

**Modern Colonization and its Consequences:
The Effects of U.S. Educational Policy on Puerto Rico's Educational Stratification,
1899-1910***

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Abstract: The debate regarding the impact of the early U.S. colonial experiment in Puerto Rico has downplayed the role of changes in educational institutions brought about by U.S. colonial policies on the island's social stratification. This study focuses on understanding how U.S. colonial education policy in Puerto Rico during the period 1899-1910 – the initial expansion of public primary schooling in Puerto Rico – affected the distribution of literacy and English-language skills among children and young adults. Taking advantage of the expansion in public primary schools across municipalities during 1899-1907 to identify the causal effects of the policy changes, we find that literacy skills increased moderately among the young population, but that English-language skills improved dramatically, especially among females. We also find that, although race-based differentials in literacy rates decreased during this period, English literacy gains were greater among native-born whites. These findings provide evidence that U.S. educational policies altered the stratification dynamics present at the turn of the century in a complex manner, by closing racial educational gaps at the bottom of the distribution, but expanding them at the top.

Keywords: colonialism, education policy, social stratification, educational stratification, literacy and English-language skills, Puerto Rico

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1. Introduction

The consequences of the transfer of colonial rule in 1898 from Spain to the United States for Puerto Rico's economic, social, and political life have been at the center of major scholarly debates on the modern history of the Island. The conclusions of several generations of researchers studying this period have diverged widely. Modernization scholars considered the institutional changes brought about under U.S. colonial tutors as a catalytic factor which profoundly affected the culture and values of an arguably traditional society (Wells, 1969). Among Puerto Rican scholars, a generation exemplified by the work of Morales Carrión considered the arrival of U.S. forces as simultaneously raising great hopes among locals, but in practice inducing great disillusionment and "trauma" due to the undemocratic and notoriously assimilationist policies these officials implemented in Puerto Rico (Morales Carrión, 1983; Fernández Méndez, 1971: 223-4).

More recently, scholars have debated the extent to which the transfer of colonial rule drastically altered the relations which characterized the social structure immediately prior to the U.S. takeover. Those who have claimed that the period following the occupation discontinuously altered the fabric of social life have emphasized the intensified commercial exploitation of land and of people that surrounded sugar cultivation (Quintero Rivera, 1988; Dietz, 1986).¹ Those who see greater continuity stress the emerging presence, under the Spanish colonial regime, of already high levels of inequality in land tenure, as well as the great extent of landless labor and budding capitalist enterprise (Bergad, 1983; Ayala and Bergad, 2001).²

Whether the U.S. occupation is considered to have induced discontinuous changes or an acceleration of pre-existing trends depends on the specific features of the social structure under consideration. The debate ultimately seems to hinge on the consequences for the forms of inequality and social stratification that emerged owing to the presence of new imperial tutors. One of the key mediating mechanisms generally

¹ This view was initially depicted by Diffie and Diffie (1931) and has been more recently portrayed by Quintero Rivera (1988), Santiago Valles (1983), and Dietz (1986). These authors argue that the devaluation of the Spanish currency, in combination with the imposition of new property tax obligations and, destroyed an independent class of small and medium-size peasants who supposedly had dominated the Puerto Rican economy during the late 19th century.

² For instance, a recent investigation that examined in detail the historical data on landholding patterns from 1899 through 1915 has contested the extent to which the occupation induced discontinuous changes in the nature of land distribution (Ayala and Bergad, 2001).

found to be of relevance for social inequality in other contexts refers to the role of education in enhancing or inhibiting pre-existing inequality patterns (Hout, Raftery, and Bell, 1993; Shavit and Blossfeld, 1993; references therein). In general, education is considered as mediating the relationship between social class and opportunity (Blau and Duncan, 1967; Bourdieu and Passeron, 1970; Bowles and Gintis, 1976). In the specific case of Puerto Rico, there is a general acknowledgement of the expansion in primary schooling during the early years of U.S. colonial rule, Osuna, 1949; Quintero-Rivera, 1977: 40-44). But the existing literature on the impact of the early U.S. colonial experiment has not focused on the important effect of changes in educational institutions under new U.S. education policies, on the social stratification of the Puerto Rican population. ;

Early U.S. educational policies became one of the key arenas of political and social change. The positions of two classic scholars exemplify the centrality ascribed to the success of educational policy as a gauge of the modernizing project brought about by U.S. authorities (Coll y Toste, 1909; Osuna, 1949). Coll y Toste, as early as 1909, defended the public education system developed under Spain as constitutive of the “culture and civilization that we possess, which constitute our historical personality and our pride” (Coll y Toste, 1909: 205-206).³ Writing approximately forty years later, Juan José Osuna, took a less sanguine view. He argued that as late as the administration of Governor Don Félix de Messina—twenty-five years prior to the take over by United States 1863-1865)—“it cannot be said that Puerto Rico had a system of public instruction.” (Osuna, 1949: 53). Among those who have examined the substantive content of educational policy between 1900 and 1948 (Negrón de Montilla, 1975; Torres, 2002; Cabán, 1999), the educational system has been regarded critically due to the explicitly assimilationist policies implemented under the U.S. Commissioners of Education. The institutionalization and expansion of a modern educational system in Puerto Rico by U.S. authorities partly induced what the colonial authorities intended; a moderate expansion of literacy, but ample effects with respect to the acquisition of English-language skills by the young population.

³ Translation by authors.

However, questions remain on the specific mechanisms that gave U.S. authorities their relative success, and whether these policies altered the pre-existing educational stratification that had prevailed under Spain's rule. The paucity in our understanding of these issues is in part due to the scarcity of micro-data for the period ranging from the end of Spanish rule through the first years of U.S. control. The publication of the micro-data for the 1910 U.S. Census for Puerto Rico allows us to address these debates anew and answer specific questions about colonial policy and its effects on the educational stratification of the population.

We thus bring together these two dimensions of the debate surrounding 1898 under one cohesive empirical examination, by examining the joint effects of the economic and public schooling expansions across municipalities on children's literacy and English language skills. Our analysis makes comparisons of inequality in these measures of educational attainment across race and gender of young potential school entrants (relative to cohorts of individuals just above school-age) during 1899-1909.⁴ To identify the effects of greater access in schooling on the literacy and English-language skills of the young population, we make these comparisons across municipalities which experienced the expansion to different degrees.⁵

One of the consequences of U.S. educational policy was to alter the inegalitarian bases of the colonial social-structure under Spain's rule, even as U.S. control created new inequalities. The expansion of public primary schooling under the United States worked to further the potential objectives of U.S. educational policy, since significant gains were achieved in English literacy, even if the expansion of education quite plausibly also extended the formalized learning of Spanish. Our main results indicate that, although literacy skills increased quite modestly, English-language skills improved dramatically – by 47 percent – among the school-age population during 1899-1909, especially among females. We also find that, although race-based differentials in literacy rates decreased during this period, English literacy gains were

⁴ To our knowledge, these specific analyses have never been carried out previously for Puerto Rico. For the cases of Costa Rica and Argentina, see Molina and Palmer (2004) and Parrado (1998), respectively. For a general discussion on Latin America and the expansion of schooling during the 19th and early 20th centuries, see Mariscal and Sokoloff (2000).

⁵ This approach allows us to avoid some of the principal methodological problems related to identifying the effects of educational policies present in the literature: the fact that during this complex transition period, many other policy and institutional reforms may have promoted or inhibited individuals' educational opportunities and familial schooling decisions (Duflo, 2001).

greater among native-born whites. These findings provide evidence that U.S. educational policies – in particular, the expansion in the number of public primary schools – altered the stratification dynamics present at the turn of the century in a complex manner. By decreasing differences in literacy by race, the educational reforms aided in the closing of racial educational gaps at the bottom of the distribution, but also aided in expanding these gaps at the top, by expanding racial differences in educational outcomes at higher levels of education (as proxied by English literacy).

Secondly, we suggest that systematic changes in education policy led to a complex change in the educational stratification of the young population. Although we do not undertake a comprehensive analysis to explain these trends, we argue that the intricacies of the reforms allow us to explain these patterns. For instance, the local financing structure of the educational system – by promoting a higher level of school expenditures in wealthier sugar-based municipalities (relative to poorer central municipalities) – led to a disproportionate increase in access to schooling in areas populated by non-white populations.⁶ This system may have had the unintended effect of encouraging convergence in the access to basic schooling of white and non-white populations across the Island.⁷ In addition, the reduction in gender-based literacy (both in English and Spanish) can partly be explained by the elimination by U.S. colonial officials of gender segregation in primary schooling; the standard practice under the Spanish system (Report of the Commissioner of Education, 1907).

Our findings are not only relevant for students of Puerto Rico. Rarely can scholars document the specific micro-stratification consequences of colonial domination. Therefore, our findings on Puerto Rico afford those interested in colonialism more generally a rare glimpse into the specificity of the effects of institutional change induced by colonial control by Western countries that sought to impose modernizing agendas on their subject peoples. Our findings also serve as a detailed comparative benchmark for other instances of expansion in education that took place in the Caribbean. Notable among these were the English

⁶ Essentially, in educational systems relying on municipality-level financing – based partly on property taxation – more affluent communities are more likely to expand educational access than poorer ones (Tiebout, 1956).

⁷ This result is perhaps a classic consequence of unintended administrative actions, since we do not find evidence in administrative documents or secondary sources that there was an explicit policy to target the promotion of educational attainment of non-white children, which could have explained this convergence in literacy rates.

colonies as well as the case of Cuba, wherein the United States sought to implement a similar educational expansion to the one in Puerto Rico (Domínguez, 1978).

The paper is structured as follows. In Section 2 we briefly discuss educational access in Puerto Rico at the turn of the century, and the actual policies implemented during the first ten years of the U.S. colonial regime. We present a concise description of the data used in the analysis in Section 3 and a discussion of the geographical distribution of the 1899-1907 primary school expansion in Section 4. In Section 5, we then describe our empirical methodology in more detail and present the main estimates of the policies' impacts on educational stratification. Finally, Section 6 concludes by suggesting modifications to the view of class structures characteristic of plantation societies during the late colonial period.

2. Educational Access in Puerto Rico during the Late 19th and Early 20th Centuries

2.1. The Primary School System during the Spanish Colonial Regime

Although there had been efforts since the 1820s to create a country-wide public primary schooling system, having founded 29 schools by 1830 across the main towns of the Island, subsequent Spanish colonial governors made limited efforts to expand the system until the mid-nineteenth century (de Córdoba 1832; Coll y Toste 1909; Osuna 1947).⁸ Statistics on the number of public schools provide evidence of some improvement in access to education throughout the period: the number of schools more than doubled in three years – from 122 schools in 1864 to 296 in 1867 – with a subsequent increase to 432 schools by 1880 (Coll y Toste 1909: 138).

During the mid-1860s, the colonial government instituted a number of reforms. “The Organic Decree of June 10, 1865 partly focused on substantially expanding access to primary schools by increasing the number and quality of public primary schools. Except for a repressive period starting with the Governorship of Laureano Sanz in the mid and late 1870s, a subsequent implementation of the Organic Decree of 1880

⁸ Resources for public schooling were concentrated toward secondary schools throughout this period, and high socio-economic status households would provide for private tutoring of their children in many cases (Osuna, 1949).

following some of the original elements of the decree of 1865 led to a mild expansion in the number of schools (see Figure 1).⁹

[Please insert Figure 1 about here]

On the arrival of the U.S. military to Puerto Rico in 1898, education was governed by the 1880 School Law implemented under Spanish Governor Eulogio Despujols (Osuna, 1949: 77-93). Education was segmented into an assortment of private schools, parochial schools, and a public primary school system subdivided into superior and elementary schools, further segregated by gender. Both elementary and superior schools were themselves divided into first and second class schools. In addition, public schooling was supplemented by public auxiliary schools, and public rural schools. These distinctions entailed that resources, such as teachers' pay, were assigned differentially among these.¹⁰ In general support for schooling relied primarily on municipal taxes (Osuna, 1949: 55, 78).

Local municipal boards had the power to remove teachers and the duty to inspect schools (Osuna, 1949: 90-91). Municipal autonomy, however, had been erratic especially given the swings of Spanish politics (see Osuna, 1949, pages 62-63, for details), and the existence of effective monitoring seems to have been ambiguous. The Governor General relied on an Insular Board of Education and on inspectors who visited schools within the two (Northern and Southern) school districts of the Island at least once a year. Schooling was compulsory for those aged 6 to 12, and generally required attendance daily anywhere from five to six hours, depending on the type of school (Osuna, 1949: 79). However, a generalized practice

⁹ Substantial discussion existed over the actual quality of schooling, as evidenced by the debates among Coll y Toste (1909) and Osuna (1949).

¹⁰ Coll y Toste, (1909: 102) details that since the Governorship of Marchesi (1866) superior schools were those where the teachers would obtain a salary of 1,500 pesos and a house; primary schools of the first class would have teachers paid 600 pesos and given a house; finally primary schools of the second class were those wherein teachers were paid 420 pesos. He does not provide information on pay scales for auxiliary or rural schools; the former were at first called incomplete schools. While salary scales increased throughout the century the classification of schools remained the same until the transfer of control over Puerto Rico to the U.S. military after the Spanish-American War of 1898. See also, Osuna, 1949: 55, 78. The Organic Decree of 1880 according to Osuna (1949), rural schools were set as those with at least 15 pupils; auxiliary schools were those with at least 20 pupils and were situated in "hamlets" beyond population centers; rural schools were those situated in even more remote areas.

prevailed of flaunting the mandatory nature of the system both by parents as well as the authorities (Osuna, 1949: 80). There was no meaningful segmentation by age or grades across primary and superior schooling levels, thereby rendering inoperative any curricular distinctions as well.¹¹

2.2 The Public Primary School System in the First 10-years of U.S. Tutelage, 1899-1909

Following the initial occupation of Puerto Rico by American forces, U.S. administrators sought to implement a ‘civilizing project’ put forth explicitly by Elihu Root, Secretary of War for the United States, with a view to teach Puerto Ricans the ways of democracy. An intrinsic component of this project involved education, in the narrower sense of schooling, through the expansion and modernization of the public school system (Go, 2000: 343). If there is any doubt on the importance afforded to education in the new colonial experiment, some figures give an indication. In 1903, \$817,815 – a third of the insular budget – was assigned to the public school system. This level of expenditures was maintained at least until the late 1920s (Cabán, 1999: 128).

Guy Henry, military governor in 1899, brought John Eaton – who had been Education Commissioner in the United States during the 1870s – to Puerto Rico to design and implement a new educational system. Eaton had been Education Commissioner in the United States (in 1870). Eaton in turn brought Victor Clark as his assistant: a figure that arguably became one of the best known U.S. social scientists to examine Puerto Rico’s “condition”. Eaton and Clark together created the organizational and policy framework that implemented the more general objectives of colonialism in Puerto Rico regarding education (see López Yustos, 1984: 100-103). The structure they implemented came to dominate public schooling in Puerto Rico until the creation of the Commonwealth.

Educational organization involved a centralized system with local school boards to provide free education for the first time.¹² Schooling would proceed on a 10-month system with mandatory primary schooling. The latter would cover six grades and these would be organized in two sub-sets, or school types:

¹¹ For details on the condition of schooling from various reports cited in Osuna (see Osuna, 1949: 91-97).

¹² At first, the military authorities sought to decentralize the system along the lines of the school districts that characterized the educational system of the Northeastern United States. This alternative was nixed almost immediately for a combination of administrative and political reasons.

rural schools and grade schools, some with double enrollment if necessary. The rulings enacted under the “Leyes Escolares” also regulated the pay, appointment, and certification of teachers.

The Foraker Act formalized these practices and granted the Commissioner of Education broad powers of administration along with the largest part of the insular budget (López Yustos, 1984; 118-124.) The initial commissioners sought to expand and implement the use of English in schooling. Samuel McCune Lindsay, Commissioner of Education from 1902-1904, instituted a program to bring teachers from the United States, a practice that continued into the 1940s.¹³ More importantly, under Lindsay, the Department of Schooling enacted pre-school teaching and vocational schools (López Yustos, 1984: 125). The School Law of 1903 also established compulsory schooling age between the ages of 8 and 14, although this was very imperfectly enforced in practice.

A key institutional change took place between the military regime and the enablement of civil rule. Under the military administration, municipal governments enjoyed the ability of selecting teachers (Cabán, 1999: 127). The School Law of 1900 took away this control on the heels of the local elections of November 1899 when the Federal Party won large victories at the municipal level. Under this Law, municipal school boards were brought under the direct control of the Commissioner of Education, bypassing municipal administrations. Moreover, municipal governments were instructed to grant to the local school boards 25 percent of its revenue. Boards were authorized to borrow from the insular government and were responsible for school construction and leasing of school buildings. A subsequent Education Law of 1901 prepared by Commissioner Brumbaugh centralized power even further.¹⁴

The expansion of English teaching in Puerto Rico gained real momentum under the supervision of Commissioner Roland Falkner (1904-07). His administration expanded the number of American teachers in the system and implemented the teaching of English in all grades. Previously, under the Clark-Eaton program, English instruction had taken place as of the second grade in the primary schooling system (López

¹³ Under Lindsay, the normal school, originally founded in Fajardo but subsequently transferred to Río Piedras, became the University of Puerto Rico. Lindsay was a key figure in the preparation of the bill that later became law creating the University of Puerto Rico.

¹⁴ The excise taxes collected on Puerto Rico goods generated the funds for the expansion of the education system in Puerto Rico. For details, see Cabán (1999: 128).

Yustos, 1984: 101). In practice, this had been implemented with limited success since there were an insufficient number of teachers who could do so.¹⁵ The third Commissioner, Edwin Dexter (1907-1912), frames the scope of our study. Like his predecessors, his administration continued to emphasize English instruction. This administration also expanded what came to be known as continuation schools, in townships in which there had been no previous high-school teaching (López Yustos, 1984: 128-129).¹⁶

3. Description of the Data and of the Population under Study

A rich array of data allows us to perform a thorough analysis of the impacts of the institutionalization and expansion of the public primary school on changes in educational stratification of the young population during 1899-1909. We employ two main sources of data. For the information on individuals, their demographic attributes, and their attainment levels, we use the Public Use Micro-Sample (PUMS) of the 1910 Puerto Rico Population Census. The 1910 PUMS, created by the Puerto Rico Census Project at University of Wisconsin, Madison, is composed of a stratified random sample of the population of individuals and households living in Puerto Rico in 1910 (Palloni, Winsborough, and Scarano, 2006).

Since the 1910 PUMS also reports the municipality of residence of each individual, we are able to match an individual's personal information to municipality-level data collected from the Reports of the Commissioners of Education for Puerto Rico (various years) and to data on economic activity from the Report of the Treasurer of Puerto Rico of 1907. These databases allow us to construct our measure of expansion of the public primary school system: the increase in the number of public primary schools per thousand school-age children (ages 6-15 years in 1910) in the municipality during 1897-1907.¹⁷

¹⁵ See however some figures on the number of American teachers brought in to attempt it (Cabán, 1999: 129, 131).

¹⁶ Straddling a second expansion burst was Commissioner Edward Bainter (1912-1915). The expansion of schooling at this time was partly brought about in 1913 by appropriations enacted by the local legislature (approx \$150,000) for school construction (López Yustos, 1984: 130). Previously, schooling facilities be mostly rented. Bainter was also instrumental in the inclusion of vocational education in the graded urban high schools (López Yustos, 1984: 131.) It is in 1914 that we see the highest elementary enrollment figures up to this point. In total, for this to be possible municipalities and the local legislature appropriated approximately \$2.7 million. Enrollment did not increase from 1914 until after 1920-21.

¹⁷ In the empirical analysis, we interpret the effect of the expansion in access to primary schools as a bundle of correlated policies and characteristics of the public school system, since there were a large number of policy changes that occurred throughout the 1899-1910 period. Since, for instance, the substantial curricular changes (i.e. the use of English as the language of instruction), were channeled to students through schools, we interpret the effects as the

We focus on individuals born between 1876 and 1900, to ensure that we examine the effect of the expansion on the educational outcomes of school-age individuals during 1899-1909. This requires some explanation: since not all children or adolescents were equally exposed to the expansion of schooling under the new education system, it is important to segment the totality of children into those most likely to have been in school at the time of the expansion. We consequently examine the educational outcomes of those children and young adults who would have been between the ages of 0 and 13 in 1899 (or 11-24 years in 1910) – who were exposed (to varying degrees) to the primary school reforms and expansion of the 1899-1909 period – relative to those of children and young adults who were immediately past school age in 1899; those above 13 years of age in 1899 (above 24 years of age in 1910). Throughout the paper, we call the former the school-age or eligible cohort and the latter the ineligible cohort. We then make these school-age and ineligible cohort comparisons across municipalities – some which experienced the primary school expansion to a large degree, and other which experienced a lower expansion – to identify the effects of the increased access in schooling on the literacy and English-language skills of the young population of the island. This research design, popular in the program evaluation literature, is called a “differences-in-differences” empirical methodology (see the Methodological Appendix for the details of this method).¹⁸

An example will help clarify the comparisons we make to estimate the effects of the educational reforms. For instance, a child born in 1884 or earlier was 15 or older in 1899, when the educational policy changes were first implemented across the Island. Since school enrollment usually took place between 6 and 15 years of age, a child age 15 or older in 1899 normally would not have been of school-age during the primary school expansion, and therefore would not have been directly affected by the increased schooling access.¹⁹ Children born between 1885 and 1893, who would be in the 6-14 age range during 1899, were

increased access to primary schools in combination with any other curricular or administrative changes as part of the school system. We do not interpret the results as holding these other characteristics fixed while the access to primary schools varies.

¹⁸ The empirical methodology closely follows Duflo (2001), who implements a similar strategy to identify the effects of a primary school construction program on men’s school attainment and wages in Indonesia.

¹⁹ Grade repetition and delayed school entry could lead some of these children to benefit from the policies for their last years in school (which would lead to a downward bias in the estimation if they are mistakenly considered as non-treated). However, the exposure to the school expansion of children 15 years old or older in 1899 was very limited, as

partially exposed to the policy changes, since the expansion gradually took place during the ten year period following 1899. Finally, a child born between 1894 and 1898 would be between one and five years old during 1899, and would have been fully exposed to the policy changes. In summary, children 15 or older in 1899 were not exposed to the policy change and as a result the effect for this group should be zero. For younger children, the exposure is decreasing with their age in 1899, and we should observe the effect of the policies to be increasing for younger children. However, among the younger children, we should observe greater effects for those who experienced a greater expansion in access to primary schooling; that is, in those municipalities in which the number of schools per school-age population increased the most.

[Please insert Table 1 about here]

Before we present some quantitative evidence of the extent of the expansion across municipalities, we will briefly discuss the summary statistics for the sample of native-born children and young adults most affected by the expansion of the system – these are presented in Table 1.²⁰ There are 60,258 individuals in the sample, of which approximately 35 percent reported being literate, and 4 percent who reported being proficient in English-language skills. These literacy rates were quite low relative to those in Cuba, the British Caribbean and the United States (Engerman and Sokoloff, 1997), providing evidence of the poor educational conditions in the Island during the late 19th and early 20th centuries.

Of the overall sample, 40,260, or 67 percent, belong to the school-eligible group during 1899-1910 (ages 11-24 in 1910), whereas 19,998, or 33 percent, belong to the age groups immediately above school eligibility. Comparing the two cohort groups gives us some suggestive evidence of the improvements in literacy and English-language skills among the young native-born population: 38.1 percent of individuals in

documented based on aggregate statistics of enrollment-by-age in the Reports of the Commissioner of Education (various years).

²⁰ Since we do not know the time of immigration of each foreign-born child and young adult, it is unfortunately more difficult to assign exposure to school reforms to this group. Therefore, we restrict the analysis to the sample of native children and young adults living in Puerto Rico in 1910, as this group is most likely to have been exposed to the primary school reforms.

the school-age cohort report being literate, a rate approximately 10.3 percentage points higher than that of individuals in the ineligible cohorts. The difference of 4.1 percentage points in the English literacy rate across cohorts is also substantial, since only 1.5 percent of non-school-age individuals report being English-literate.

The difference in literacy and English-language skills across cohorts by race and gender also provide some illustrative evidence of the changes in educational stratification experienced during the period. Although only 22 percent of non-whites of school ages in the Spanish regime were literate, (relative to a literacy rate of 30.9 percent of whites), those of school-age during the early years of the U.S. regime converge substantially: the literacy rate for non-whites is 34.1 percent relative to that of whites of 40.4 percent. Perhaps shockingly, the opposite pattern in white/non-white differentials occurs for English-literacy skills: native-born whites' English-speaking skills differ by 4.4 percentage points across the younger and older cohorts, whereas those for non-whites differ only by 3.6 percentage points. Also, the differences in both literacy rates and English-language skills across genders close during this period, partly due to the elimination of sex segregation in primary schooling during the early U.S. colonial period.

Finally, note that the other socio-demographic characteristics of the two cohort groups are similar: approximately 36 percent of the population in both groups is non-white, specifically black or mulatto. Almost all individuals in the sample (97 percent) report having had native-born parents. Although we do not have detailed data on the wealth and landholdings of each household in the sample, these statistics suggest that most individuals belonged to lower classes and intermediate elites – midsize and small-scale agriculturalists – as expected, given the high degree of social stratification during the time period and the fact that many elite households tended to be either European-born or the offspring of Europeans (Ayala and Bergad, 2001; Bergad, 1983).

It is important to recognize the complexity of racial categorizations in the case of Puerto Rico in the early 20th century, a categorization which is closely linked to the geography of race-specific settlement patterns in Puerto Rico. Settlement patterns tended to reflect a disproportionate concentration of whites in the interior highlands, a group which would be strongly immersed in the coffee and the *campesinado* sectors

of the economy (Picó, 1979; Bergad, 1983; Seda Prado, 1996; Bobonis, 2007). This generated substantial heterogeneity in class and socio-economic status within the ‘white’ racial group, including subgroups whose living conditions could have been described as appalling. Unfortunately, the data does not permit us to successfully stratify the sample of whites by class background, impeding us from analyzing the heterogeneity in responses across social class within the white population.²¹

Using the data on the number of schools in each municipality at the end of the Spanish regime (in 1897), and during the first four and nine years of the U.S. occupation (1902 and 1907), we construct measures of access to formal primary schooling at the municipality-level: the number of schools per thousand school-age children (in 1910) in each municipality.²² As mentioned above, we then use as the main measure of *expansion* of primary schooling access the increase in the number of schools per thousand school-age students (in 1910) in each municipality (i) from 1897 until 1902 and (ii) from 1897 until 1907.²³ Summary statistics from these measures are also reported in Table 1.

According to the available administrative data, there were on average 1.65 schools per thousand school-age children in each municipality in 1897. This statistic may accurately represent the late but limited efforts of Spanish administrations to provide basic formal schooling to the Puerto Rican population. For instance, since each classroom could potentially have the capacity for approximately 40-50 students (in sub par conditions), and many schools essentially had one or two classrooms, this measure represents that there would be, on average, space available for 100-150 primary school students per thousand children in a municipality (10-15 percent of all children in the municipality).

Therefore, the expansion of the primary school system following the U.S. occupation represented a substantial improvement in access to schooling. According to the administrative data from Reports of the

²¹ This is the case because, for adult males and females who do not reside with their parents, we do not observe measures of parental socio-economic status (i.e. schooling levels, wealth, land ownership status), which precludes us from classifying all cohorts of white individuals by social class (see Section 5 for methodological details).

²² Unfortunately, we do not have data on the number of school-age children in each municipality in 1897, 1892, and 1907, which inhibits us from constructing measures of access relative to the contemporaneous number of school-age children in each municipality. However, as long as the relative number of school-age children in each municipality is stable over time, our measures of the increase in access should not suffer from large biases.

²³ We collected administrative data on the number of schools in each municipality for the fiscal years 1897, 1902, and 1907, from existing Reports of the Commissioner of Education (various years) and the 1899 Puerto Rico Census of Population.

Commissioner of Education, there was a moderate increase in the number of schools across municipalities during the first four years of the U.S. occupation (an average increase of 1.27 schools per thousand school-age children), and a substantially greater expansion by 1907 (an average increase of 1.94 schools per thousand school-age children). Based on an analogous analysis, the data implies that there was a doubling in school capacity during this period, increasing to approximately 200-300 students per thousand children in the municipality.

[Please insert Figure 2 about here]

The increase in resources devoted to schooling is also reflected in the increase in public school system expenditures per child and the school enrollment rate of school-age children during this ten-year period (see Figure 2). Although we do not have data on the school expenditures per child during the Spanish regime to compare trends before and after the change in rulership, the trends during the 1900-1909 period provide a clear picture of the increased importance that early U.S. colonial administrations gave to the educational sector, as part of its assimilationist project. The level of expenditures of approximately \$1.25 per school-age child in 1900-1901, rose substantially (by 66 percent) to approximately \$2.50 per child until 1908, and had reached a peak of almost \$4.00 per school-age child by 1909. Child school enrollment rates also mimicked this increased funding effort, as they gradually rose from approximately 10 percent in 1900-01 to 28 percent in 1909.

[Please insert Figure 3 about here]

However, this overall expansion in basic formal schooling and school resources hides the degree of heterogeneity in the expansion across regions. The increase in access to schooling varied widely across municipalities. The standard deviation of the 1897-1907 school expansion per thousand children, a measure of the variation across municipalities in the expansion of the public system, is 1.38, or one school for

approximately one hundred of each thousand children. The municipalities with the greatest expansion were Toa Baja, San Juan, Bayamón, Aguadilla, San Germán, Río Piedras, Guayama, Arecibo, Santa Isabel, and Manatí (in decreasing order, with the expansion ranging from 7.86 to 3.10 more schools per thousand children), whereas those with the smallest expansion were Rincón, Culebra, Dorado, Loíza, Patillas, Peñuelas, and Cidra (in increasing order, with the expansion ranging from -0.45 to 0.33 more schools per thousand children). Figure 3 presents a histogram of the distribution of the expansion in the number of primary schools per thousand school-age children across municipalities.

The municipality-level differences in the expansion of access to schooling are useful for our analysis, as we use this heterogeneity to identify the effects of the policies on the educational stratification of the local population. In the following subsection, we provide some suggestive evidence of the main determinants of the diversity in the expansion of the primary school system.

4. Geographic Patterns of the Distribution of the Primary School Expansion, 1897-1907

Table 2 presents the results of a number of municipality-level regressions of the primary school system expansion for the first four-year and nine-year periods of the U.S. occupation.

[Please insert Table 2 about here]

During the first four years of the U.S. occupation, the expansion in the number of schools seems to have been regressive, as municipalities with a greater number of primary schools per school-age children in 1897 (immediately prior to the expansion) experienced a greater expansion in the number of primary schools than those municipalities that had a smaller number of primary schools. The correlation coefficient is 0.25 (significant at 10 percent significance level; Table 2, column 1). However, this relationship is driven by the expansion in the small municipality of Culebra; removing this observation from the sample leads to a correlation of -0.04, which suggests that the expansion was neutral to the existing number of schools in the

municipality²⁴ This pattern remains constant over the next five years, as the correlation between the 1897-1907 expansion and the initial number of schools in 1897 is small and insignificantly different from zero (Table 2, column 6). Panels A and B of Figure 3 represent graphically this neutral relationship (both figures exclude the municipality of Culebra).

Although the relationship with the initial number of schools suggests that the educational financing policies put in place were neutral to the socio-economic circumstances of the local population, correlations with structural socio-economic characteristics of the municipalities indicate otherwise. The simple correlation between the 1897-1902 period primary school expansion and the share of the agricultural land under sugar cane cultivation by 1907 is negative, but not statistically significant (Table 2, column 2). Once we condition on the share of agricultural land under coffee cultivation, the negative relationship becomes stronger and statistically significant (Table 2, column 3). This pattern in the data indicates that during the very early years of the U.S. occupation, municipalities which were eventually not specialized in the cultivation of any of the main cash crops (i.e. sugar cane and coffee) experienced a disproportionate increase in the expansion of the primary school system.

However, when we examine these correlations with the measure of expansion for the 1897-1907 period, we find a reversal of fortunes. Municipalities specialized in sugar cane cultivation experienced a substantially greater expansion than those municipalities which specialized in the cultivation of other crops. Panels A and B of Figure 3 characterize the positive and negative associations of the expansion for municipalities specializing in sugar cane and coffee cultivation. The linear prediction suggests that a municipality with a 10 percent greater share of land under sugar cane cultivation experienced on average an increase of 0.35 schools per thousand children, a result that emerges as statistically significant (at the 10 percent level; Table 2, columns 7 and 8).

This evidence suggests a particular pattern of the distribution of (central and local) government resources towards primary education, consistent with the decentralized nature of the system of public school funding, as well as with various political mechanisms, mainly the targeting of educational expenditures

²⁴ The standard error in the regression is 0.15, which is not significantly different from zero; not reported in the tables.

towards various constituencies for political purposes. We briefly discuss these in turn. Regarding the first explanation, the financing of school constructions and expansions, expenditures for the maintenance of schools, the provision of school supplies, teacher salaries and fringe benefits, and other disbursements were largely based on municipal government revenue (Report of the Commissioner of Education, 1906). In particular, a property tax earmarked for public school expenditures was a significant source of local governments' revenues (Report of the Commissioner of Education, 1906). This decentralized system of public primary school provision could have generated a great degree of inequality in children's access to schooling across municipalities in the Island, with affluent communities – arguably those located in sugar-growing areas (Ayala, 1999) – enjoying a greater pool of resources to use for expanding schooling access than poorer ones (Tiebout, 1956; Bénabou 1996a; 1996b). The correlations of the expansion measure with the value of municipal government budgets (in 1907) provide further evidence in favor of these arguments: although the size of 1907 municipal budgets are not correlated with the 1897-1902 expansion in access to primary schools, it is strongly correlated with the 1897-1907 expansion (Table 2, columns 4 and 9).

U.S. officials may have also used central and local government revenues, particularly targeted towards educational expenditures, for various political purposes. The U.S. colonial government may have used the provision of public schooling to appease unrest among popular sectors which may have lost economic and political ground during the new episode of land and wealth concentration, especially in sugar-based, coastal municipalities.²⁵ An early manifestation of this geographically-focused opposition was the strength of the Federal Party – a political party strongly opposed to the political and economic reforms of early U.S. administration – in the Northern and Northeast regions of the Island, (Bayrón Toro, 1989). To the extent that the expansion of the school system may have had the intention to undermine the political clout of the Federal Party in these strongholds, we should observe a pattern of public primary school expansion as the one described above.

²⁵ Quintero Rivera (1988) documents that the episodes of labor unrest experienced in the Island throughout the 1910s and 1920s were concentrated in coastal municipalities, which suggests that the policy of co-optation through the provision of local public goods may not have been as effective as originally expected.

The primary school expansion is also positively associated with the proportion of the non-white population in the municipality. The coefficient estimate indicates that municipalities with a 10 percentage point greater share of the population being non-white (i.e. black or mulatto) would have experienced a greater increase in the number of schools per thousand children of 0.27 schools by 1907, on average, or approximately one more school per every four thousand children (Table 2, column 10). The fact that former slave and non-white populations were more concentrated in coastal areas, and that the expansion of educational access was more prevalent in coastal municipalities, could explain why the non-white population had a greater exposure to the primary school expansion and institutionalization.

On the other hand, it is possible that, within a municipality, primary schools may have been located so as to limit the access to schooling of lower class or non-white populations. The available administrative data does not allow us to identify the access of each individual to a nearby primary school within the municipality, and may lead to some degree of ecological bias by assigning the municipality-level increase in school access to each individual within the local jurisdiction. This may be particularly important to the extent that white and non-white children may have had a different degree of access to graded (i.e. urban) and rural schools, which offered a somewhat different curriculum. This aspect could have been specifically related to the use of English in the classroom, as this language was more likely to be taught in graded schools than in rural schools (Report of the Commissioner of Education, 1907). However, the geographical distribution of the expansion will help us explain several of the educational stratification changes that we document in the study, in particular, the closing of the white/non-white literacy differentials.

[Please insert Figure 6 about here]

5. Expansion of the Primary School System and Educational Stratification

5.1. Graphical Evidence

Figure 6 illustrates the methodology that we have used to estimate the effect of school expansion on the educational outcomes of the young native-born population (see the Methodological Appendix for details).

In both Figure 6-A and 6-B, we gauge the difference in the rate of attainment for school-age children relative to ineligible cohorts. Figure 6-A shows the relationship between the size of the expansion in primary schools in each municipality and the difference in literacy rates across cohorts. Figure 6-B graphs the analogous increase in the number of schools by municipality against the corresponding difference across cohorts in the rate of English-language skills.

Relative to older cohorts, the cohort of school-age children most exposed to the expansion show improvements in literacy rates and their improvement increases with the extent of the municipality-specific expansion. In other words, as the number of schools in any given municipalities increased between 1897 and 1907, the literacy rate of the cohort of “exposed” children moved further away from that of older children in the municipality. The linear prediction implies that, for every additional school per thousand school-age children, literacy rates would have increased by 0.52 percentage points.

The linear prediction for improvements in English-language skills suggests an even stronger relationship: for every additional school per thousand school-age children, rates in English-language skills would have increased by 0.53 percentage points (statistically significant at 90 percent confidence).²⁶ Since the number of schools per thousand children increased on average by 1.78 during the 1897-1907 period, the linear predictions imply that literacy rates increased on average by 0.93 percentage points ($0.52 \times 1.78 = 0.93$), and English-language skills rate by 0.94 percentage points ($0.53 \times 1.78 = 0.94$).

Since we are comparing differences in the outcomes of individuals across municipalities, we purge our estimates of the influence of any other factors that may have affected the schooling outcomes of school-age children in the same manner during the early years of the U.S. occupation. An example of this could be any national-level political or constitutional reforms that may have influenced families’ decisions to enroll their children in primary school, such as the possibility to migrate to the United States. Also, by comparing the difference in outcomes of younger and older cohorts in each municipality, this methodology allows us to purge for any characteristics of municipalities – *fixed over time* – that may have affected the educational

²⁶ Both relationships are statistically significant at conventional significance levels using the individual-level data.

outcomes of the population, such as any geographic determinants of school enrollment (i.e. ruggedness of the terrain, which may make schools effectively more distant to children's homes).

A potential concern with the identification strategy is the extent to which other institutional or structural changes in the island which varied across municipalities were positively associated with the expansion and institutionalization of the primary school system as well as with the educational outcomes for the young population. Important in this regard is the extent of internal migration in Puerto Rico during the first decade of the twentieth century: the coffee region went into economic decline and lost population to the two other regions, which experienced explosive growth of sugar cane and tobacco production (Dietz, 1986; Quintero Rivera, 1988; Ayala and Bergad, 2001). In these municipalities where economic activity was expanding, population growth was more dynamic than in the coffee producing zones, and tobacco producing municipalities experienced the fastest population growth of all.

However, we provide indirect evidence that internal migration patterns do not bias our results. Our methodology allows for there to be migration of disproportionately literate (or illiterate) individuals from municipalities with a low degree of expansion to those with a higher degree of expansion. The main assumption which if violated would invalidate our results is that the selective migration could not differ across by age groups, across school-eligible (ages 10-21 years in 1910) and ineligible (ages 22-34 years in 1910) individuals. Although we cannot test this assumption directly, we can provide indirect evidence that this is unlikely to have taken place. We essentially construct a 'placebo' experiment, comparing groups of ineligible individuals (ages 22-28 and 29-34 years in 1910), both of which should not have been directly affected by the educational policy changes, and compare whether their literacy and English-language skills differ substantially across municipalities with different degrees of public primary schooling expansion. If there were some differential migration of the disproportionately literate (illiterate) or those with English-language skills in the younger ineligible cohort, we should observe significant differences in these rates across these two groups. However, the estimated differences across groups are literally zero, which suggests

that there was no differential education-level and age-based selective migration. A thorough discussion of this empirical methodology and the ‘placebo’ experiment is contained in the Methodological Appendix.²⁷

[Please insert Table 3 about here]

5.2. Effects on Literacy Rates

Table 3 reports estimates of the effect of the expansion in access to primary schooling on the literacy rates of the native-born population. The rows present information for the overall sample and also segmented by race and gender groups. The first column reports the municipality-specific effect of an increase in one school per thousand school-age children on the literacy rate of the school-age population. The second column reports the average increase in the number of schools per thousand children experienced by each group.

The overall estimate for literacy effects indicates that one more available school per thousand children increased literacy rates of the school-age population by 0.69 percentage points, a modest effect. The non-white population experienced a stronger response to the school reforms than the native-born white population, as the coefficient estimates indicate; for an increase in one primary school per thousand children, non-whites’ literacy rates improved by 0.98 percentage points (statistically significant at a 10 percent significance level), whereas it led to a smaller (0.38 percentage points) and insignificant improvement in native-born whites’ literacy rates. This greater sensitivity of non-whites to the school expansion may have been partly due to this group’s greater propensity to be away from the school system, to be marginalized children with lower access to primary school.

²⁷ Moreover, to the extent that internal migrants came disproportionately from the lower echelons of the social structure, the internal migration trends would only attenuate these estimates. This is the case for two reasons: first, because we would be (1) underestimating the increase in the capacity of the primary school system in those municipalities which (over time) gained a greater number of children and a greater increase in the number of primary schools, and (2) overestimating it in those which lose population and experience a lower expansion of the public system, the difference in our explanatory variable of interest is smaller than it would have been. Additionally, to the extent that internal migrants had a disproportionately lower socio-economic status, we would be including children with a lower likelihood of enrolling in the school system (due to SES differences) in areas of greater expansion relative to those in areas with a lower expansion in the public school system, thus dampening our effects. We have re-estimated the models using the number of 6-10 year old children in 1899 in each municipality and the results are qualitatively and quantitatively similar – available from the authors upon request.

As documented in Section 4, non-white children also experienced a greater increase in access to primary school. For white children, the municipality-specific expansion was approximately 1.81 schools per 1,000 children, whereas for non-white children, the expansion was above two schools per 1,000 children in the relevant municipalities. This suggests that the municipality-specific expansion in access favored non-white children disproportionately by approximately 20 percent.

The third and fourth columns respectively report the percentage increase in literacy resulting from an average increase in access for each group, and as a percent of the overall literacy rate in the population.²⁸ The implied average effect of the school expansion, assuming that the representative child was exposed to the mean expansion in the population (1.94 schools per thousand children), implies a small increase in literacy rates in the population of 1.34 percentage points ($0.69\% \times 1.94 = 1.34\%$), or 3.9 percent, based on a literacy rate in the population of 34.7 percent. This is arguably just a moderate improvement in literacy among the native-born population. For non-whites the effect is larger than it is for white children since the expansion in access increased literacy by about 2.13 percentage points (7.1 percent) for non-whites, but by 0.69 percentage points (or 1.9 percent) for white children (see columns 3 and 4).

We also find that literacy improvements were concentrated among females. The estimated literacy response to an additional school (per thousand school-age children) for females was 1.36 percentage points, whereas that for males was small and insignificantly different from zero. According to our measure of primary school availability, females and males had an equivalent increase in access to primary schooling. However, this measure hides the fact that females experienced a greater increase in access to primary schools due to the establishment of co-ed primary education across the island, whereas boys experienced increased competition from girls for what used to be exclusively male primary schools. The estimates of the effect of

²⁸ The formula used to calculate the average effect is:

$$\text{Average Effect} = (\text{Coefficient Estimate} \times \text{Mean Num. Schools p/1,000 children})$$

and the average effect as the percent of the overall literacy rate in the population is:

$$\text{Average Percent Impact} = (\text{Coef. Estimate} \times \text{Mean Num. Schools p/1,000 children}) / (\text{overall literacy rate in the sample}).$$

the reform take this into account.²⁹ As a result, the estimates of the effect of the reforms suggest that females substantially benefited from these, as their literacy rates increased on average by 2.64 percentage points, or 8.3 percent. On the other hand, males experienced no (statistically) significant improvement in literacy.

[Please insert Table 4 about here]

5.3. Effects on English-Language Skills

Table 4 reports estimates of the effect of the reforms on the English-literacy rates for the native-born population, overall and segmented by gender and race. The aggregate effect on the English-language skills of the young population is substantial. One additional school per thousand children increased the English-language skills of the school-age population by 1.01 percentage points. The average effect of the school expansion is 1.97 percentage points, or a 46.8 percent increase relative to the average English-language skills rate of the population of 4.2 percent. These estimates indicate that the effects of the increase in primary school access as implemented by U.S. colonial authorities was greater for English-language skills than for literacy rates. This is perhaps as expected, since literacy skills were already more prevalent than English-language skills in the absence of the reforms, and also because of the concerted efforts of U.S. colonial administrators to include the teaching of English as one of the main objectives of the curriculum.

The expansion in access to schooling had race-specific effects on English literacy that favored whites over non-whites, the obverse of the pattern found for literacy improvements. As mentioned above, the geography of race-specific settlement patterns in Puerto Rico tended to reflect a disproportionate concentration of whites in the highlands and this unobserved heterogeneity determined by social class among whites (and non-whites) might partly account for the sensitivity of the results for whites to the locus of expansion. Native whites' improvements in English literacy were more sensitive to school expansion and reforms than those of non-white children (coefficient estimates of 1.47 and 0.65 percentage points for the

²⁹ Unfortunately, our data does not allow us to construct gender-specific measures of changes in availability of primary schools that appropriately incorporates the co-educational reforms put in place.

former and latter groups, both significant at 1 percent significance levels). This phenomenon may reflect that those white children who were favored by the expansion could have been more likely to attend graded schools in urban areas, which were arguably of higher-quality and in which the teaching of English was more prevalent. However, since we cannot control for class background, it is less clear what the results would have reflected for poor whites.

Although we do not have data on the actual schools attended by each child enrolled in school, indirect evidence may suggest the contrary. Approximately 37.5 percent of school-age blacks and mulattos lived in urban areas, whereas only 23.9 percent of school-age native-born whites lived in urban areas. This evidence would suggest that non-whites had greater access to graded schools than native-born whites, although this may not have been the case to the extent that white children from rural areas were more likely to travel to urban areas in order to attend graded schools. This pattern in the data may also be explained by the possibility that white school-age children completed more grades in school, therefore having a greater capacity to gain English-language skills. Finally, the acquisition of English language skills would be facilitated by the fact that white children, who already had greater literacy skills, would be more likely to learn a second (or third) language (Baker, 2006; Lambert, 1980). We unfortunately do not have data on school enrollment, attendance, or attainment by racial group, which would allow us to assess these hypotheses.

The improvement in English-language skills by gender suggests a pattern consistent with those found for literacy. Females experienced higher sensitivity to the expansion (a coefficient of 1.53, significant at 1 percent confidence). Boys however had higher average rates of English skills than any other group (at 4.5 percent) and their sensitivity to the expansion in access to schooling is low and only marginally significant (0.46 percent per school per thousand children; Table 4, column 1). Thus, their net improvement in English skills is low (19.2 percent relative to all in the male population) compared to the effect experienced by women, and compared to the magnitude of the effects by racial group.

6. Conclusion

Colonial powers expanded education in their colonies throughout the nineteenth and twentieth centuries. The British and the French did so in the Caribbean, although the specific mode of such expansion differed from that of U.S. educational policy in Puerto Rico. While it is beyond the scope of our work to make determinate comparative conclusions, our analysis suggests that variation in the nature of financing, and in the levels of schooling access brought about by U.S. educational policy, induced a more thorough incorporation of hitherto excluded groups. In the specific context of Puerto Rico, the expansion of educational access brought non-white and female children more directly into the colonial institutional fold.

U.S administrators created a system in which the deployment of resources stimulated improvements in literacy and in English skills of children and young adults. Those cohorts of young children most exposed to the reforms benefited and improved their language skills over and above those of children educated under the Spanish regime. However, the expansion in access to schooling improved skills asymmetrically. When segmented by race and gender, non-white and female children most exposed to the expansion in schooling benefited disproportionately vis-à-vis their white peers. In terms of English language skills, the reforms seem to have benefited white children most. This finding suggests that increased access interacted with existing racial and class-based cleavages, with differences in the availability of English-speaking teachers, and other aspects of educational quality, to favor schools and regions where white children were predominant. The data do not permit disentangling these hypotheses so we present these as plausible explanations for our findings.

Our findings on the effects of the changes in public education institutions are broadly consistent with the thrust of evidence and analysis put forth by the New History of Puerto Rico of the 1970s and 1980s, the social history of mass unionization and labor movements on the island in particular (Quintero Rivera, 1977; García and Quintero Rivera, 1982). The expansion of education may have even facilitated the politicization of workers by creating the literacy requirements needed for a militant labor movement. Greater access to education plausibly conformed as well with the expressions of betterment for the working class articulated in popular working class venues since the late 19th century such as various *centros de estudios sociales*, *casinos de artesanos*, *La Sociedad Protectora de la Inteligencia del Obrero*, the *teatro obrero*, and through

newspapers that catered explicitly to workers (see Dávila Santiago, 1985: 20-21; García and Quintero Rivera, 1982: 18-23). Our study also complements recent inquiries into the transformation of gender roles brought about by the new colonial regime (e.g. Findlay, 1999), as the insertion of women into new economic and legal spaces may have induced a greater interest and emphasis in the primary education of females. In summary, changes in the structure of primary schooling, in the nature of regulations pertaining to marriage and divorce, and in the legal status of unionization plausibly came together to create complex patterns and institutional interactions that on one hand mitigated pre-existing inequality by class, race and gender, but simultaneously created new mechanisms for the reproduction of social differences in the context of a highly dynamic agrarian capitalist structure.

More generally, our findings have implications for the social history of inequality in the Caribbean. During the first half of the twentieth century, most Caribbean societies conformed in their social configurations to those of enclave economies organized around the export of agricultural products, primarily sugar cane and tobacco (Mintz, 1974; Knight, 1978). Consistent with this view, scholars have examined the direct consequences for Caribbean class structures ensuing from these enclave social formations, but have said less about the interplay of the economic causes of social inequality with the educational systems put in place in the Caribbean by European colonial powers. Our study might suggest how, in other Caribbean plantation societies during the early twentieth century, new economic inequalities produced by the increased presence of sugar corporations interacted with expanded school access to mitigate previously existing inequalities and to incorporate, albeit in a limited way, groups at the margins of whatever limited opportunities existed prior to the institutionalization of colonial school systems.

Methodological Appendix

In our analysis, we compare cohorts of school-age children who were most likely exposed to the expansion of education brought about by the U.S. colonial reforms immediately after the occupation of 1898 and for subsequent period lasting for the first 10 years of U.S. colonial control over Puerto Rico. We evaluate the effects of the expansion by evaluating the aforementioned group of children to the birth cohort of children who would have been just above the school-age between 1899 and 1909. This allows us to identify the effects of the increased access in schooling on the literacy and English-language skills of the young population of the Island. The empirical methodology closely follows Duflo (2001), who implements a similar strategy to identify the effects of a primary school construction program on men's school attainment and wages in Indonesia.

The individual's date of birth and his/her municipality of birth jointly determine the person's exposure to the policy changes. A simple comparison of the educational outcomes of school-age relative to non-school age cohorts during 1899-1910 would potentially give us a biased estimate of the impact of the educational policy changes on the changes in educational stratification, since a large number of other political, institutional and policy changes occurred following the U.S. occupation of Puerto Rico which may have promoted or inhibited individuals' schooling prospects. We thus rely on a more nuanced methodology to identify these effects.

Partly as a result of the local nature of public financing for the provision of public schooling, as discussed in Sections 2 and 4, the intensity of the expansion in access to primary schools varied substantially across municipalities. The variation in the increased access to public primary schools across municipalities then allows us to make comparisons of school-age and non-school-age cohorts for each municipality to identify the effects of the educational policies on the outcomes of interest. In the analysis, we compare the literacy and English-language skills of individuals who had little or no exposure to the policy changes (ages 25 to 34 in 1910), relative to those of individuals who were exposed at the time (ages 11 to 24 in 1910), in both types of municipalities. The design of the municipal financing scheme, which essentially encouraged the expansion of primary schools in relatively affluent municipalities, is reflected in the differences in schooling outcomes across the higher and lower intensity regions. The average literacy and English-language skills rates in municipalities with a greater expansion in the number of primary schools are higher than in municipalities that experienced a lower degree of expansion. Also, the educational outcomes improved for younger cohorts relative to older ones in both groups of municipalities, as expected based on the secular trends in educational improvements during the period. However, the improvements in both literacy rates and English-language skills rates across municipalities were greater for the school-age cohorts relative to the older cohorts, and this difference in the differences can be interpreted as the causal effect of

the policy, under the assumption that, in the absence of the policy change, the improvements in educational outcomes would not have been different across regions with different program intensities.

The main empirical model that we estimate is the following equation for the two large school-age (11 to 24 years in 1910) and older (25 to 34 years in 1910) cohorts:

$$(1) \quad s_{ijcm} = \alpha_m + \gamma_c + (P_m \times T_c)\beta + X_{ijcm}\delta + \varepsilon_{ijcm},$$

where s_{ijcm} is the educational outcome (i.e. literacy, English-language skills) of individual i in household j of cohort c living in municipality m ; T_c is an indicator variable stating whether the individual is in the ‘young’/school-age cohort in the sample; P_m denotes the intensity of the school expansion in the individual’s municipality as measured by the number of schools constructed per one thousand children during 1897-1907; γ_c is a cohort of birth fixed effect, and α_m is a municipality fixed effect. The main coefficient of interest, β , can be interpreted as the effect of an increase in one classroom per one thousand children available during 1897-1907 on children’s educational outcomes. We estimate these models also for each racial group and gender-based sub-sample, to examine the changes in educational stratification due to the policy changes. This approach allows us to avoid some of the principal methodological problems related to identifying the effects of educational policies present in the literature: essentially, that during this complex transition period, many other policy and institutional reforms may have promoted or inhibited individuals’ educational opportunities and schooling choices.

However, we need to be cautious about a number of potential pitfalls not necessarily addressed with this methodology. First, to the extent that the policy effectively encouraged the expansion of schooling access in municipalities which already had greater access to primary schools and thus better educational outcomes of the local population, a further expansion may have led to lower improvements in the educational outcomes of the population (leading to a downward bias in our results). Second, it may have been possible that, since cross-municipality household and individual migration was so prevalent during this time period, that the sorting of individuals from municipalities with poorer access to those with greater access to primary schooling may have led individuals of different characteristics to migrate, partly based on their propensities to achieve higher levels of educational attainment. Since we do not have data on the municipality of birth or the municipality of education of each individual, we cannot directly examine this potential source of bias.

Therefore, we employ a strategy now common in the program evaluation literature to assess this potential source of bias: we compare individuals across birth cohorts within the group of individuals of school-age during 1890-1898 (not exposed to the U.S. educational policy change), located in municipalities with differential increases in schooling access. Since the increase in educational outcomes between these older cohorts should not differ systematically across high and low-intensity municipalities, this essentially

constitutes a control experiment to assess whether there has been selective migration of individuals across municipalities based on their educational characteristics (Heckman and Hotz, 1989; Rosenbaum, 1987). We do not find evidence of any selective migration (estimates available upon request).

A robust method to assess the validity of our research design is to make our empirical model more flexible, by allowing for potential effects among cohorts exposed as well as for those not exposed to the school expansion. This can be done by generalizing the empirical model presented above, where we allow each two-year cohort to have a potential effect from the expansion, as following:

$$(2) \quad s_{ijcm} = \alpha_m + \gamma_c + \sum_c (P_m \times d_c) \beta_c + X_{ijcm} \delta + \varepsilon_{ijcm},$$

where d_c is an indicator variable that indicates whether the individual is in the two-year cohort group, for cohort groups ages 0-1, 2-3, 4-5, ..., 22-23 years in 1899, and the other variables are defined as above. Each β_c coefficient can be interpreted as the estimate of the expansion on a given cohort. This specification allows us to assess whether older cohorts, those 14-15 years and older (in 1899), are impacted by the program (relative to those ages 24-25 in 1899), and whether the effects of the expansion are increasing in the years of exposure of different cohorts (decreasing in age).

Figures A1 and A2 graphically show the coefficient estimates and confidence intervals for each two-year cohort group effect, for the literacy and English-skills equations, respectively. Each dot on the solid line represents the coefficient estimate for the respective two-year age group (confidence intervals are shown as dots in the dashed lines). The coefficients on the literacy model fluctuate around zero for older cohorts until they reach ages 6-7, where they start increasing in size and fluctuate around 0.5 percentage points afterwards (Figure 4). However, note that all these coefficient estimates are imprecisely estimated, which indicates that we cannot reject that these are significantly different from zero at conventional significance levels. The analogous series of coefficients for the English-language skills model also fluctuate around zero for older cohorts until they reach ages 6-7, where they again increase in size and fluctuates around one percentage point afterwards (Figure A2). Among the latter age groups, the coefficient estimates are significantly different from zero, which shows evidence of our expected impacts by cohort as a result of the timing of the school expansion. In summary, the control experiment and the flexible analysis show that our research design is reasonable and that the policy had positive impacts on literacy and English-language skills.

Finally, the inference of causality of the estimates also relies on the assumption that there are no omitted time-varying and municipality-specific effects correlated with the expansion of schools at the municipality level. Since the allocation of schools is partly determined by municipal government resources, this assumption would be violated if other unobserved changes in the determinants of educational outcomes

between these groups varied across municipalities. For instance, this assumption would be violated if other programs, interventions, or policy changes put in place across local areas differentially affected school-age children families' school enrollment decisions. Since it is well-known that other health, sanitation, and physical infrastructure-based interventions such as (i) anemia control stations and other health care facilities, (ii) adult schooling programs (Report of the Commissioner of Education, 1906), and (iii) improvements in road infrastructure (Report of the Treasurer, 1907), may have been targeted towards particular municipalities, and these may have affected individuals and households' opportunities to send their children to school, we need to be cautious in that our empirical predictions may be strong given the great degree of changes during this time period.

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Table 1: Descriptive Statistics

	Overall Sample	Samples by Age Group (in 1909)	
	Mean (1)	11-24 Years Mean (2)	25-34 Years Mean (3)
Proportion Literate			
All Natives	0.347	0.381	0.278
Non-white Natives (blacks & mulattos)	0.301	0.341	0.220
White Natives	0.372	0.404	0.309
Native Females	0.317	0.358	0.235
Native Males	0.378	0.405	0.324
Proportion w/ English-Language Skills			
All Natives	0.042	0.056	0.015
Non-white Natives (blacks & mulattos)	0.037	0.049	0.013
White Natives	0.045	0.060	0.016
Native Females	0.038	0.053	0.007
Native Males	0.047	0.058	0.023
Other Socio-Economic Status Characteristics			
Individual's Age	20.9 [6.8]	17.1 [2.9]	28.6 [2.9]
Proportion Female	0.51	0.51	0.52
Proportion Black or Mulatto	0.36	0.36	0.35
Proportion who live in an urban area	0.31	0.30	0.32
Proportion whose father is native	0.97	0.97	0.97
Expansion in number of primary schools			
Num. primary schools per thousand children, 1897	1.65 [0.62]	1.65 [0.62]	1.65 [0.62]
Num. primary schools constructed per thousand children, 1897-1902	1.27 [0.82]	1.27 [0.82]	1.26 [0.81]
Num. primary schools constructed per thousand children, 1897-1907	1.94 [1.38]	1.93 [1.37]	1.97 [1.40]
Num. Observations	60,258	40,260	19,998

Notes to Table 1: Standard deviation of continuous variables in brackets.

Sources: 1910 Puerto Rican Population Census PUMS; Reports of the Commissioner of Education, 1907.

Table 2: Determinants of the Public Primary School Expansion during period 1897-1907

Explanatory variables	Dependent variables: Number of primary schools constructed per 1,000 children,									
	Period 1897-1902					Period 1897-1907				
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Num. primary schools per 1,000 children, 1897	0.25* (0.15)					0.02 (0.22)				
Share of agr. land under sugar cane cultivation, 1907		-1.49 (1.31)	-3.01** (1.32)				3.95** (1.94)	3.47+ (2.09)		
Share of agr. land under coffee cultivation, 1907			-3.31*** (1.05)					-1.03 (1.66)		
Total municipal government revenues (\$1,000 USD)				-0.001 (0.002)					0.008** (0.003)	
Share of population non-white					0.20 (0.72)					2.73** (1.04)
Constant	0.91*** (0.29)	1.48*** (0.16)	1.85*** (0.19)	1.28*** (0.28)	1.32*** (0.11)	1.66*** (0.44)	1.35*** (0.23)	1.47*** (0.30)	0.74* (0.40)	1.51*** (0.19)
Observations	67	67	67	67	66	67	67	67	67	66
R-squared	0.04	0.02	0.15	0.00	0.00	0.00	0.06	0.07	0.10	0.08

Notes to Table 2: Coefficients reported in each column are estimated from different OLS regressions. Standard errors are in parentheses; significantly different from zero at (+) 85%, (*) 90%, (**) 95% and (***) 99% confidence levels.

Table 3: Effect of the Primary School Expansion on Literacy Rates

Sample	<u>Coefficient Estimate:</u> Num. Schools Constructed per 1,000 School-Age Children * Young Cohort	Average Num. of Schools Constructed per 1,000 School- Age Children	Average Effect [= (1) x (2)]	Average Effect, as % of Literacy Rate in Pop. [= (3) / (5)]	Literacy Rate in Population	N
	(1)	(2)	(3)	(4)	(5)	(6)
All Natives	0.69* (0.28)	1.94	1.34%	3.9%	34.7%	60159
Non-White Natives	0.98 ⁺ (0.50)	2.17	2.13%	7.1%	30.1%	20368
White Natives	0.38 (0.53)	1.81	0.69%	1.9%	37.2%	39791
Native Females	1.36** (0.39)	1.94	2.64%	8.3%	31.7%	30912
Native Males	-0.02 (0.33)	1.94	-0.04%	-0.1%	37.8%	29247
Control variables:						
Individual characteristics	Yes					
Year of birth indicators	Yes					
Municipality indicators	Yes					

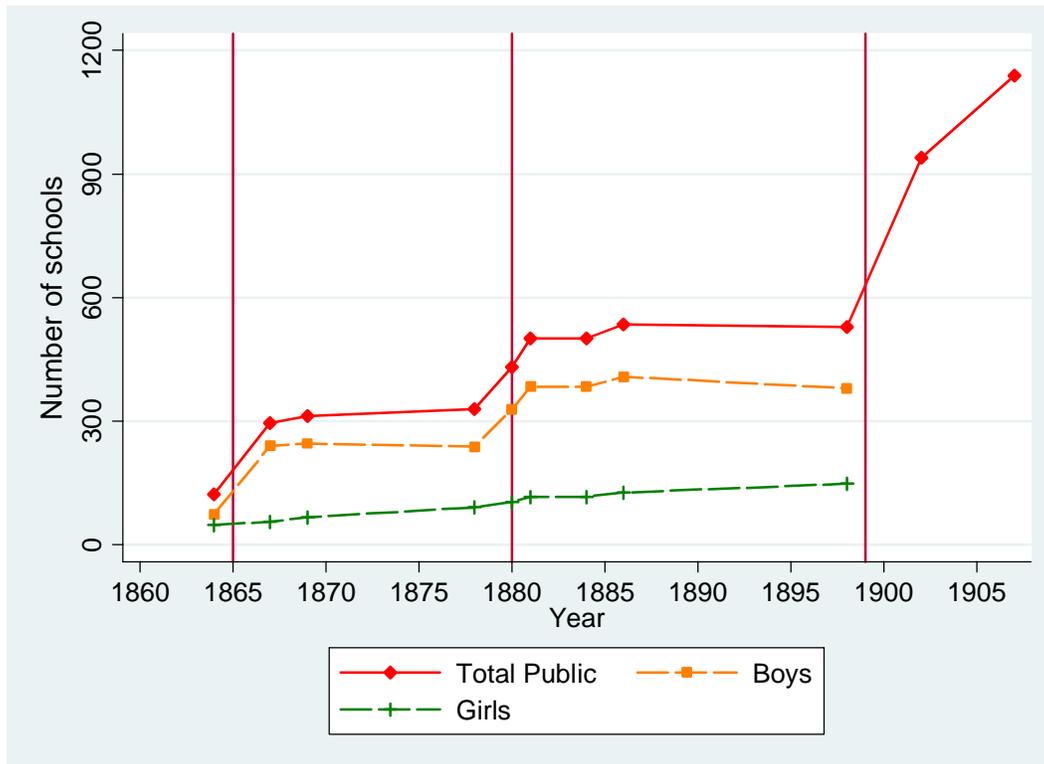
Notes to Table 3: Each coefficient is from a different regression. Coefficient estimates of the interaction between a young cohort indicator and the number of schools constructed per 1,000 children in the municipality from OLS regressions are reported. Robust standard errors are in parentheses; disturbance terms are allowed to be correlated within municipality - cohort group, but not across groups; significantly different from zero at (+) 10%, (*)5%, and (**) 1% significance levels. All specifications include municipality and year of birth indicator variables. Controls include the individual's race, gender, rural location, and an indicator for a foreign-born parent.

Table 4: Effect of the Primary School Expansion on English-Language Skills

Sample	<u>Coefficient Estimate:</u> Num. Schools Constructed per 1,000 School-Age Children * Young Cohort	Average Num. of Schools Constructed per 1,000 School- Age Children	Average Effect [= (1) x (2)]	Average Effect, as % of English- Skills Rate in Pop. [= (3) / (5)]	English Skills Rate in Population	N
	(1)	(2)	(3)	(4)	(5)	(6)
All Natives	1.01** (0.37)	1.94	1.97%	46.8%	4.2%	60258
Non-White Natives	0.65* (0.29)	2.17	1.40%	37.9%	3.7%	20405
White Natives	1.47** (0.52)	1.81	2.66%	59.3%	4.5%	39853
Native Females	1.53** (0.47)	1.94	2.97%	78.9%	3.8%	30990
Native Males	0.46+ (0.28)	1.94	0.89%	19.2%	4.7%	29268
Control variables:						
Individual characteristics	Yes					
Year of birth indicators	Yes					
Municipality indicators	Yes					

Notes to Table 4: Each coefficient is from a different regression. Coefficient estimates of the interaction between a young cohort indicator and the number of schools constructed per 1,000 children in the municipality from OLS regressions are reported. Robust standard errors are in parentheses; disturbance terms are allowed to be correlated within municipality - cohort group, but not across groups; significantly different from zero at (+) 10%, (*)5%, and (**) 1% significance levels. All specifications include municipality and year of birth indicator variables. Controls include the individual's race, gender, rural location, and an indicator for a foreign-born parent.

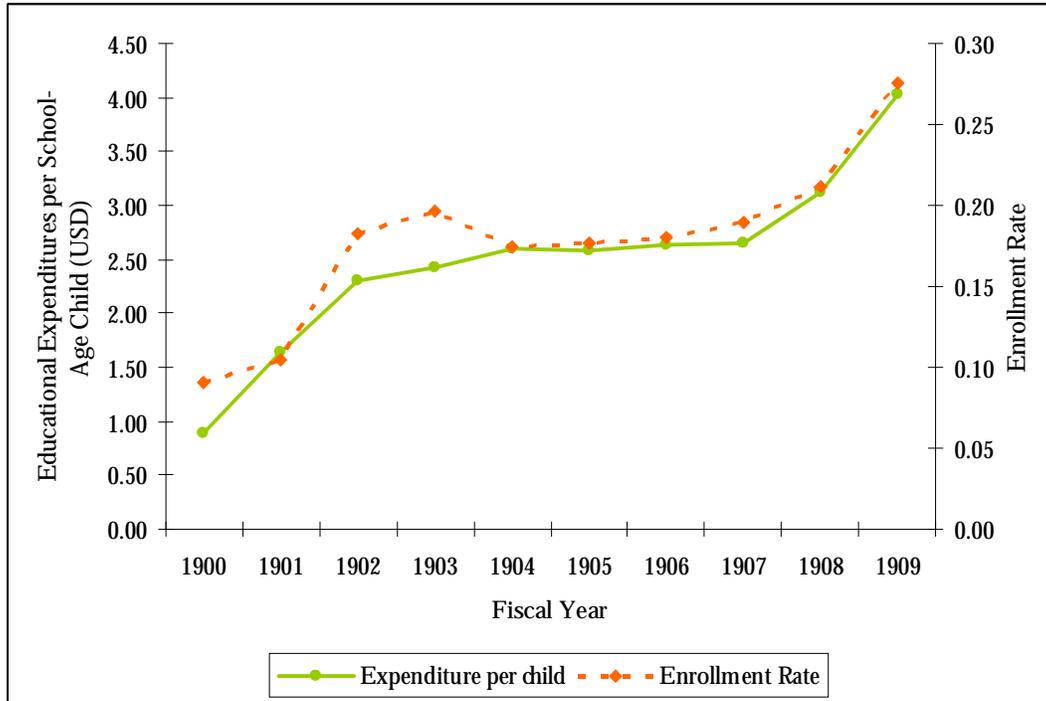
Figure 1: Expansion in Number of Public Primary Schools during the Spanish Regime (1864-1898) and the Initial U.S. Occupation (1898-1907)



Notes to Figure 1: Total number of primary schools (urban and rural) for various fiscal years, and number of primary schools (also urban and rural) for boys and for girls, during Spanish regime (until 1897).

Sources: Coll y Toste (1909); Report of the Commissioner of Education for Porto Rico, years 1899-1910, in Osuna (1947).

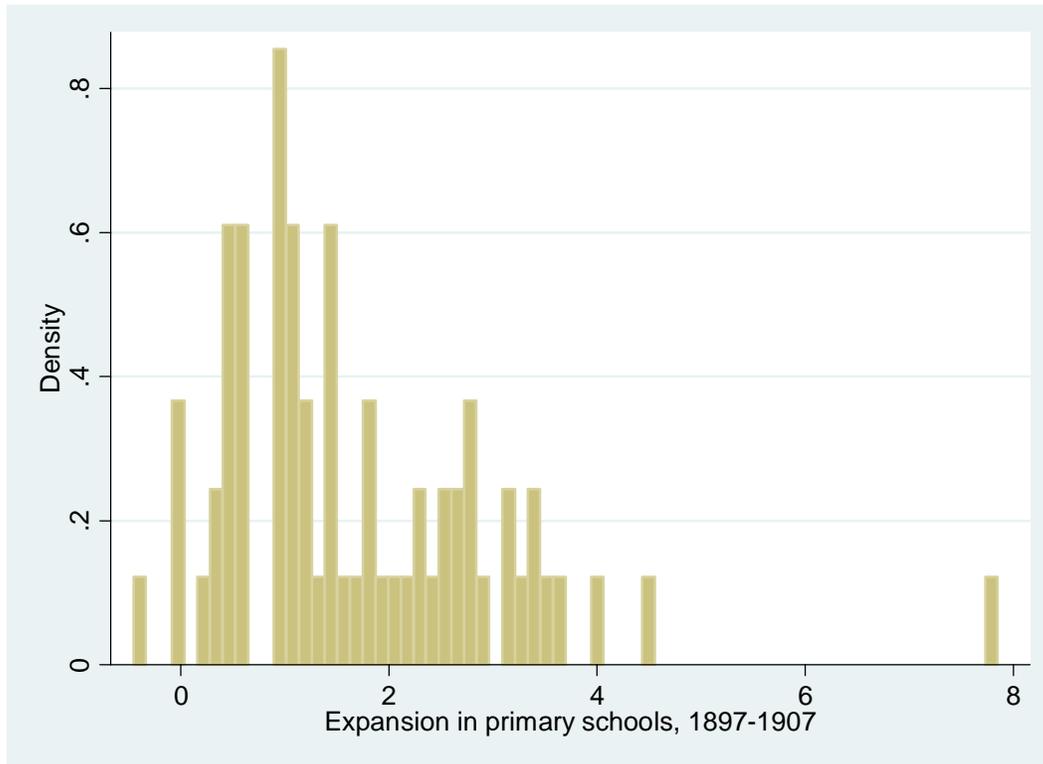
Figure 2: Expansion in Educational Expenditures and Public Primary and School Enrollment, Fiscal Years 1899/1900 – 1908/1909



Notes to Figure 2: Total expenditures for public elementary and secondary schooling per school-age child by fiscal year, and enrollment rate, by fiscal year, constructed from data on (i) total population of school-age individuals, (ii) total public elementary and secondary school enrollment, and (iii) total expenditures for public elementary and secondary schooling, per fiscal year, available from the Report(s) of the Commissioner of Education for Porto Rico, years 1899-1910.

Source: Report of the Commissioner of Education for Porto Rico, years 1899-1910, in Osuna (1947).

Figure 3: Distribution of the Primary School Expansion across Municipalities, 1897-1907

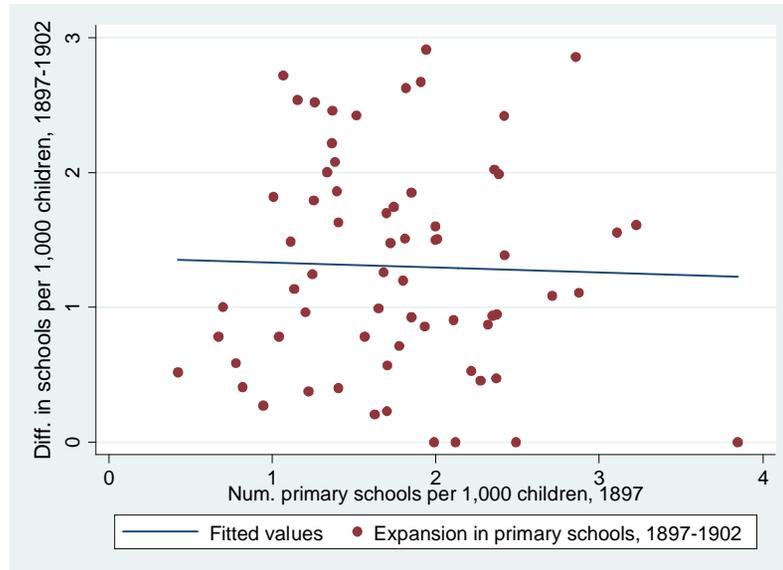


Notes to Figure 3: Histogram of the change in the number of primary schools per thousand school-age children from 1897 until 1907, by municipality.

Sources: Public Use Micro-Sample (PUMS) of the 1910 Puerto Rican Population Census; Reports of the Commissioner of Education, 1907.

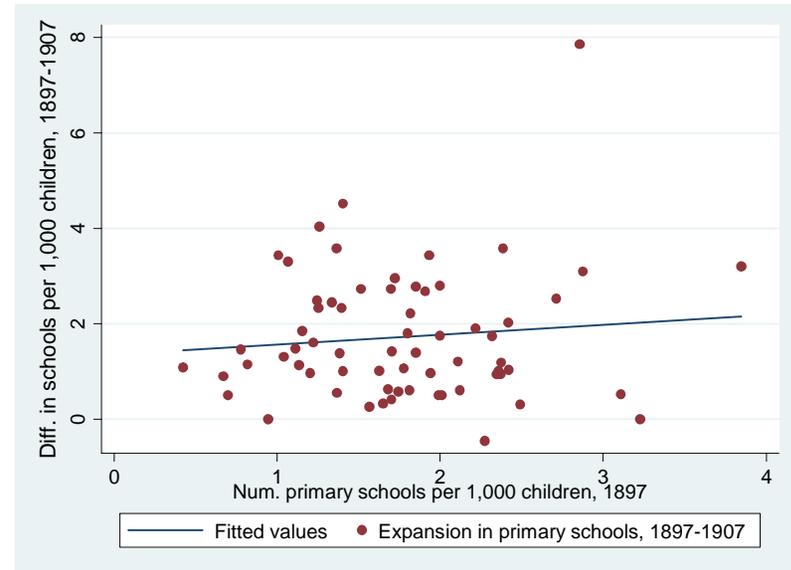
Figure 4: Distribution of Primary School Expansion by Availability of Primary Schools across Municipalities in 1897

Panel A: Expansion in primary schools, 1897-1902



Linear regression coefficient estimate (standard error) = -0.04 (0.15)

Panel B: Expansion in primary schools, 1897-1907

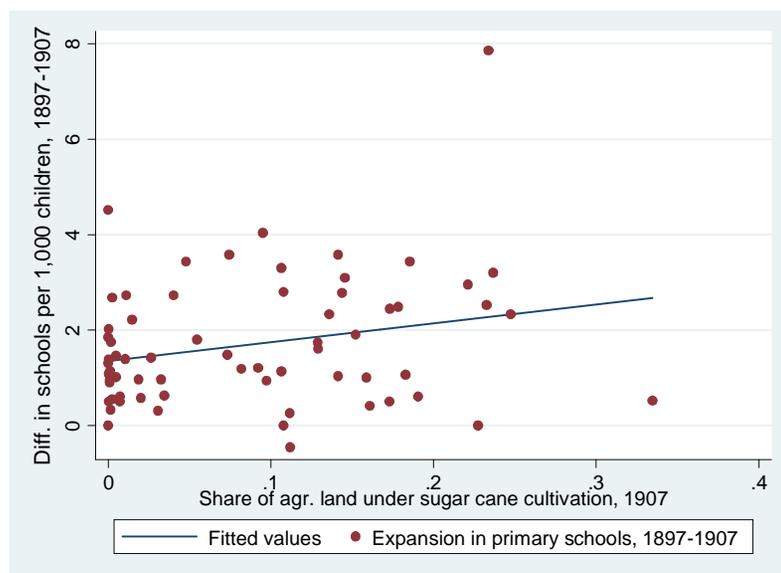


Linear regression coefficient estimate (standard error) = 0.21 (0.25)

Notes to Figure 4: Linear predictions from OLS regression of expansion in number of primary schools per 1,000 children during 1897-1902 and 1897-1907 as a function of the existing number of primary schools per 1,000 children during 1897. Coefficient estimate and standard error reported below each figure; * denotes that the coefficient is significantly different from zero at the 5 percent significance level.

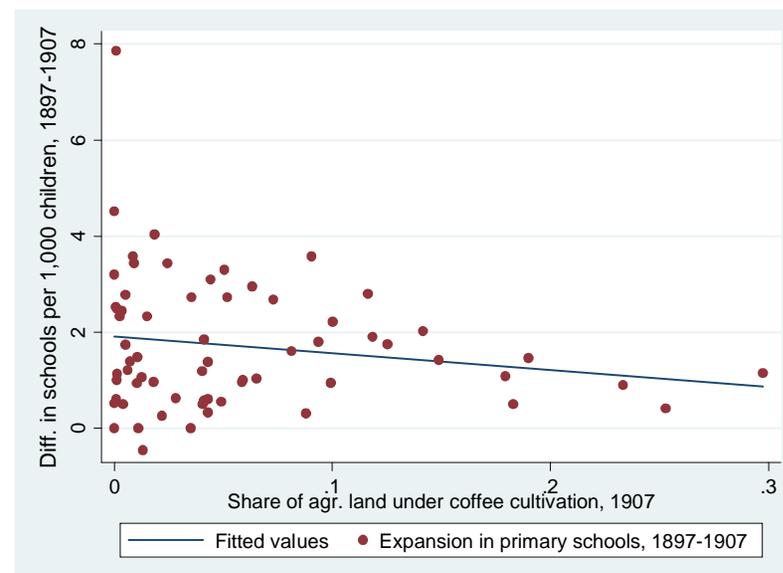
Figure 5: Distribution of Primary School Expansion (1897-1907) by Concentration of Sugar Cane and Coffee Cultivation across Municipalities in 1907

Panel A: Sugar and Non-Sugar-based Local Economies



Linear regression coefficient estimate (standard error) = 3.95* (1.94)

Panel B: Coffee and Non-Coffee-based Local Economies



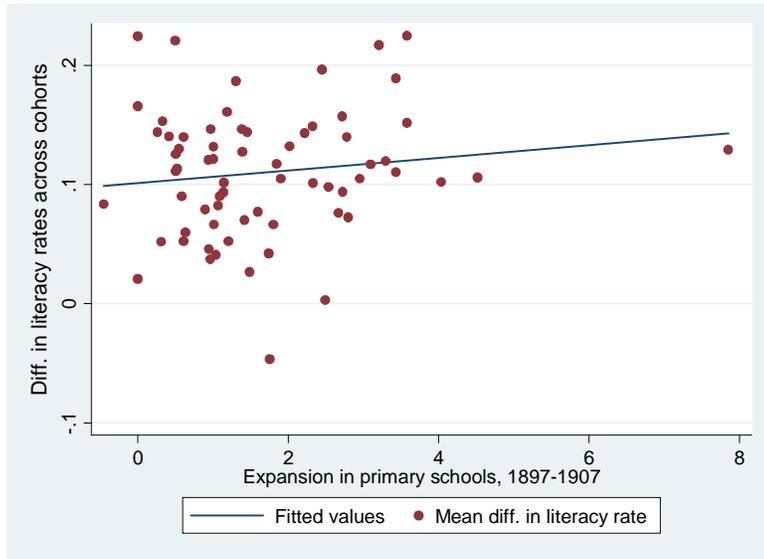
Linear regression coefficient estimate (standard error) = -3.49 (2.53)

Notes to Figure 5: Linear predictions from OLS regression of expansion in number of primary schools per 1,000 children during 1897-1902 and 1897-1907 as a function of the share of agricultural land under sugar cane cultivation (Panel A) and coffee cultivation (Panel B) in 1907. Coefficient estimate and standard error reported below each figure; * denotes that the coefficient is significantly different from zero at the 5 percent significance level.

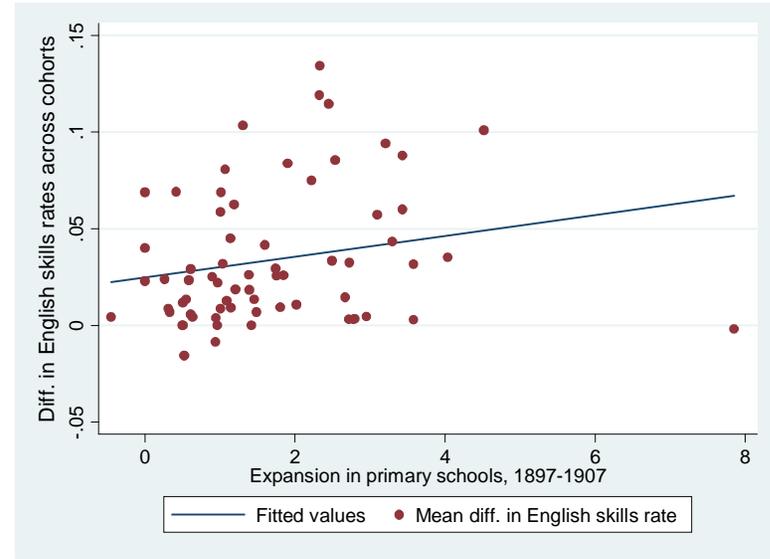
Figure 6: Graphical Relationship between 1897-1907 Primary School Expansion at the Municipality-Level and Municipality-Level Differences in Literacy and English-Language Skills Rates across Age Cohorts

Panel A: Municipality-Level Cohort Differences in Literacy Rates

Panel B: Municipality-Level Cohort Differences in English Literacy Rates



Linear regression coefficient estimate (standard error) = 0.52% (0.49%)

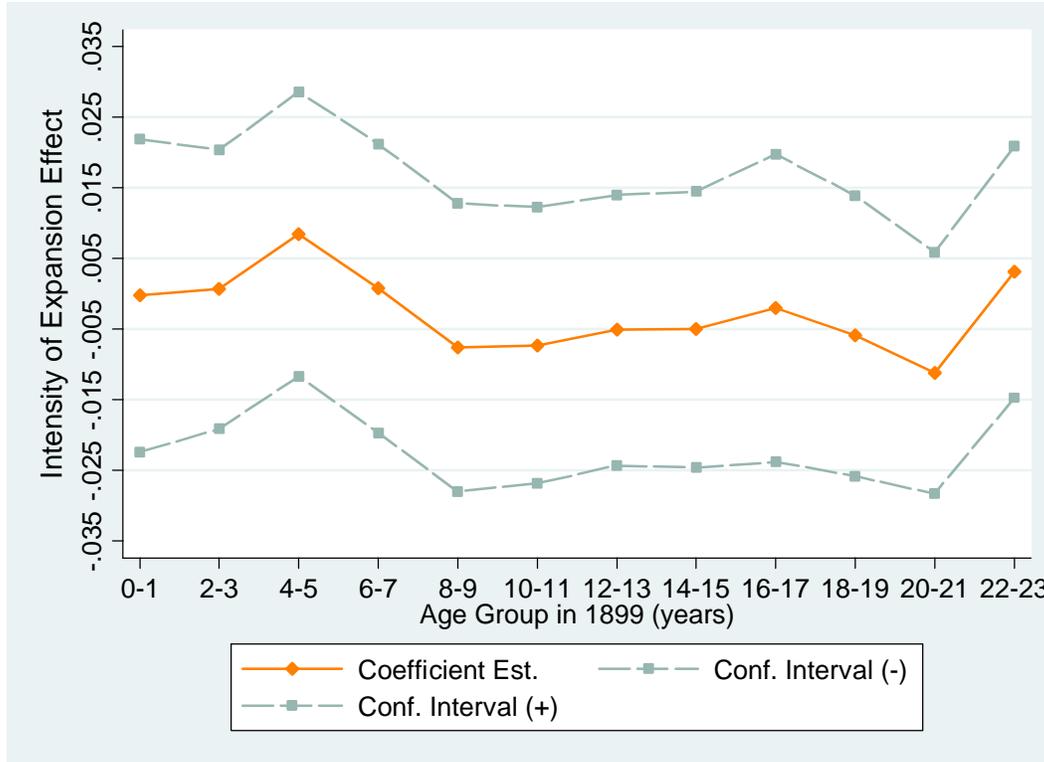


Linear regression coefficient estimate (standard error) = 0.53%* (0.31%)

Notes to Figure 6: Each dot represents a municipality. The figures depict the difference in literacy rates (Panel A) or English-language skills rates (Panel B) across school-age and ineligible cohorts in each municipality in 1910 as a function of the 1897-1907 primary school expansion. Linear predictions are from OLS regressions of the association between cohort differences in educational outcomes in each municipality and the expansion in the number of primary schools per thousand children during 1897-1907. Coefficient estimate and standard error reported below each figure; * denotes that the coefficient is significantly different from zero at the 10 percent significance level.

Figure A1: Effect of the Primary School Expansion on Literacy Skills

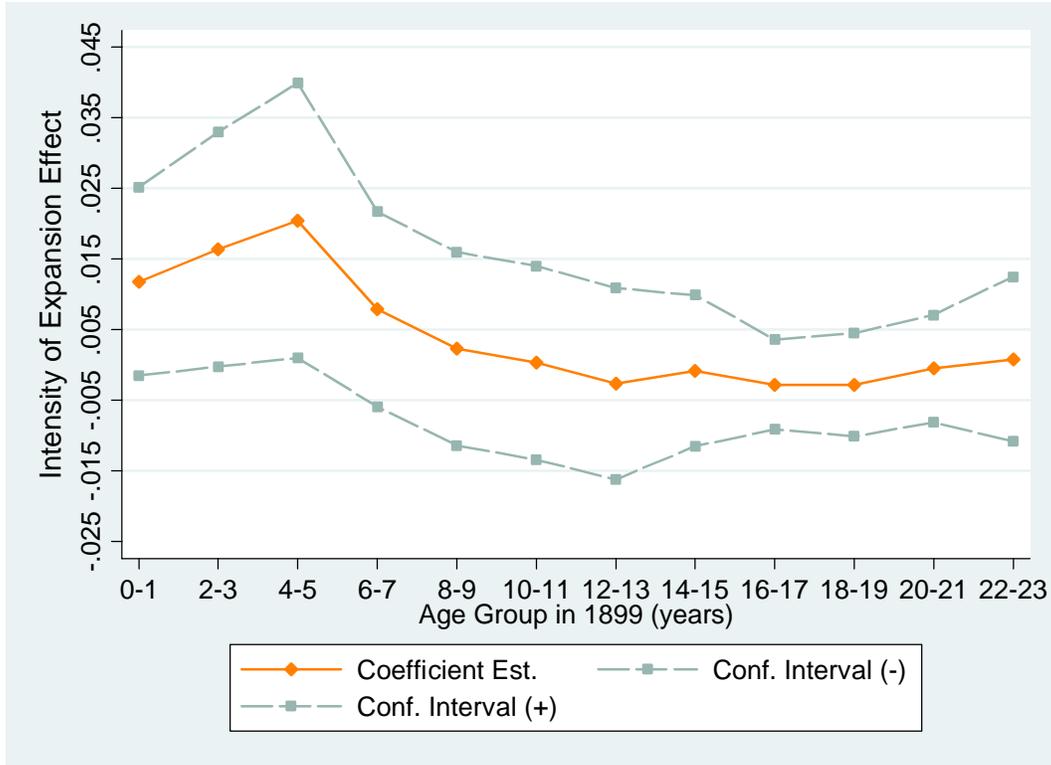
Coefficients of the Interaction between Cohort Indicators and the Number of Schools Constructed per Thousand Children in the Municipality, for each Age Group



Notes to Figure A1: Values of coefficient estimates from OLS regressions and their 95 percent confidence intervals are presented. Robust standard errors are in parentheses; disturbance terms are allowed to be correlated within municipality - cohort group, but not across groups; significantly different from zero at (+) 90%, (*) 95%, (**) 99% confidence levels. Specification includes municipality and year of birth indicator variables. Controls include the individual's race, gender, rural location, and an indicator for a foreign-born parent.

Figure A2: Effect of the Primary School Expansion on English-Language Skills

Coefficients of the Interaction between Cohort Indicators and the Number of Schools Constructed per 1,000 Children in the Municipality, for each Age Group



Notes to Figure A2: Values of coefficient estimates from OLS regressions and their 95 percent confidence intervals are presented. Robust standard errors are in parentheses; disturbance terms are allowed to be correlated within municipality - cohort group, but not across groups. Specification includes municipality and year of birth indicator variables. Controls include the individual's race, gender, rural location, and an indicator for a foreign-born parent.