooled in the English-only period, may be confounded by education-specific cohort trends in English proficiency. Such trends could have arisen through several channels, primarily as a by-product of the rapid expansion of the Puerto Rican public education system for affected cohorts. First, as access to education spread, the average ability of more educated people may have fallen. A related point is that the education distribution—and unobserved ability conditional on schooling and cohort—may have changed as a consequence of the language reform. Second, rapid expansion of the public school system may have led to a decline in the quality of upper-grade classrooms relative to lower-grade classrooms. Third, although most schools with more than the first four grades were located in cities and towns, access to upper grades was becoming increasingly common in rural areas. Finally, some Puerto Ricans may

have developed English-language skills when they served in the U.S. military, and service was more prevalent among older and more educated cohorts. All of these channels may generate spurious treatment effects, since the treated group consists of relatively old and more-educated cohorts. We examine these sources of bias below.

A natural comparison group for the investigation of education-specific cohort trends can be drawn from the populations both older and younger than the two 10-year cohorts analyzed in Table 3. Schooling was increasing similarly for these cohorts, a fact documented in Figure 3. The figure shows marked shifts in the schooling distribution as we move from one 10-year cohort to another. English proficiency levels in cohorts other than the treated cohort may therefore reflect some of the same schooling-specific trends.

As a first pass at a formal falsification test, we repeated a Table 3-type analysis using pairs of 10-year birth cohorts unaffected by the reform. These results are shown in Table 4. For comparison, results using the original treatment and control cohorts are reported in columns 1 and 2. Columns 3 and 4 show results for two cohorts that we think of as *always* treated (i.e, both were born 1933 or earlier), while columns 5 and 6 use two cohorts that were *never* treated (i.e., both were born 1934 or later). Finally, columns 7 and 8 show results for a second pair of never-treated cohorts, born 1944-53 and 1954-63.

For the purposes of this specification check, we assigned a pseudo-treatment variable as if the older cohort in each pairing had been born 1924-33 and the younger one had been born 1934-43, i.e., using the assignment rule for the original treatment and control cohorts. For example, to produce the estimates in column 3 and 4, we assume that those born 1914-23 were treated as if they had been born 1924-33 and those born 1924-33 were not treated. This falsification test generates spurious treatment effects. The hypothesis that the eight pseudo-treatment effects are jointly zero can be rejected at the 99% level in each column. Moreover, the

magnitudes of the coefficients in the falsification experiments are similar to the magnitudes in columns 1 and 2 for the affected cohorts.

While Table 4 generates clear evidence of confounding trends, it remains possible that the treatment-control contrast for the cohorts actually experiencing a change in language policy still exceeds that for the falsification cohorts, perhaps significantly. As a check on this, we employed a triple differences regression strategy which uses the falsification cohorts to net out the cohort-education trend associated with treatment status. In particular, we estimated the following equation using the cohorts born 1924-63:

$$(2) \quad y_{ijk} = \alpha + \sum_{m=1}^{8} \beta_m I(E_{jk} = m) + \sum_{m=1}^{8} \delta_m I(ET_{jk} = m) + \theta_j + \rho_k + \pi_k I(j \geq 1944) + \varepsilon_{ijk}$$

for individual *i* born in year *j* with *k* years of schooling, and where ET_{jk} is the exposure trend. For those born 1924-43, ET_{jk} equals E_{jk}, and for those born 1944-63, ET_{jk} equals years of pseudo-treatment, i.e., treatment status assigned as if these cohorts had been born 20 years earlier. The resulting estimates of β_m equal the treatment effects from Table 3 minus the pseudo-treatment effects (differential trends) estimated using the younger cohorts born 1944-63. The results, reported in Table 5, show that controlling for differential trends eliminates any positive effects of English-intensive instruction on English proficiency.

C. Controlling for Education-Related Selection

A likely source of education-specific cohort trends is a decrease in positive selection into higher levels of education over time. As education spread and compulsory schooling laws were increasingly enforced, children with less ability or from a more disadvantaged family background increasingly entered higher grades. As a result, the well-educated from more recent cohorts might have been less likely to speak English than the well-educated from earlier cohorts.

A related point is the possibility of an endogenous schooling response to language reform. That is, language reform itself could be responsible for increasing educational attainment, since instruction in English might have been a barrier for some children in school. This is a concern here because we are relying on differences between schooling groups across cohorts to identify the effects of reform. Still, our results suggest the cohort-schooling strategy should allow us to learn something about reform effects. This is because a (sharp) endogenous increase in negative selection in the post-reform period should generate positive triple differences estimates, since these estimates control for (presumably smooth) trends using non-reform cohorts. In practice, however, the estimates in Table 5 are close to zero or negative. This suggests that a sharp endogenous schooling response is not a confounding factor, though the placebo experiment does indicate the presence of a relatively smooth selection trend.

As a further check on the selection hypothesis, we added a quadratic function of a measure of the education cumulative distribution function (CDF) by cohort and educational attainment level to equation (1). Specifically, the "education CDF" measure for each respondent is the fraction of people in the Census born the same year with lower educational attainment than the respondent.[13] The results, reported in columns 3 and 4 of Table 6, show treatment effects that are on average lower by 40% and 17%, respectively, relative to the original results not controlling for education CDF (redisplayed in columns 1 and 2). Moreover, in column 3, the positive coefficients for both the education CDF and its square imply that as the proportion of one's cohort with less schooling increases, ability to speak English increases. In column 4, the negative coefficient for education CDF and positive coefficient of greater magnitude for its square imply that at high levels of educational attainment, the higher the proportion of a cohort

[13] Note that controlling for the education CDF also helps control for a possible endogenous schooling response to the reform, since any jump in educational attainment for treated cohorts should be reflected in the education CDF.

with less schooling, the higher is the propensity to speak English very well.

In addition to exploring the impact of CDF controls in the basic differences-in-differences setup without trends, we added the schooling-CDF quadratic to equation (2) as well; these results are shown in columns 5-8 of Table 6. Only 1990 data are used for triple differences estimation with CDF controls since some in the youngest cohorts would not have completed schooling by 1980. These triple differences estimates of the treatment effects are (jointly) insignificantly different from zero, as in Table 5. Thus, while changing selection bias based on unobservable characteristics appears to be an important source of education-specific cohort trends, controlling for this source of bias does not change the finding that more English-intensive instruction does not raise English-speaking ability.

D. Other Sources of Differential Trends

The analysis of education-specific cohort trends concludes with a brief look at a few other possible explanations. First, the positive difference-in-differences estimates observed among cohorts that did not experience a change in language of instruction may be caused by changes in school quality. Increased enrollment was made possible by increased spending on school inputs (e.g., new classrooms were built, new teachers were hired, and teacher salaries were increased). At the same time, however, double enrollment—a practice in which teachers teach two half-day sessions to different groups of students to relieve overcrowding—was gradually eliminated. Double enrollment was most common in the first two grades and in rural areas; in the 1943-44 school year, for example, 78% of rural schools were on double enrollment compared with 44% of urban schools.[14] Elimination of double enrollment meant more

[14] Osuna (1949), p. 291. We do not have data for urban and rural schools separately for other years. In 1920, 90% of rural schools were on double enrollment (Osuna 1949, p. 213).

instruction time in the early grades, including in English class. This may have reduced the gap between upper- and lower-grade English proficiency among younger cohorts, thereby contributing to spurious reform effects.

As a rough check on the school quality story involving double enrollment, we dropped people with one to four years of schooling. The only remaining members of the low-education control group are then people with no schooling. Those with 1-4 years of schooling were probably most affected by the elimination of double enrollment, while people with no schooling were unaffected. The results of estimating equation (1) with this restricted sample, reported in columns 1 and 2 of Table 7, are similar to the original results reported in columns 5 and 6 of Table 3. Likewise, results from the control experiments without grades 1-4 are similar to those from the full sample and are not reported here. Thus, the elimination of double enrollment does not appear to be behind the education-specific cohort trends.

Second, education-specific cohort trends may be induced by the gradual spread of higher-grade schools to rural areas. In the first decades of the American occupation, few rural communities offered schooling beyond the 4th grade. Later, however, the number of schools in rural areas increased rapidly. As a result, the urban proportion of 5th grade enrollment fell from 66% in 1930 to 57% in 1940, and the urban proportion of 8th grade enrollment fell from 93% in 1930 to 77% in 1940.[15] Our cohort-schooling differences-in-differences strategy may be biased by the increased likelihood that more educated individuals from more recent cohorts came from rural areas and therefore had reduced English proficiency (since cities and towns present more opportunities for exposure to English in daily life).

The effects of increased schooling in the countryside are difficult to control for in

[15] Authors' calculations based on enrollment data by year, grade and urban/rural status from Osuna (1949), pp. 624-25, Appendix VIII, Table 1.

practice since the Census records urban/rural status for current residence but not birthplace. Still, an analysis based on place of residence may provide useful information so long as urban residents are more likely than rural residents to have grown up in cities and towns. The most consistent definition of urban status that can be used for both the 1980 and 1990 censuses is residence in the San Juan-Bayamón primary metropolitan statistical area (PMSA).[16]

The results of estimating equation (1) restricting the sample to residents of the San Juan-Bayamón PMSA are reported in columns 3 and 4 of Table 7. Columns 5 and 6 of Table 7 show the results using an urban subsample that had not recently moved; probably people in this subsample are more likely to live where they were born. In practice, both sets of estimates show the same strong effects observed in Table 3. Thus, changes in the likelihood of urban residence for the more educated do not appear to account for the positive difference-in-differences estimates in Table 3.

A third possible explanation for education-specific cohort trends is changes in the probability of military service. Many Puerto Ricans served in the U.S. military, especially among the older cohorts in our sample. For example, 30% of men born and living in Puerto Rico from the 1924-33 cohorts had served compared with 18% from the 1934-43 cohorts. Veterans from these cohorts were also more educated than non-veterans. Among the 1924-33 cohorts, average schooling was 12.5 for veterans and 6.7 for non-veterans. Military service may have increased the English-speaking ability of Puerto Ricans. Given the strong education differences by veteran status, this in turn may have induced an education-specific cohort trend in English.

To determine whether military service accounts for education-specific cohort trends, we re-estimated equation (1) restricting the sample to non-veteran men. The results, available on

[16] This area contains the largest and oldest cities of Puerto Rico, containing over 30% of the total population and over 60% of the urban population. Estimates using other definitions of urban status generate similar results.

request, again show significant positive difference-in-differences estimates in both the true and control experiments. We also see similar results in a sample restricted to women, in spite of the fact that almost no Puerto Rican women served in the military. Thus, changes in the likelihood of serving in the U.S. military for the more educated do not appear to account for patterns observed in Table 3.

IV. Alternative Identification Strategies

Among the sources of education-specific cohort trends explored above, changing selection bias (based on unobserved characteristics) seems the most likely explanation for the patterns found in Tables 3-5. Although control for changes in the education CDF across cohorts does not account for all of the apparently spurious treatment effects in Table 3, allowance for changes in the distribution of schooling clearly makes a difference. As an alternative to strategies that control for unobservables using unaffected Puerto Rican cohorts, we also experimented with an identification strategy that compares Puerto Ricans living on the mainland with immigrants from former Spanish colonies.

Especially interesting and relevant comparison groups are immigrants from Cuba and the Philippines since, like Puerto Rico, these territories became U.S. possessions in 1898. Unlike Puerto Rico, however, the language of instruction in Cuba and the Philippines has been unchanged since the American occupation. Cuba, which became independent in 1902, has always had Spanish-only instruction in its public schools. The Philippines, which became independent in 1946, has had English instruction since occupation. We also look at two other comparison countries: the Dominican Republic, a Spanish-speaking neighbor, and Mexico, the largest source of Hispanic immigrants to the U.S. A drawback of the cross-country strategy, not shared by our first strategy, is that immigrants are self-selected and subject to U.S. eligibility

rules, some of which are country-specific. An advantage, however, is that we need not rely on comparisons across schooling groups, since schooling itself is a potentially endogenous variable.

For the cross-country analysis, we focus on adult migrants and adult immigrants because they would have obtained their grades 1-12 education in their place of birth. The data are for 1990 only because year of arrival to the mainland is not available for Puerto Ricans in the 1980 census, making it impossible to drop people who would have been educated in the mainland.[17] Figure 4 provides an initial look at the English-language skills of Puerto Rican migrants to the mainland relative to the immigrant control groups. This figure shows deterioration in the relative position of Puerto Ricans, especially among the mid-1930s to 1940s cohorts, though the relative position of the youngest Puerto Rican migrants appears to have improved.

To control for cohort trends that vary by country of origin, we used a regression setup similar to that used to produce the estimates in Table 5. In particular, working with a sample born 1924-63, we estimated

$$(3) \qquad y_{ijk} = \alpha + \beta PR_k \times E_j + \delta PR_k \times ET_j + \theta_j + \rho_k + \pi_k I(j \geq 1944) + X_{ijk}\Gamma_k + \varepsilon_{ijk}$$

for individual i born in year j in country k. PR_k is a dummy variable indicating the Puerto Rican born, E_j is dummy indicating being born 1924-33 and ET_j is dummy indicating being born either 1924-33 or 1944-53. The coefficient β gives a triple differences estimate, implicitly constructed by subtracting the country-of-birth trend estimated using people born 1944-63 (with those born 1944-53 in Puerto Rico taken to be pseudo-treated) from the difference-in-differences estimate for those born 1924-43 (with those born 1924-33 in Puerto Rico receiving treatment). To increase the comparability of migrants from Puerto Rico with immigrants from other countries, equation (3) also controls for individual covariates (denoted by X_{ijk}). The covariates are potential experience, years of schooling, sex and year of arrival to the mainland, with the latter three

[17] A similar analysis using 2000 PUMS data and pooled 1990 and 2000 PUMS data generates similar results.

allowed to have effects (Γ_k) that vary by country of birth.

The results of estimating equation (3) are presented in Table 8, which reports estimates of country-specific cohort trends, δ, as well as the triple differences parameter, β. The differential trends for all three English proficiency measures are mostly positive (there are three exceptions, only one of which is significant). This suggests that the improvement in English proficiency across cohorts has been smaller for Puerto Rican migrants than for other groups (or the decline for Puerto Ricans has been larger). But because this decline relative to other immigrant groups occurred for both treated and pseudo-treated cohorts, it does not point to an adverse effect of the Puerto Rican language reform. In fact, the triple differences estimates of English instruction on all three English proficiency measures are either statistically insignificant or negative. Thus, estimates using immigrants as a control group are consistent with the earlier findings using a within-Puerto Rican identification strategy.

V. Conclusions

Puerto Rico's 1949 language reform provides a unique opportunity to assess the long-run consequences of English-intensive instruction for the English-language skills of a Spanish-speaking population. Perhaps surprisingly, our results suggest that the change from English to Spanish as the medium of instruction in public schools had little effect on Puerto Rican English proficiency, at least as far as self-reported English-speaking skills are concerned. These results are especially unexpected given the presumption by American policymakers at the time that English-only instruction was the best way to raise English proficiency among Puerto Ricans.

Our findings also contrast with those reported by Angrist and Lavy (1997), who evaluated the effects of a similar language reform in Morocco—in their case, a change from the colonial language (French) to Arabic in middle and secondary schools. The Angrist and Lavy

results show a marked decline in French-language skills among affected groups, though it should be noted that they found a significant effect on French *writing* skills, but not on French *reading* skills. A more detailed analysis might show a similar pattern in Puerto Rico. Another likely difference between the Puerto Rican and Moroccan experiences is the relatively abundant supply of French speakers in Morocco, including French citizens and an educated workforce comfortable with a French-speaking milieu.[18]

While our results suggest English-intensive instruction is not sufficient for improved English-language skills, there is good circumstantial evidence that English-intensive instruction is not necessary for good English-language skills either. For example, in a 2000 survey, 41% of Europeans said they knew English even though their language of instruction was a non-English mother tongue, with English taught only as a foreign language.[19] Moreover, 80 percent of those surveyed in Denmark, the Netherlands, and Sweden knew some English, and 60% of respondents in these countries reported "good or better" English. The best way to improve English skills, at least for non-native English speakers, may therefore be to *teach English* as opposed to teaching *in English*. This possibility has implications for contemporary policy issues. Both the continued use of colonial language instruction in many former colonies and the American movement away from native-language instruction for immigrant children are partially predicated on the belief that children instructed in a non-native language will have better non-native language skills. For the Puerto Rican-born, at least, this does not appear to be true.

[18] Angrist and Lavy also found negative earnings effects. We briefly explored models for wages as well; consistent with our results for language skills, after adjusting for education-specific cohort trends, these models show no effects. It is also worth noting that Angrist and Lavy relied on a less-comprehensive specification check than our triple differences models with full nonparametric control for education-specific cohort trends.

[19] INRA (Europe), 2000. Along these lines, in 2003, Chile launched a program called English Opens Doors, designed to raise English proficiency. This program focuses on teaching English as a second language in public schools (Rohter 2005).

References

Angrist, Joshua D. and Victor Lavy, "The Effect of a Change in Language of Instruction on the Returns to Schooling in Morocco," *Journal of Labor Economics* 15 (January 1997, Part 2): S48-S76.

Baker, K.A. and A.A. de Kanter, *Effectiveness of Bilingual Education: A Review of the Literature*, Washington, D.C.: Office of Planning, Budget and Evaluation, U.S. Department of Education, 1981.

Cafferty, Pastora San Juan and Carmen Rivera-Martínez, *The Politics of Language: The Dilemma of Bilingual Education for Puerto Ricans*, Boulder, Colorado: Westview Press, 1981.

Greene, Jay P., "A Meta-Analysis of the Effectiveness of Bilingual Education," Tomás Rivera Policy Institute, 1998.

Hess, Jerry N., "Oral History Interview with Philleo Nash," Transcript of a Tape-Recorded Interview, October 18, 1966, Independence, Missouri: Harry S. Truman Library (http://www.trumanlibrary.org/oralhist/nash7.htm).

INRA (Europe), "Europeans and Languages," Eurobarometer 54 Special, February 2001.

Kominski, Robert, "How Good Is 'How Well'? An Examination of the Census English-Speaking Ability Question," *American Statistical Association Proceedings of the Social Statistics Section*, 1989, 333-338.

Matsudaira, Jordan D., "Sinking or Swimming? Evaluating the Impact of English Immersion versus Bilingual Education on Student Achievement," University of Michigan mimeo, 2004.

Munshi, Kaivan and Mark Rosenzweig, "Traditional Institutions Meet the Modern World: Caste, Gender and Schooling Choice in a Globalizing Economy," Brown University mimeo, 2005.

Osuna, Juan José, *A History of Education in Puerto Rico*, Río Piedras, Puerto Rico: Editorial de la Universidad de Puerto Rico, 1949.

Pousada, Alicia, "The Singularly Strange Story of the English Language in Puerto Rico," *Milenio* 3 (1999): 33-60.

Puerto Rico Department of Education, *Report of the Commissioner of Education of Puerto Rico*, San Juan, Puerto Rico, various years.

Rohter, Larry, "Learn English, Says Chile, Thinking Upwardly Global," *New York Times*, December 29, 2004.

Rossell, Christine H. and Keith Baker, "The Educational Effectiveness of Bilingual Education," *Research in the Teaching of English* 30 (February 1996), 7-74.

Ruggles, Steven, Matthew Sobek, Trent Alexander, Catherine A. Fitch, Ronald Goeken, Patricia Kelly Hall, Miriam King and Chad Ronnander, *Integrated Public Use Microdata Series: Version 3.0* [Machine-readable database], Minneapolis, Minnesota: Minnesota Population Center [producer and distributor], 2004 (http://www.ipums.org).

Solís, José, *Public School Reform in Puerto Rico: Sustaining Colonial Models of Development*, Westport, Connecticut: Greenwood Press, 1994.

Tollefson, James W. and Amy B.M. Tsui (Eds.), *Medium of Instruction Policies: Which Agenda? Whose Policy?*, Mahwah, New Jersey: Lawrence Erlbaum Associates, 2004.

United Nations Development Programme, *Human Development Report 2004: Cultural Liberty in Today's Diverse World*, New York: Oxford University Press, 2004.

U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, 1970 [Puerto Rico]: Public Use Microdata Sample: State, County and Neighborhood Samples* [Computer file], Washington, DC: Bureau of the Census [producer], 1995, Washington, D.C.: National Archives and Records Administration [distributor], 1996.

U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, 1980 [Puerto Rico]: Public Use Microdata Sample: A and B Samples* [Computer file], Washington, D.C.: Bureau of the Census [producer and distributor], 1985.

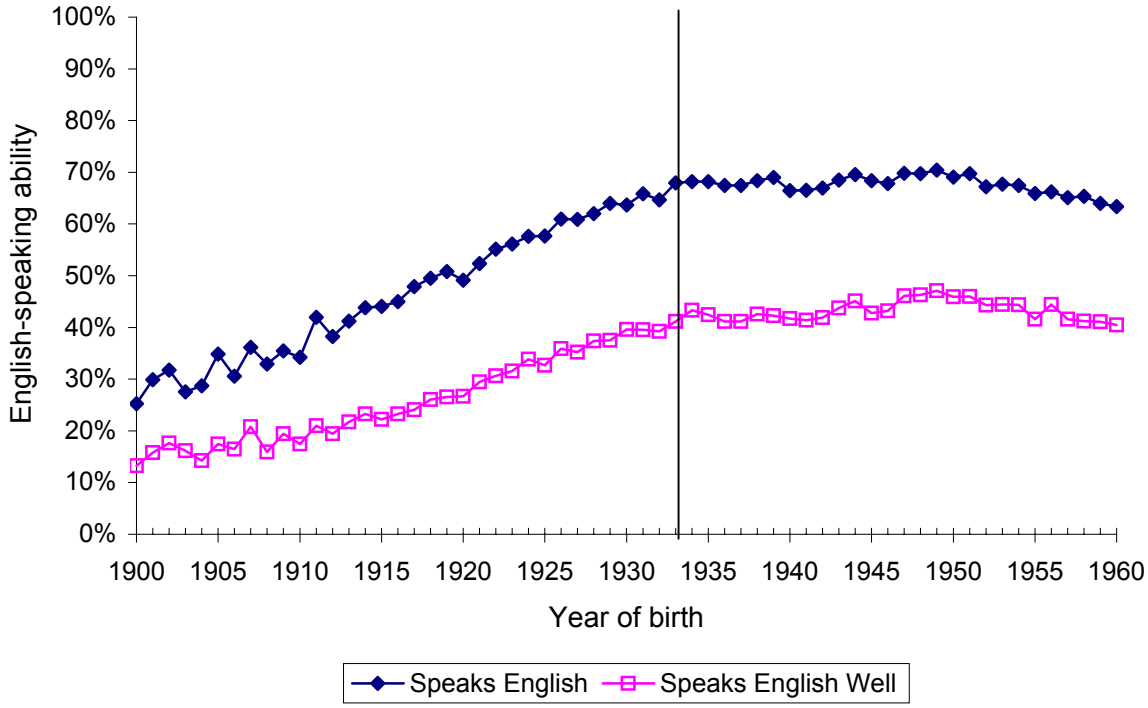
U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, 1990 [Puerto Rico]: Public Use Microdata Sample: 5% Sample* [Computer file], Washington, DC: Bureau of the Census [producer], 1995, Ann Arbor, Michigan: Inter-university Consortium for Political and Social Research [distributor], 1996.

U.S. Department of Commerce, Bureau of the Census, *Census of Population and Housing, 1990 [Puerto Rico]: Public Use Microdata Sample: 1% Sample* [Computer file], Washington, DC: Bureau of the Census [producer], 1995, Ann Arbor, Michigan: Inter-university Consortium for Political and Social Research [distributor], 1996.

Willig, Ann C., "Meta-Analysis of Selected Studies on the Effectiveness of Bilingual Education," *Review of Educational Research* 55 (Fall 1985), 269-317.

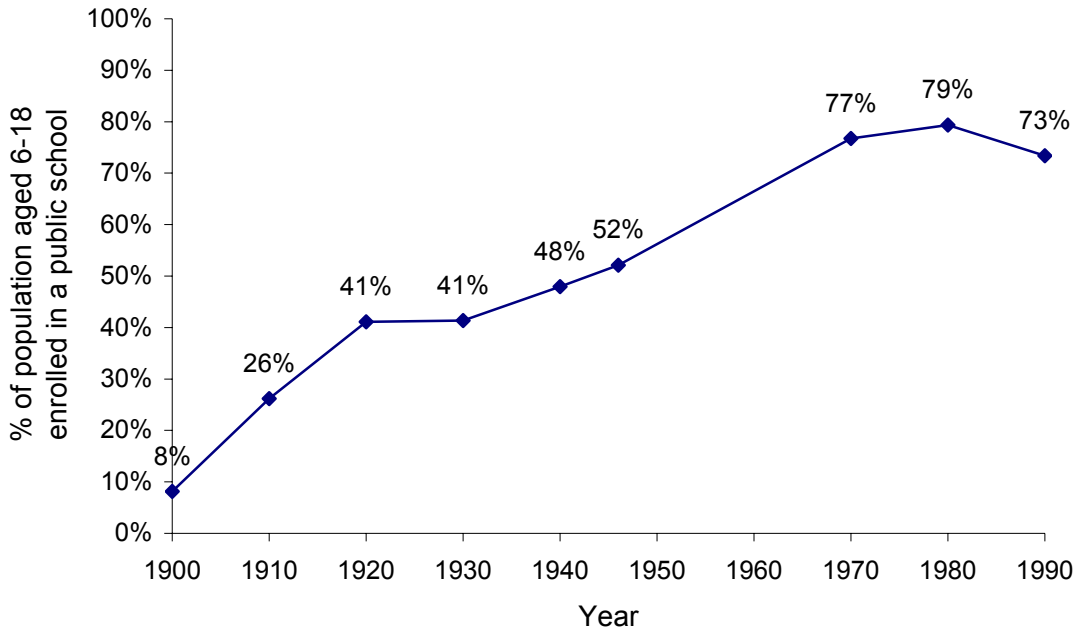
Zehler, Annette M., Howard L. Fleischman, Paul J. Hopstock, Todd G. Stephenson, Michelle L. Pendzick and Saloni Sapru, *Descriptive Study of Services to LEP Students and LEP Students with Disabilities, Volume IA Research Report – Text*, Washington, D.C.: Department of Education, 2003.

Figure 1. English-Speaking Ability by Year of Birth for Puerto Rican-Born: 1900-1960



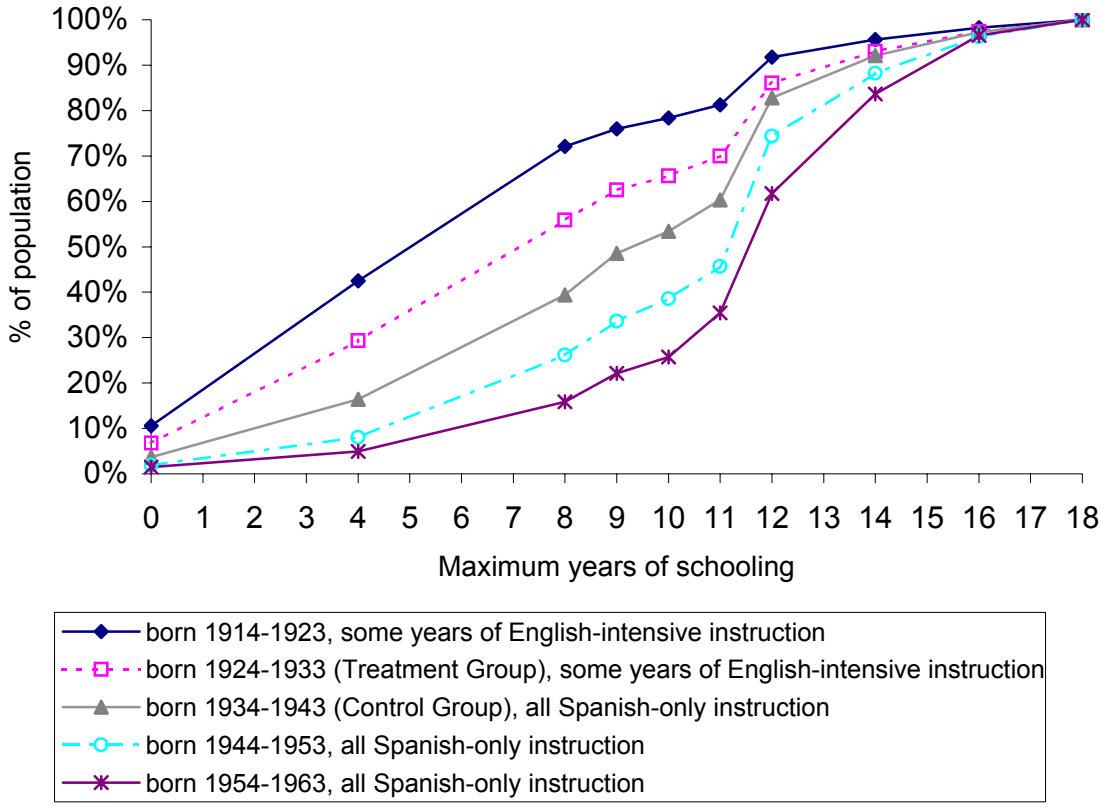
Notes: The sample includes 221,911 Puerto Rican-born men and women aged 30-80 from the 1980 and 1990 PUMS files for Puerto Rico and the mainland.

Figure 2. Enrollment in Puerto Rican Public Schools: 1900-1990



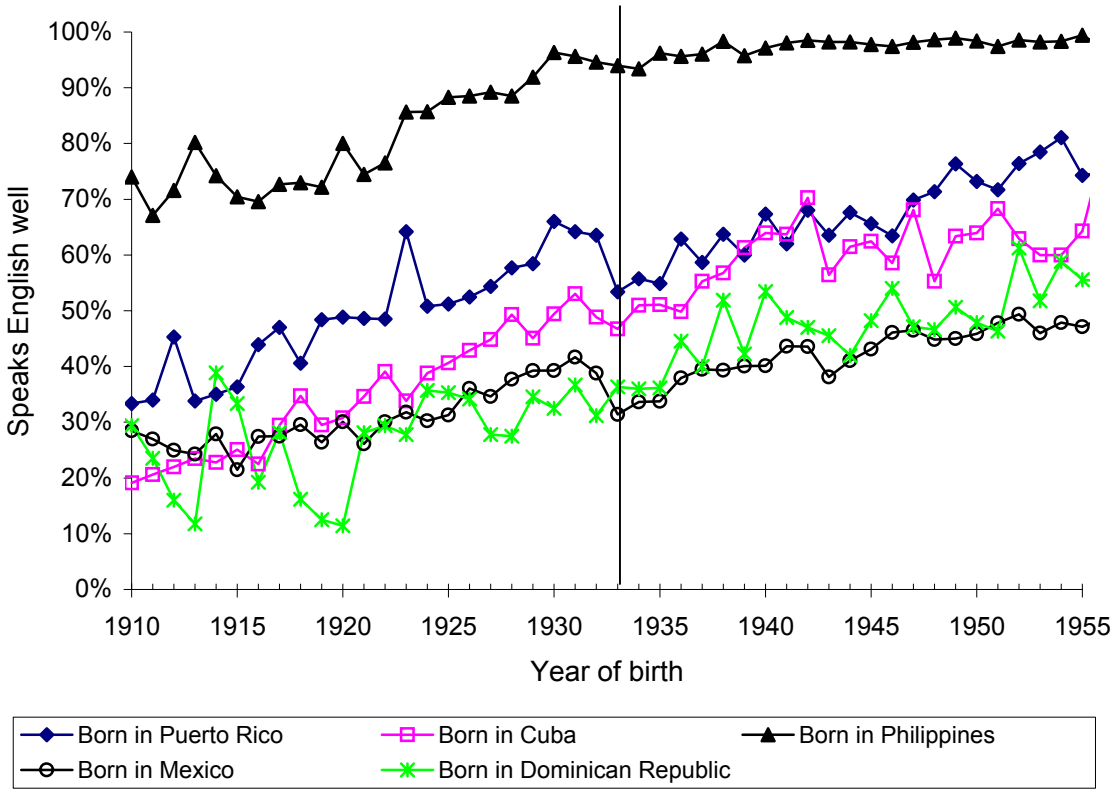
Notes: Enrollment rates for 1946 and earlier are from Osuna (1949), Appendix VIII, Table 2. Osuna's source is the *Report of the Commissioner of Education* , 1945-46. Enrollment rates for 1970, 1980 and 1990 were computed by the authors using the PUMS files for those years for Puerto Rico residents.

Figure 3. Puerto Rican Education Distribution by Cohorts



Notes: The sample includes Puerto Rican-born men and women from the 1980 and 1990 PUMS files for Puerto Rico and the mainland. Each point represents the fraction of the the total number of people in that cohort at or below the indicated schooling level. The following educational attainment categories are used: 0=no schooling, 4=1-4 grades, 8=5-8 grades, 9-12=9-12 grades, respectively, 14=some college, 16=college degree and 18=more than college degree. Data for the 1954-63 cohort came from 1990 only.

Figure 4. English-Speaking Ability by Year of Birth for Puerto Rican Adult Migrants and Hispanic and Filipino Adult Immigrants to the Mainland: 1910-1955



Notes: The sample consists of 9,457 Puerto Rican-born adult migrants and adult immigrants from Cuba (16,664), the Philippines (15,539), Mexico (41,280) and the Dominican Republic (3,238) who arrived to the mainland between 1950 and 1979 from the 1990 PUMS files. Adult migrants and adult immigrants are defined as individuals who arrived to the mainland at age 18 or above.

Table 1. Language of Instruction Policies in Puerto Rican Public Schools

Years	Policy
1493-1898	Puerto Rico was a Spanish colony throughout the period. Spanish was the medium of instruction.
1898-1900	In 1898, Puerto Rico became a U.S. territory. 1898-1900 was a transitional period in which Puerto Rico was run by military government. The official policy was English instruction, but little changed from the Spanish period.
1900-1905	Brumbaugh policy: Spanish instruction in elementary school (grades 1-8) and English in secondary school (grades 9-12).
1905-1916	Falkner policy: English instruction in all grades.
1916-1934	Miller policy: Spanish instruction in grades 1-4, half Spanish and half English in grade 5, and English in grades 6-12.
1934-1937	Padín policy: Spanish instruction in elementary school (grades 1-8) and English in secondary school (grades 9-12).
1937-1942	Gallardo policy: Spanish instruction in grades 1-2, both Spanish and English in grades 3-8 with progressive increase in English, and English in grades 9-12.
1942-1945	Revert to Padín policy: Spanish instruction in elementary school (now grades 1-6) and English in secondary school (now grades 7-12).
1945-1949	No official policy change but a gradual transition to Spanish instruction in all grades.
1949-present	Villaronga policy: Spanish instruction in all grades.

Notes: Sources were Osuna (1949) and Cafferty and Rivera-Martínez (1981). Policy names refer to Commissioners of Education. A given calendar year may have two different policies since the school year begins with the fall semester and ends with the spring semester.

Table 2. Potential Exposure to English-Intensive Instruction

year of birth	year of entry into grade 1	potential years of exposure to English-intensive instruction if highest grade completed is:												
		< grade 1	grade 1	grade 2	grade 3	grade 4	grade 5	grade 6	grade 7	grade 8	grade 9	grade 10	grade 11	≥ grade 12
1900	1906	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1901	1907	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1902	1908	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1903	1909	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1904	1910	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1905	1911	0.0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0	10.0	11.0	12.0
1906	1912	0.0	1.0	2.0	3.0	4.0	4.5	5.5	6.5	7.5	8.5	9.5	10.5	11.5
1907	1913	0.0	1.0	2.0	3.0	3.0	3.5	4.5	5.5	6.5	7.5	8.5	9.5	10.5
1908	1914	0.0	1.0	2.0	2.0	2.0	2.5	3.5	4.5	5.5	6.5	7.5	8.5	9.5
1909	1915	0.0	1.0	1.0	1.0	1.0	1.5	2.5	3.5	4.5	5.5	6.5	7.5	8.5
1910	1916	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1911	1917	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1912	1918	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1913	1919	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1914	1920	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1915	1921	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1916	1922	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1917	1923	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1918	1924	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1919	1925	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1920	1926	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	3.5	4.5	5.5	6.5	7.5
1921	1927	0.0	0.0	0.0	0.0	0.0	0.5	1.5	2.5	2.5	3.5	4.5	5.5	6.5
1922	1928	0.0	0.0	0.0	0.0	0.0	0.5	1.5	1.5	1.5	2.5	3.5	4.5	5.5
1923	1929	0.0	0.0	0.0	0.0	0.0	0.5	0.5	0.5	0.5	1.5	2.5	3.5	4.5
1924	1930	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.7	2.7	3.7	4.7
1925	1931	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.7	1.3	2.3	3.3	4.3	5.3
1926	1932	0.0	0.0	0.0	0.0	0.0	0.0	0.5	1.2	1.8	2.8	3.8	4.8	5.8
1927	1933	0.0	0.0	0.0	0.0	0.0	0.5	1.0	1.7	2.3	3.3	4.3	5.3	6.3
1928	1934	0.0	0.0	0.0	0.0	0.3	0.8	1.3	2.0	2.7	3.7	4.7	5.7	6.7
1929	1935	0.0	0.0	0.0	0.3	0.7	1.2	1.7	2.3	3.3	4.3	5.3	6.3	7.3
1930	1936	0.0	0.0	0.0	0.3	0.7	1.2	1.7	2.7	3.7	4.7	5.7	6.7	7.7
1931	1937	0.0	0.0	0.0	0.3	0.7	1.2	1.2	2.2	3.2	4.2	5.2	6.2	7.2
1932	1938	0.0	0.0	0.0	0.3	0.7	0.7	0.7	1.7	2.7	3.7	4.7	5.7	5.7
1933	1939	0.0	0.0	0.0	0.3	0.3	0.3	0.3	1.3	2.3	3.3	4.3	4.3	4.3
1934 and later	1940 and later	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Notes: For each year of birth and level of educational attainment, the years of exposure to English-intensive instruction is given assuming that individuals began first grade at age 6 and were promoted yearly up through the last grade completed. Variation from cohort to cohort comes from the policy shifts described in Table 1. We coded grade-years in which both English and Spanish were used as languages of instruction as a fraction of a whole year of treatment. Under the Miller policy, grade 5 was half Spanish and half English. Under the Gallardo policy, grades 3-8 used both Spanish and English with a gradual increase in English.

Table 3. Estimates of Effect of English-Intensive Instruction

	All Individuals Born in Puerto Rico				Born & Living in PR	
	Speaks English (1)	Speaks English Well (2)	Speaks English (3)	Speaks English Well (4)	Speaks English (5)	Speaks English Well (6)
Years of exposure:						
One	0.0124	0.0080	0.0313	0.0286	0.0481	0.0282
	(0.0090)	(0.0074)	(0.0079)	(0.0067)	(0.0097)	(0.0065)
Two	0.0760	0.0608	0.0550	0.0379	0.0725	0.0392
	(0.0110)	(0.0103)	(0.0095)	(0.0091)	(0.0135)	(0.0098)
Three	0.0557	0.0373	0.0691	0.0520	0.1033	0.0595
	(0.0121)	(0.0119)	(0.0106)	(0.0106)	(0.0150)	(0.0120)
Four	0.0496	0.0470	0.0595	0.0578	0.0943	0.0683
	(0.0101)	(0.0104)	(0.0090)	(0.0093)	(0.0120)	(0.0109)
Five	0.0536	0.0719	0.0542	0.0725	0.0769	0.0752
	(0.0105)	(0.0120)	(0.0096)	(0.0107)	(0.0127)	(0.0132)
Six	0.0354	0.0698	0.0421	0.0771	0.0595	0.0826
	(0.0101)	(0.0109)	(0.0092)	(0.0099)	(0.0114)	(0.0118)
Seven	0.0305	0.0662	0.0441	0.0810	0.0630	0.0923
	(0.0106)	(0.0115)	(0.0096)	(0.0105)	(0.0117)	(0.0122)
Eight	0.0524	0.0892	0.0660	0.1041	0.0915	0.1218
	(0.0144)	(0.0169)	(0.0133)	(0.0155)	(0.0161)	(0.0182)
Dummy for lives on the mainland	NO	NO	0.3971	0.4334	NO	NO
			(0.0025)	(0.0029)		
F-test p-value for treatment dummies	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
Number of observations	92,430	92,430	92,430	92,430	62,597	62,597

Notes: The sample consists of individuals born 1924-43 in Puerto Rico from the 1980 and 1990 PUMS files. Each column is from a separate OLS regression controlling for year of birth dummies, educational attainment dummies (using categories defined in Figure 3), age dummies, census year dummies, female dummy and a quadratic in potential experience (age-years of schooling-6). Years of exposure to English-intensive instruction is from Table 2, rounded to the nearest whole number. Robust standard errors are shown in parentheses. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.

Table 4. Control Experiments Using Younger and Older Cohorts Born and Living in Puerto Rico

	From Table 3, Columns 5 and 6 Born 1924-33 (affected) vs. born 1934-43 (control)		Always Treated Born 1914-23 (placebo) vs. born 1924-33 (control)		Never Treated Born 1934-43 (placebo) vs. born 1944-53 (control)		Never Treated Born 1944-53 (placebo) vs. born 1954-63 (control)	
	Speaks English	Speaks English Well	Speaks English	Speaks English Well	Speaks English	Speaks English Well	Speaks English	Speaks English Well
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years of exposure or pseudo-exposure:								
One	0.0481	0.0282	0.0271	-0.0011	0.0371	0.0173	0.0562	0.0259
	(0.0097)	(0.0065)	(0.0097)	(0.0061)	(0.0098)	(0.0065)	(0.0097)	(0.0061)
Two	0.0725	0.0392	0.1105	0.0185	0.0540	0.0216	0.0883	0.0290
	(0.0135)	(0.0098)	(0.0148)	(0.0107)	(0.0122)	(0.0087)	(0.0116)	(0.0078)
Three	0.1033	0.0595	0.1191	0.0269	0.0902	0.0451	0.1243	0.0513
	(0.0150)	(0.0120)	(0.0157)	(0.0124)	(0.0133)	(0.0103)	(0.0130)	(0.0094)
Four	0.0943	0.0683	0.0917	0.0301	0.0824	0.0419	0.0996	0.0575
	(0.0120)	(0.0109)	(0.0135)	(0.0131)	(0.0109)	(0.0089)	(0.0110)	(0.0082)
Five	0.0769	0.0752	0.0668	0.0496	0.1033	0.0812	0.1165	0.0932
	(0.0127)	(0.0132)	(0.0159)	(0.0182)	(0.0114)	(0.0104)	(0.0112)	(0.0090)
Six	0.0595	0.0826	0.0935	0.0512	0.0949	0.0717	0.1128	0.0875
	(0.0114)	(0.0118)	(0.0122)	(0.0153)	(0.0111)	(0.0098)	(0.0114)	(0.0089)
Seven	0.0630	0.0923	0.0553	0.0731	0.0704	0.0541	0.1132	0.1054
	(0.0117)	(0.0122)	(0.0130)	(0.0159)	(0.0118)	(0.0105)	(0.0120)	(0.0094)
Eight	0.0915	0.1218	0.0807	0.0681	0.1081	0.0936	0.1237	0.1155
	(0.0161)	(0.0182)	(0.0186)	(0.0241)	(0.0161)	(0.0152)	(0.0157)	(0.0129)
F-test p-value	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	62,597	62,597	48,478	48,478	81,454	81,454	96,302	96,302

Notes: The sample consists of individuals born and currently living in Puerto Rico from the 1980 and 1990 PUMS files. Each column is from a separate OLS regression controlling for year of birth dummies, educational attainment dummies (using categories defined in Figure 3), age dummies, census year dummies, female dummy and a quadratic in potential experience (age-years of schooling-6). Years of pseudo-exposure equals actual years of exposure as if the older cohort were born 1924-33 (which is the older cohort in Columns 1 and 2) and the younger cohort were born 1934-43 (which is the younger cohort in Columns 1 and 2). Robust standard errors are shown in parentheses. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.

Table 5. Estimates of Effect of English-Intensive Instruction Using Younger Cohorts to Control for Differential Trend

	All Individuals Born in Puerto Rico				Born & Living in PR	
	Speaks English (1)	Speaks English Well (2)	Speaks English (3)	Speaks English Well (4)	Speaks English (5)	Speaks English Well (6)
Years of exposure:						
One	-0.0020	0.0027	-0.0018	0.0029	-0.0081	0.0023
	(0.0133)	(0.0108)	(0.0113)	(0.0097)	(0.0137)	(0.0089)
Two	-0.0102	0.0021	-0.0214	-0.0114	-0.0158	0.0102
	(0.0153)	(0.0139)	(0.0129)	(0.0122)	(0.0178)	(0.0126)
Three	-0.0110	-0.0129	-0.0132	-0.0156	-0.0209	0.0082
	(0.0167)	(0.0159)	(0.0143)	(0.0138)	(0.0199)	(0.0153)
Four	0.0080	-0.0047	-0.0015	-0.0162	-0.0053	0.0107
	(0.0145)	(0.0140)	(0.0125)	(0.0123)	(0.0163)	(0.0136)
Five	0.0067	0.0005	-0.0196	-0.0314	-0.0396	-0.0180
	(0.0148)	(0.0154)	(0.0131)	(0.0136)	(0.0169)	(0.0160)
Six	-0.0040	0.0007	-0.0258	-0.0256	-0.0533	-0.0049
	(0.0150)	(0.0148)	(0.0131)	(0.0132)	(0.0162)	(0.0148)
Seven	-0.0065	-0.0189	-0.0197	-0.0348	-0.0502	-0.0130
	(0.0157)	(0.0156)	(0.0137)	(0.0140)	(0.0167)	(0.0154)
Eight	0.0205	0.0053	0.0003	-0.0191	-0.0323	0.0063
	(0.0205)	(0.0219)	(0.0182)	(0.0196)	(0.0225)	(0.0223)
Dummy for lives on the mainland	NO	NO	0.4247	0.5124	NO	NO
			(0.0015)	(0.0018)		
F-test p-value for treatment dummies	0.7309	0.8593	0.2849	0.2003	0.0317	0.7708
Number of observations	233,990	233,990	233,990	233,990	158,899	158,899

Notes: The sample consists of individuals born 1924-63 in Puerto Rico from the 1980 and 1990 PUMS files. Each column is from a separate OLS regression which contains as controls years of pseudo-exposure dummies and the same covariates as in Table 3. The education, age, census year, female and potential experience coefficients are allowed to vary by two groupings of year of birth, born 1924-43 and born 1944-63. Years of pseudo-exposure is equal to actual years of exposure for individuals born 1924-43. On the other hand, individuals born 1944-63 are assigned the actual years of exposure as if they were born twenty years earlier. Robust standard errors are shown in parentheses. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.

Table 6. Specifications Controlling for Education Distribution

	From Table 3, Columns 5 and 6 1980 & 1990 sample born 1924-43 (DD using PR-born & resident)		Table 3, Columns 5 and 6 specs adding education CDF controls, 1980 & 1990 sample born 1924-43 (DD using PR-born & resident)		Table 5, Columns 5 and 6 specs adding education CDF controls, 1990 sample born 1924-63 (DDD using PR-born & resident)		Table 5, Columns 1 and 2 specs adding education CDF controls, 1990 sample born 1924-63 (DDD using all PR-born)	
	Speaks English	Speaks English Well	Speaks English	Speaks English Well	Speaks English	Speaks English Well	Speaks English	Speaks English Well
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Years of exposure:								
One	0.0481	0.0282	0.0200	0.0301	0.0108	0.0095	-0.0141	-0.0158
	(0.0097)	(0.0065)	(0.0103)	(0.0070)	(0.0204)	(0.0136)	(0.0199)	(0.0160)
Two	0.0725	0.0392	0.0305	0.0377	0.0043	0.0093	-0.0233	-0.0045
	(0.0135)	(0.0098)	(0.0144)	(0.0105)	(0.0269)	(0.0197)	(0.0230)	(0.0211)
Three	0.1033	0.0595	0.0558	0.0513	0.0068	0.0094	0.0009	0.0009
	(0.0150)	(0.0120)	(0.0158)	(0.0127)	(0.0302)	(0.0238)	(0.0267)	(0.0248)
Four	0.0943	0.0683	0.0579	0.0538	-0.0043	-0.0095	-0.0151	-0.0247
	(0.0120)	(0.0109)	(0.0126)	(0.0115)	(0.0257)	(0.0217)	(0.0236)	(0.0225)
Five	0.0769	0.0752	0.0502	0.0483	0.0152	-0.0311	0.0137	-0.0242
	(0.0127)	(0.0132)	(0.0145)	(0.0148)	(0.0306)	(0.0289)	(0.0264)	(0.0278)
Six	0.0595	0.0826	0.0367	0.0607	-0.0097	-0.0147	-0.0115	-0.0230
	(0.0114)	(0.0118)	(0.0125)	(0.0127)	(0.0285)	(0.0262)	(0.0263)	(0.0262)
Seven	0.0630	0.0923	0.0434	0.0715	-0.0201	-0.0291	-0.0284	-0.0513
	(0.0117)	(0.0122)	(0.0126)	(0.0130)	(0.0293)	(0.0272)	(0.0276)	(0.0275)
Eight	0.0915	0.1218	0.0794	0.1029	0.0169	-0.0020	0.0221	-0.0030
	(0.0161)	(0.0182)	(0.0166)	(0.0186)	(0.0370)	(0.0368)	(0.0340)	(0.0358)
Education CDF measure	NO	NO	0.3833	-0.3000	0.5690	-0.1962	0.3704	-0.2044
			(0.1129)	(0.0914)	(0.1152)	(0.0983)	(0.1024)	(0.1005)
Education CDF measure squared	NO	NO	0.2169	0.3981	0.0769	0.4687	0.0688	0.4337
			(0.1115)	(0.1003)	(0.1072)	(0.1057)	(0.0884)	(0.0977)
F-test p-value	0.0000	0.0000	0.0000	0.0000	0.8552	0.8308	0.3415	0.5827
N	62,597	62,597	62,597	62,597	77,398	77,398	113,578	113,578

Notes: The sample consists of individuals born in Puerto Rico from the PUMS files, with Columns 1-4 using both 1980 and 1990 data and Columns 5-8 using only 1990 data.
This education cumulative distribution function (CDF) measure gives the fraction of people of the same year of birth with less education than the individual.
Robust standard errors are shown in parentheses. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.

Table 7. Additional Specifications

	Drop first to fourth graders		San Juan-Bayamon PMSA residents		San Juan-Bayamon PMSA residents who lived in same house 5 years ago	
	Speaks English (1)	Speaks English Well (2)	Speaks English (3)	Speaks English Well (4)	Speaks English (5)	Speaks English Well (6)
Years of exposure:						
One	0.0574	0.0444	0.0771	0.0402	0.0787	0.0434
	(0.0129)	(0.0088)	(0.0183)	(0.0127)	(0.0224)	(0.0148)
Two	0.0661	0.0390	0.0872	0.0272	0.1099	0.0204
	(0.0153)	(0.0111)	(0.0236)	(0.0170)	(0.0296)	(0.0199)
Three	0.0952	0.0579	0.1445	0.0631	0.1695	0.0648
	(0.0168)	(0.0133)	(0.0249)	(0.0204)	(0.0316)	(0.0251)
Four	0.0971	0.0730	0.1114	0.0632	0.1403	0.0684
	(0.0142)	(0.0122)	(0.0207)	(0.0182)	(0.0259)	(0.0225)
Five	0.0727	0.0791	0.0697	0.0751	0.0994	0.0805
	(0.0148)	(0.0143)	(0.0206)	(0.0203)	(0.0258)	(0.0256)
Six	0.0627	0.0891	0.0668	0.1057	0.0920	0.1310
	(0.0146)	(0.0138)	(0.0194)	(0.0189)	(0.0240)	(0.0232)
Seven	0.0632	0.1039	0.0477	0.0807	0.0628	0.1037
	(0.0151)	(0.0144)	(0.0204)	(0.0196)	(0.0255)	(0.0241)
Eight	0.0909	0.1294	0.1127	0.1195	0.1562	0.1540
	(0.0199)	(0.0206)	(0.0271)	(0.0281)	(0.0334)	(0.0350)
F-test p-value for treatment dummies	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
N	51,238	51,238	22,640	22,640	13,523	13,523

Notes: The sample consists of individuals born and currently living in Puerto Rico from the 1980 and 1990 PUMS files. Columns 1 and 2 report the results of omitting those with 1st-4th grade educational attainment. For Columns 3-6, the sample contains only residents of the San Juan-Bayamon primary metropolitan statistical area (PMSA). Each column is from a separate OLS regression controlling for year of birth dummies, educational attainment dummies (using categories defined in Figure 3), age dummies, census year dummies, female dummy and a quadratic in potential experience (age-years of schooling-6). Robust standard errors are shown in parentheses. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.

Table 8. Estimation Using Puerto Rican Adult Migrants
and Hispanic and Filipino Adult Immigrants to the Mainland

	Sample composed of adult migrants from Puerto Rico and immigrants from:			
	Cuba	Philippines	Mexico	Dominican Republic
	(1)	(2)	(3)	(4)
	Panel A. Dependent Variable is Pr(Speaks English)			
Triple differences estimate	-0.0451	-0.0347	0.0178	-0.0631
	(0.0200)	(0.0130)	(0.0170)	(0.0288)
Differential trend estimate	0.0747	-0.0080	0.0351	0.0783
	(0.0145)	(0.0068)	(0.0091)	(0.0164)
Number of observations	30,284	38,001	81,919	18,883
	Panel B. Dependent Variable is Pr(Speaks English Well)			
Triple differences estimate	-0.0487	-0.0025	0.0047	-0.0553
	(0.0261)	(0.0216)	(0.0219)	(0.0337)
Differential trend estimate	0.1203	0.0057	0.0097	0.0872
	(0.0198)	(0.0125)	(0.0137)	(0.0216)
Number of observations	30,284	38,001	81,919	18,883
	Panel C. Dependent Variable is Pr(Speaks English Very Well)			
Triple differences estimate	-0.0510	-0.0349	0.0076	-0.0097
	(0.0251)	(0.0259)	(0.0217)	(0.0305)
Differential trend estimate	0.0840	0.0688	-0.0303	-0.0097
	(0.0190)	(0.0164)	(0.0143)	(0.0305)
Number of observations	30,284	38,001	81,919	18,883

Notes: The analysis uses data on Puerto Rican adult migrants and Hispanic and Filipino adult immigrants born 1924-63 from the 1990 PUMS files for U.S. residents. Adult migrants and adult immigrants are defined as individuals who arrived to the mainland at age 18 or above. Each panel of each column reports the results of a separate OLS regression controlling for year of birth dummies, place of birth dummies, educational attainment dummies (using categories defined in Figure 4), female dummy, year of arrival dummies and a quadratic in potential experience (age-years of schooling-6). The coefficients for the last five variables are allowed to vary by two groupings of year of birth, born 1924-43 and born 1944-63. Additionally, the coefficients for all education, sex and year of arrival variables are allowed to differ for Puerto Ricans. Robust standard errors are shown in parentheses.

Appendix Table 1. Descriptive Statistics for Puerto Rican-Born

	Born 1914-23			Born 1924-33 (Treatment Cohort)			Born 1934-43 (Control Cohort)		
	total	4 or less yrs educ	5 or more yrs educ	total	4 or less yrs educ	5 or more yrs educ	total	4 or less yrs educ	5 or more yrs educ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Years of exposure to English-intensive instruction	2.20	0.00	3.82	2.85	0.13	3.98	0.00	0.00	0.00
	(2.66)	(0.00)	(2.47)	(2.66)	(0.22)	(2.37)	(0.00)	(0.00)	(0.00)
speaks English (not well, well or very well)	0.50	0.21	0.71	0.63	0.31	0.76	0.68	0.34	0.74
	(0.50)	(0.41)	(0.45)	(0.48)	(0.46)	(0.43)	(0.47)	(0.47)	(0.44)
speaks English well (well or very well)	0.27	0.07	0.41	0.37	0.11	0.48	0.42	0.15	0.48
	(0.44)	(0.25)	(0.49)	(0.48)	(0.32)	(0.50)	(0.49)	(0.35)	(0.50)
age	65.65	66.03	65.37	56.14	56.66	55.93	46.03	46.77	45.89
	(5.66)	(5.65)	(5.65)	(5.75)	(5.73)	(5.75)	(5.75)	(5.76)	(5.74)
proportion female	0.53	0.57	0.50	0.53	0.59	0.51	0.53	0.58	0.53
	(0.50)	(0.49)	(0.50)	(0.50)	(0.49)	(0.50)	(0.50)	(0.49)	(0.50)
years of schooling	6.36	2.20	9.42	7.89	2.26	10.22	9.30	2.29	10.67
	(4.52)	(1.50)	(3.43)	(4.72)	(1.48)	(3.48)	(4.33)	(1.48)	(3.24)
proportion with no schooling	0.11	0.25	0.00	0.07	0.23	0.00	0.04	0.22	0.00
	(0.31)	(0.43)	(0.00)	(0.25)	(0.42)	(0.00)	(0.19)	(0.42)	(0.00)
proportion with 1-4 years schooling	0.32	0.75	0.00	0.23	0.77	0.00	0.13	0.78	0.00
	(0.47)	(0.43)	(0.00)	(0.42)	(0.42)	(0.00)	(0.33)	(0.42)	(0.00)
proportion with 5-8 years schooling	0.30	0.00	0.51	0.27	0.00	0.38	0.23	0.00	0.28
	(0.46)	(0.00)	(0.50)	(0.44)	(0.00)	(0.48)	(0.42)	(0.00)	(0.45)
proportion with 9 or more years schooling	0.28	0.00	0.49	0.44	0.00	0.62	0.61	0.00	0.72
	(0.45)	(0.00)	(0.50)	(0.50)	(0.00)	(0.48)	(0.49)	(0.00)	(0.45)
lives on the mainland	0.23	0.18	0.27	0.30	0.26	0.32	0.34	0.30	0.35
	(0.42)	(0.38)	(0.45)	(0.46)	(0.44)	(0.47)	(0.47)	(0.46)	(0.48)
number of observations	27,554	11,692	15,862	39,059	11,425	27,634	53,371	8,731	44,640

Notes: Table continues on next page.

Appendix Table 1. Descriptive Statistics for Puerto Rican-Born (Continued)

	Born 1944-53			Born 1954-63		
	total (10)	4 or less yrs educ (11)	5 or more yrs educ (12)	total (13)	4 or less yrs educ (14)	5 or more yrs educ (15)
Years of exposure to English-intensive instruction	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)	0.00 (0.00)
speaks English (not well, well or very well)	0.69 (0.46)	0.31 (0.46)	0.72 (0.45)	0.62 (0.49)	0.22 (0.42)	0.64 (0.48)
speaks English well (well or very well)	0.45 (0.50)	0.13 (0.34)	0.48 (0.50)	0.38 (0.48)	0.11 (0.31)	0.39 (0.49)
age	36.32 (5.73)	36.74 (5.66)	36.29 (5.73)	26.31 (5.80)	26.74 (5.88)	26.29 (5.80)
proportion female	0.53 (0.50)	0.49 (0.50)	0.54 (0.50)	0.52 (0.50)	0.42 (0.49)	0.53 (0.50)
years of schooling	10.71 (3.93)	2.32 (1.53)	11.44 (3.15)	11.23 (3.43)	2.17 (1.58)	11.68 (2.81)
proportion with no schooling	0.02 (0.14)	0.23 (0.42)	0.00 (0.00)	0.01 (0.12)	0.28 (0.45)	0.00 (0.00)
proportion with 1-4 years schooling	0.06 (0.24)	0.77 (0.42)	0.00 (0.00)	0.03 (0.18)	0.72 (0.45)	0.00 (0.00)
proportion with 5-8 years schooling	0.18 (0.38)	0.00 (0.00)	0.20 (0.40)	0.13 (0.34)	0.00 (0.00)	0.14 (0.35)
proportion with 9 or more years schooling	0.74 (0.44)	0.00 (0.00)	0.80 (0.40)	0.82 (0.39)	0.00 (0.00)	0.86 (0.35)
lives on the mainland	0.35 (0.48)	0.29 (0.45)	0.36 (0.48)	0.29 (0.45)	0.20 (0.40)	0.29 (0.45)
number of observations	71,422	5,716	65,706	70,138	3,382	66,756

Notes: Sample consists of individuals born in Puerto Rico 1924-63 from the 1980 and 1990 PUMS files with non-missing and non-allocated values for age, education, place of birth and English-speaking ability variables. Years of exposure to English-intensive instruction is from Table 2.

Appendix Table 2. Estimation Using Logit

	Table 3, Columns 1 and 2 specifications (DD using all PR-born)		Table 3, Columns 5 and 6 specifications (DD using PR-born & resident)		Table 5, Columns 5 and 6 specifications (DDD using PR-born & resident)	
	Speaks English (1)	Speaks English Well (2)	Speaks English (3)	Speaks English Well (4)	Speaks English (5)	Speaks English Well (6)
Years of exposure:						
One	0.0050	0.0304	0.0545	0.0758	-0.0042	0.0195
	(0.0101)	(0.0075)	(0.0135)	(0.0010)	(0.0212)	(0.0210)
Two	0.0514	0.0832	0.0589	0.0824	-0.0194	0.0137
	(0.0131)	(0.0088)	(0.0172)	(0.0015)	(0.0251)	(0.0234)
Three	0.0351	0.0489	0.0837	0.1045	-0.0245	0.0052
	(0.0150)	(0.0096)	(0.0190)	(0.0018)	(0.0275)	(0.0245)
Four	0.0498	0.0627	0.1041	0.1091	0.0195	0.0136
	(0.0150)	(0.0090)	(0.0187)	(0.0017)	(0.0270)	(0.0235)
Five	0.0644	0.0904	0.1045	0.1117	-0.0069	-0.0013
	(0.0189)	(0.0100)	(0.0224)	(0.0020)	(0.0298)	(0.0236)
Six	0.0469	0.0899	0.0831	0.1197	-0.0238	0.0097
	(0.0179)	(0.0100)	(0.0217)	(0.0018)	(0.0303)	(0.0251)
Seven	0.0485	0.0843	0.0962	0.1370	-0.0132	0.0090
	(0.0196)	(0.0106)	(0.0235)	(0.0019)	(0.0325)	(0.0266)
Eight	0.0808	0.1129	0.1490	0.1728	0.0340	0.0291
	(0.0311)	(0.0148)	(0.0354)	(0.0028)	(0.0446)	(0.0323)
F-test p-value for treatment dummies	0.0000	0.0000	0.0000	0.0000	0.5512	0.9407
number of observations	92,430	92,430	62,597	62,597	158,899	158,899

Notes: The sample consists of individuals born 1924-43 in Puerto Rico from the 1980 and 1990 PUMS files, with the analysis in Columns 3-6 restricted to those living on the island. Columns 1-4 report difference-in-differences estimates and Columns 5-6 report triple differences estimates. Logit marginal effects are reported. The standard errors associated with the marginal effects are shown in parentheses, and are calculated as (p)*(1-p)*(robust SE for logit coefficient) where p is the mean of dependent variable. The F-test p-value reported is for a test of the joint significance of the eight years of exposure dummies.