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THE EFFECTS OF SPANISH-LANGUAGE BACKGROUND ON COMPLETED SCHOOLING AND APTITUDE TEST SCORES

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We investigate the effect of speaking Spanish at home as a child on completed schooling and aptitude test scores using data from the NLSY79 on Hispanics who grew up in the United States. We model the accumulation of traditional human capital and English fluency, leading to the joint determination of schooling and test scores. We find that speaking Spanish at home reduces test scores, but has no significant effect on completed schooling. The reduction in test scores (1) increases in magnitude in three of the tests when the parents are more educated; (2) is much more dramatic when the choice of home language is made endogenous; and (3) is not systematically greater for the verbal than for the math tests. (*JEL* I20, J15)

I. INTRODUCTION

Does growing up in the United States in a home where Spanish is spoken affect an individual's cognitive abilities as measured by aptitude tests? Does it have any influence on how much schooling that individual eventually acquires? The purpose of this article is to investigate these questions using data on persons of Hispanic ancestry who grew up in the United States. While there is an extensive literature linking earnings to aptitude test scores and educational attainment (two areas in which Hispanics continue to lag non-Hispanic whites), not much attention has been devoted to whether these measures of intellectual development are themselves affected by the language spoken at home. As the Hispanic share of the population in the United States continues to grow, understanding the determinants of Hispanic test scores and educational attainment is of increasing importance.

According to the Current Population Survey, there were 40.4 million Hispanics living in the United States in 2004—14.0% of the population, which represents an increase from 12.6% in 2000. The differences in educational attainment between Hispanics and non-Hispanic whites are quite stark. In 2005, 25.1% of Hispanics, aged 25 and above, had less than 9 years of education, while only 3.3% of non-Hispanic whites did. At higher education levels, only 12.1% of Hispanics had a bachelor's degree or more, whereas the corresponding figure for non-Hispanic whites was 30.6%.

Differences in standardized test scores are also large. In 2004, for example, the average

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ABBREVIATIONS

AFQT: Armed Forces Qualification Test
ASVAB: Armed Services Vocational Aptitude Battery
ECLS-K: Early Childhood Longitudinal Study of Kindergartners
ELS-02: Education Longitudinal Study
NALS: National Adult Literacy Survey
NELS-88: National Education Longitudinal Study
NLSY79: National Longitudinal Survey of Youth 1979
OLS: Ordinary Least Squares
SIE: Survey of Income and Education

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verbal and math SAT scores for Hispanics were 456.3 and 458.3, respectively. Correspondingly, the averages for non-Hispanic whites were 528 and 531.[1] In the two verbal Armed Services Vocational Aptitude Battery (ASVAB) tests used in this article, scores for Hispanics and non-Hispanic whites are 20.5 and 26.7 on the word knowledge exam and 8.6 and 11.2 on the paragraph comprehension exam. Similar differences arise for the two math ASVAB tests we used: 13.2 and 18.4 points for the arithmetic reasoning exam and 9.9 and 13.8 points for the math knowledge exam.[2]

Related topics have been explored by various authors. For example, McManus (1990) finds that the return to English proficiency is lower in Spanish enclaves. Chiswick (1991) and Gonzalez (2000) find greater returns to speaking fluency than to reading fluency; the latter also finds a premium to writing skills over reading skills. Recently, Bleakley and Chin (2004, 2008) have addressed the possible correlation between measures of English proficiency and the error term in wage regressions by exploiting the cognitive theory that children learn languages more easily at younger ages. This hypothesis is also explored by Chiswick and Miller (2008), Chiswick, Lee, and Miller (2005), and Gonzalez (2003). For the families of Hispanic children born or raised in the United States, however, the issue is not so much whether or not their children should become fluent in English—as they overwhelmingly do—but whether they should, to the extent that they are able, expose them to Spanish. Being bilingual has obvious benefits, but being raised in a home where Spanish is spoken may have drawbacks in an English-speaking society.

To our knowledge, the economics literature has been mostly silent on the effect of speaking Spanish at home on educational attainment and aptitude test scores. Fryer and Levitt (2006) mention in passing that speaking Spanish at home has little effect on the initial gap or the trajectory of test scores between Hispanics and non-Hispanic whites, but they provide no formal results, as this was not the focus of their study. Other papers investigating ethnic and racial differences in test scores include Clotfelter, Ladd, and Vigdor (2009) and Fryer and Levitt (2004).[3] Rosenthal, Baker, and Ginsburg (1983), from the sociology literature, use a nationally representative sample of elementary students and find a negative relationship between speaking Spanish at home and verbal and math aptitude, with the effect being stronger for the former than for the latter.

In Section II of this article we construct a formal model of the joint determination of schooling level and aptitude test scores. We view test scores as measures of an individual's human capital at the time the test is administered. We modify Ben-Porath's (1967) model of human capital to allow for two types of complementary capital: traditional human capital (measured by aptitude tests) and English fluency. Speaking Spanish at home can slow down the acquisition of English fluency, thus impairing the transmission of skills, resulting in lower test scores. How much it does so may depend on the characteristics of the parents.[4] The implications of the model for the effect of speaking Spanish at home on schooling levels are ambiguous, however. Anything that lowers the productivity of the process of human capital accumulation reduces both the marginal benefits and the marginal costs of staying in school.

Section III presents the empirical formulation we employ. A detailed description of the data is given in Section IV and in Appendix A. We use data from the National Longitudinal Survey of Youth 1979 (NLSY79). The NLSY79 has been widely used in the labor economics literature, but to our knowledge this article is the first to use it in exploring the relationship between Spanish language background and academic achievement. The nature of the NLSY79 enables us to determine a respondent's final level of schooling, and it also contains verbal and math aptitude test scores from the ASVAB tests. Section V presents our results. We find that speaking Spanish at home as a child reduces test scores, but has no statistically significant effect on schooling levels. As much as 19–34% of the white-Hispanic test differential can be accounted for by speaking Spanish

1. See www.collegeboard.com.

2. At the time, the maximum verbal and math SAT scores were 800. The corresponding maximum ASVAB word knowledge, paragraph comprehension, arithmetic reasoning, and math knowledge scores are 35, 15, 30, and 25. The numbers mentioned here do not match the figures presented in Table 1 as they correspond to all the Hispanics and non-Hispanic whites in the data set, and not to the subset used in our empirical analysis.

3. On a somewhat related note, Angrist, Chin, and Godoy (2008) study the effect of using English as the medium of instruction on English proficiency in Puerto Rico.

4. We will use "skills," "knowledge," and "human capital" interchangeably throughout the article.

at home. We also find that for three of the tests the reduction in test scores from speaking Spanish at home tend to increase with parents' schooling.

Section V treats speaking Spanish at home as a child as an exogenous characteristic of families. In Section VI we model the decision to speak Spanish at home, and we find that endogenizing it substantially increases its negative effect on test scores. Doing so helps to explain an even greater fraction of the white-Hispanic test differential (59–97%). Section VII briefly explores how varying propensities to self-identify as Hispanic across generations in the United States may affect our results. We conclude in Section VIII with a summary of our results.

II. CONCEPTUAL FRAMEWORK AND EMPIRICAL SPECIFICATION

Like Hansen, Heckman, and Mullen (2004) we assume that aptitude test scores are not measures of innate ability, but rather outcome variables that themselves are generated in part by this latent ability. We view the arithmetic reasoning, math knowledge, word knowledge, and paragraph comprehension test scores as measures of different types of human capital at the time the test is administered. In what follows, however, we take a simplified approach and treat human capital as all of one type.

Our model is a modified version of Ben-Porath's (1967) model of human capital. In the period $[0, t_s]$, which we refer to as the schooling/home period, the individual is born, lives with his parents, and attends school, but does not work. During this time the individual invests in human capital and becomes fluent in English. By English fluency we mean the ability to understand basic spoken English, and do not mean the full mastery of verbal skills. According to this interpretation of fluency, the average high school student who has spoken only English in his entire life is considered as fluent as a Shakespearian scholar. At time t_s the individual enters the labor force and uses his acquired human capital to generate income and for further investment.

A. The Schooling/Home Period

During the schooling/home period human capital is accumulated according to the following:

$$
\begin{aligned}
(1)\qquad & \dot{h} = bh^{\alpha}\,(E/2)^{\eta}\,,\ 1 > \alpha,\ \eta > 0,\\
& \dot{E}/E = g > 0 \text{ if } E < 2,\\
& \dot{E} = 0 \text{ otherwise},\\
& E(0) = 1,\ h(0) = h_0,
\end{aligned}
$$

where $h(t)$ is human capital and $E(t)$ is fluency in English, both at time t, which coincides with the individual's age. Fluency is acquired at an exogenous rate, g, determined by one's language environment, including that of the home. Initial human capital, h_0, and the productivity parameter of the human capital accumulation equation, b, may also be related to observable household characteristics. Everyone begins life with a level of English fluency, $E(0) = 1$, and achieves fluency at time t_{F} where $E(t_{\mathrm{F}}) = 2$. The time at which fluency is achieved is given by $e^{gt_{\mathrm{F}}} = 2$, or $t_{\mathrm{F}} = ln(2)/g$. We assume that everyone achieves fluency before the end of the schooling period, that is $t_{\mathrm{F}} < t_s$. (In the empirical work we assume that fluency has been achieved by the time the aptitude test is administered, which for some individuals is before they have completed their schooling.)

The model summarized in Equation (1) does not allow for any positive influences from the knowledge of Spanish in terms of human capital accumulation. The model could be easily modified to allow for such benefits of bilingualism if the empirical work to follow suggests that such a modification would be fruitful. For the period $[0, t_F]$ the solution to the differential equation for human capital in Equation (1) is

$$
\begin{aligned}
(2)\qquad h(t) = [h_0^{1-\alpha} &+ (b(1-\alpha)/\eta g 2^{\eta})\\
&\times (e^{\eta g t} - 1)]^{1/(1-\alpha)}.
\end{aligned}
$$

From Equation (2) we can obtain $h(t_{\mathrm{F}})$, which is the initial condition for the human capital differential equation for the period between achieving fluency and completing school, that is $[t_{\mathrm{F}}, t_s]$. For the period $[t_{\mathrm{F}}, t_s]$ human capital is given by:

$$
\begin{aligned}
&(3)\\
&h(t) = [h_0^{1-\alpha} + b(1-\alpha)\,(t - (\pi/\eta g))]^{1/(1-\alpha)},
\end{aligned}
$$

where $\pi = 2^{-\eta} + \eta ln(2) - 1 > 0$ and $t > \pi/\eta g$. From Equation (3) we can obtain $h(t_s)$, which is the initial condition for human capital during the working period, that is $[t_s, T]$, where T is the time of retirement.

In the empirical implementation, we assume that every member of our sample was administered the aptitude test after they achieved fluency. This implies that for a person who was in school at the time of the test, t_τ, Equation (3) gives that person's level of human capital, and consequently his test score, τ. Define s_τ as the years of schooling at the time the test is administered. Then $s_\tau = t_\tau - 6$, and we can express the person's test score as:[5]

$$\tau(s_\tau, g, b, h_0) = h(s_\tau + 6). \tag{4}$$

We can determine from Equations (3) and (4) that:

$$\begin{aligned}
(5)\quad \partial\tau/\partial s_\tau &= b(h(t_\tau))^\alpha > 0,\\
\partial\tau/\partial g &= ((b\pi(h(t_\tau))^\alpha)/\eta g^2) > 0,\\
\partial\tau/\partial b &= ((h(\tau))^\alpha(\eta g t_\tau - \pi))/\eta g\\
&> ((h(t_\tau))^\alpha(1 - 2^{-\eta}))/\eta g > 0,\\
\partial\tau/\partial h_0 &= ((h(t_\tau))^\alpha)/h_0^\alpha > 0.
\end{aligned}$$

The first condition in Equation (5) states that the longer the individual is in school before he or she takes the exam, the higher his or her human capital at the time of the test and therefore the higher the test score. The next three conditions state that an increase in the rate of accumulation of English fluency, g, in the productivity of human capital accumulation, b, or in the initial human capital endowment, h_0, will raise the test score at the time the test is administered.

B. The Working Period

After completing school the individual enters the labor market with human capital $h_s = h(t_s)$ given by Equation (3). Following Ben-Porath (1967) we assume that the individual can allocate any portion of his or her human capital to generate earnings, $y(t)$, or to generate more human capital through on-the-job training. Let $x(t)$ be the amount of human capital devoted to on-the-job training at time t. The individual's earnings are then given by:

$$y(t) = w(h(t) - x(t)), \tag{6}$$

where w is the wage rate per unit of human capital. We assume that the production of human capital through on-the-job training is governed by a process similar to that of the schooling/home period:

$$\dot{h} = ax^\alpha, \tag{7}$$

where a is a productivity parameter. The individual's objective is to determine the path of investment in human capital, $x(t)$, that maximizes the present value of earnings, $y(t)$, minus the direct cost of schooling, which is given by:

$$\begin{aligned}
(8)\quad &\int_{t_s}^{T} \mathrm{e}^{-rt} y(t)\mathrm{d}t - p\int_0^{t_s} \mathrm{e}^{-rt}\mathrm{d}t\\
&= \int_{t_s}^{T} \mathrm{e}^{-rt} y(t)\mathrm{d}t - ((p(1 - \mathrm{e}^{-rt_s}))/r),
\end{aligned}$$

where p is the direct cost of schooling per unit of time and r is the discount rate. Taking t_s as given, Equation (8) is maximized subject to Equations (6) and (7), the boundary condition $h(s) = h_s$, and the non-negativity constraint, $x(t) \geq 0$.

At the start of the working period, t_s, the individual will invest positive amounts in his or her human capital. That investment will decline over time as retirement age approaches. At time T investment in human capital becomes 0. Let us define potential work experience, t_w, as $t_w = t - t_s$. The solution to the working period problem, which is $x(t) = \left(a\alpha/r(1 - \mathrm{e}^{r(t-T)})\right)^{1/(1-\alpha)}$, gives rise to the optimal path of human capital given by:

$$h(t) = h(t_w + t_s) = h_s + \int_0^{t_w} a(x(z + t_s))^\alpha \mathrm{d}z. \tag{9}$$

The first term on the right-hand side of Equation (9) is the human capital at the end of the schooling period, and the second term on the right-hand side is the net accumulation of human capital between the end of the schooling period, t_s, and time t.

Equation (9) provides the human capital for someone who has left school by the time the test is administered. Since for such a person the years of schooling at the time of the test, s_τ, equals the years of completed schooling, s, we can express his test score as:

$$\tau(s, t_w, a, g, b, h_0) = h(t), \tag{10}$$

where $h(t)$ is given by Equation (9).

According to Equation (9), human capital at the end of the schooling period is reflected one-for-one in human capital during the working

5. This assumes that an individual begins his schooling at age 6—the typical age in the United States.

period. The effects of (s, g, b, h_0) on the test score after the schooling period are therefore the same as those during the schooling period, and are given by Equation (5). From Equation (9) we can derive the effect of t_w and a on the test score as:

$$(11)\quad \partial\tau/\partial t_w = a(x(t_w + t_s))^{\alpha} > 0 \text{ if } a > 0,$$

$$\partial\tau/\partial a = \int_0^{t_w} (a(x(z + t_s))^{\alpha})/(1 - \alpha)\mathrm{d}z > 0 \text{ if } a > 0.$$

The optimal value of the present value of income net of the direct schooling costs is

(12)

$$V(h_s, t_s) = (w(\mathrm{e}^{-rt_s} - \mathrm{e}^{-rT})h_s)/r + w\int_{t_s}^{T} \mathrm{e}^{-rt}\int_{t_s}^{t} ax^{\alpha}(z)\mathrm{d}z\mathrm{d}t - w\int_{t_s}^{T} \mathrm{e}^{-rt}x(t)\mathrm{d}t - (p(1-\mathrm{e}^{-rt_s}))/r.$$

The first term on the right-hand side of Equation (12) is the present value of earnings generated by the human capital acquired during the schooling/home period. The next term is the present value of the earnings generated by the human capital accumulated during the working life. From the first two terms, the third term, representing the present value of foregone earnings from on-the-job investment in human capital, must be subtracted. The fourth term on the right-hand side is the present value of direct schooling costs.

From Equation (12) we obtain that:

$$(13)\qquad V_{h_s} = (w(\mathrm{e}^{-rt_s} - \mathrm{e}^{-rT}))/r > 0.$$

Increasing human capital at the end of the schooling period by one unit permanently raises the path of human capital by one unit. This in turn increases earnings by w per unit of time. Equation (13) gives the present value of that increase in earnings. Similarly for changing the date of completion of schooling:

$$(14)\quad V_{t_s} = -w[h_s\mathrm{e}^{-rt_s} + (a(x(t_s))^{\alpha} \times (\mathrm{e}^{-rt_s} - \mathrm{e}^{-rT}))/r] + w\mathrm{e}^{-rt_s}x(t_s) - p\mathrm{e}^{-rt_s} < 0.$$

Holding human capital at the end of the schooling/home period, h_s, constant, extending the period of schooling increases the direct cost of schooling and reduces the period of potential earnings. The latter is partially offset by a reduction in post-schooling investment, but the overall effect is to reduce the present value of earnings.

The individual's problem is then to choose the length of the schooling/home period so as to maximize Equation (12), where $h(s)$ is given by Equation (3). Since $t_s = s + 6$, we can express the objective function as $v(s; a, g, b, h_0) = V(h(s + 6), s + 6)$, where $h(t)$ is given by Equation (3). The first-order condition for this problem is given by the following:

(15)

$$v_s(s; a, g, b, h_0) = V_{h_s}b(h(t_s))^{\alpha} + V_{t_s} = 0,$$

where V_{h_s} is given by Equation (13) and V_{t_s} by Equation (14). The solution to Equation (15) is the optimal level of schooling, $s(a, g, b, h_0)$. The effects of (a, g, b, h_0) on schooling can be obtained by differentiating Equation (15). Their effects, however, will generally be ambiguous. Consider, for example, the effect of more rapid growth of English fluency. Differentiating Equation (15), we obtain:

$$(16)\qquad (\partial s(a, g, b, h_0))/\partial g = -v_{sg}/v_{ss}.$$

The second-order conditions require that $v_{ss} < 0$, so the sign of $\partial s/\partial g$ will be the same as that of v_{sg}. The latter is given by:

(17)

$$v_{sg} = (wb\pi(h(t_s))^{\alpha})/\eta g^2[((b\alpha(\mathrm{e}^{-rt_s} - \mathrm{e}^{-rT}) \times (h(t_s))^{\alpha-1})/r) - \mathrm{e}^{-rt_s}],$$

which cannot be signed. A higher rate of growth of English fluency makes the schooling/home period more productive in the acquisition of human capital, encouraging the individual to stay in school longer. Since this results in higher human capital at every point in time, it results in greater foregone earnings from staying in school. Our model predicts that the overall effect on completed schooling is thus ambiguous.

C. Speaking Spanish at Home and Parental Schooling

Our main interest in this article is to assess the effects of speaking Spanish at home as a child on aptitude test scores, and secondarily, because the theoretical predictions are ambiguous, on schooling. For now we will treat speaking Spanish at home as an exogenous variable. In Section VI we endogenize the decision of the language environment of the home.

Of the three productivity parameters in the schooling/home period of the model developed above, (g, b, h_0), the most natural one through which speaking Spanish at home should influence the acquisition of human capital is the growth rate of English fluency, g. We expect that a child who grows up in a home where the parents are fluent in English, but nevertheless speak Spanish, will become fluent in English more slowly. As shown above, this will result in lower test scores, but it will have an ambiguous effect on the level of schooling. In a household where the parents are not fluent in English, the alternative to speaking Spanish may be to speak very poor English, which may lower rather than raise the rate at which a child becomes fluent in English. Presumably such a household would be a Spanish-speaking one. The effect of speaking Spanish at home on the accumulation of human capital, therefore, may interact in complex ways with parental characteristics.

Unfortunately, our data set does not include measures of the English fluency of the parents. It does, however, include their levels of schooling and whether they were born abroad, both of which we believe are correlated with their degree of fluency in English. Furthermore, parental schooling should be directly related to the other productivity parameters, namely b and h_0, and through these indirectly related in the production of human capital to speaking Spanish at home.

We can envision at least four ways in which parental schooling can impact the accumulation of human capital and therefore the test scores of the individuals in our sample. First, parental schooling is likely to be correlated with the innate ability of the parents and thus with their children's inherited abilities. In our model, higher innate ability can manifest itself in terms of higher values of h_0, b, or g. Second, parents with higher levels of education are likely to have higher incomes, which will be associated with better quality schools and other inputs into the human capital accumulation process. Furthermore, parents with more schooling are likely to have more knowledge to impart to their children and be better at doing so. These last two should work through increasing the productivity parameters b and g. Finally, better educated parents are more likely to be fluent in English and this can affect the growth rate of English directly as well as through its interaction with the language spoken at home, as stated above.

Perhaps the potential interaction between ability and home language that first springs to mind is that if speaking Spanish at home reduces g, the rate at which fluency is acquired, its negative effects will be weaker for more able individuals. If this effect is present, the test scores of the children of more-educated parents should not be reduced as much by speaking Spanish at home as those of less-educated parents. There are, however, other ways in which ability and home language can interact. From Equation (5) it can be shown that $\partial^2\tau/\partial g\partial h_0 > 0$ and $\partial^2\tau/\partial g\partial b > 0$. This means that any reduction in g resulting from speaking Spanish at home will have a larger negative effect on test scores the greater are h_0 and b. The more productive parents are at imparting human capital to their children, the greater the opportunity cost for parents fluent in English to speak Spanish at home. This does not mean that higher education on the part of parents will result in lower test scores for their children if Spanish is spoken at home, but rather that the positive effects of parental schooling on their children's scores will be reduced. It also means that speaking Spanish at home will reduce test scores more for children of more-educated parents.

Above we listed several ways parental schooling levels can affect test scores. We expect that inherited abilities and family income are not much affected by the home language environment. This is not our expectation for the other mechanisms listed.[6] Suppose, for example, that more-educated parents are simply better at transmitting their skills—including language skills—to their children. Then each hour spent speaking Spanish at home means foregoing the acquisition of more English skills for a child of more-educated parents, than for one with less-educated parents.[7] Even if parental education is not associated with how productive parents are at transmitting knowledge to their children, it is still likely to be related to the amount of academic knowledge they have to impart. By speaking Spanish to their children, more-educated parents may end up transmitting less academic knowledge at the higher skill range—a skill range in which their less-educated counterparts

6. We thank an anonymous referee for some of the following formulations.

7. To the extent that more-educated parents are more likely to have received at least their higher education in the United States, it is quite possible that when not speaking to their children in English the transmission of all types of academic skills, not just English skills, are impaired.

may not be interacting with their children regardless of the language spoken at home.[8]

III. THE EMPIRICAL IMPLEMENTATION

The model from the previous section gives rise to the following two equations for completed schooling and test scores:

$$s(a, b, g, h_0) \tag{18}$$

$$\tau_i(s_\tau, t_w, a, b, g, h_0). \tag{19}$$

For our empirical implementation we will assume that the schooling Equation (18) is given by:

$$s = \gamma Z + u, \tag{20}$$

where Z is a set of observable determinants of schooling and u is an error term, which we assume is distributed as $N(0, \sigma_u)$. Among the elements included in Z are individual and family characteristics, including parents' schooling, and measures of the direct and indirect costs of schooling similar to those used in Hansen, Heckman, and Mullen (2004).

We assume for an individual's score on test i, τ_i, the following empirical formulation:

$$\tau_i = f_i(s_p)\psi + \theta_i s_\tau + \lambda_i t_w + \beta_i X + \varepsilon_i \quad \text{for } i = 1, ..., 4, \tag{21}$$

where ψ takes on the value of "1" if an individual spoke Spanish at home as a child, and "0" otherwise, s_p is a vector of the schooling level of each parent, $f_i(\cdot)$ is a function of s_p, X is a vector of individual and family characteristics (again including measures of parental schooling), and ε_i is the error term representing unobservable determinants of the test score.

Equation (21) cannot be estimated by ordinary least squares (OLS) because s_τ is likely to be correlated with the error term. The ASVAB tests were administered to all the participants in the NLSY79 in the same year, 1980. Respondents, therefore, varied in age at the time they took the aptitude tests. If more able respondents also obtain more schooling, then the more able are more likely to be in school when the tests were administered. Years of schooling in 1980 would in part measure the effects of unobserved ability. To correct for this bias we substitute the expected value of s_τ for its actual value in estimating Equation (21).

Define t_0 as the age at which an individual begins school, and $\Delta = t_\tau - t_0$ as the maximum years of schooling he could have completed at the time of the test.[9] Let $I = 1$ if $s \leq \Delta$, and $I = 0$ otherwise. If $I = 0$ an individual is still in school at the time of the test and so $s_\tau = \Delta$ and $t_w = 0$. If $I = 1$ an individual has completed his schooling at the time of the test and so $s_\tau = s$ and $t_w = t_\tau - s - t_0 = \Delta - s$. We can now restate Equation (21) as:

$$\tau_i = \begin{cases} f_i(s_p)\psi + \theta_i\Delta + \beta_i X + \varepsilon_i, & \text{if } I = 0 \\ f_i(s_p)\psi + \theta_i\gamma Z + \lambda_i(\Delta - \gamma Z) + \beta_i X \\ \quad + (\theta_i - \lambda_i)u + \varepsilon_i, & \text{if } I = 1. \end{cases} \tag{22}$$

From Equation (22) we can compute the expected score of test i. Let $c = \frac{(\Delta - \gamma Z)}{\sigma_u}$, and $\Phi(c)$ and $\phi(c)$ be the standard normal distribution and density evaluated at c. The expected score of test i is given by:

$$\begin{aligned} E(\tau_i) = {} & f_i(s_p)\psi + \theta_i[\Delta(1 - \Phi(c)) \\ & + \gamma Z\Phi(c) - \sigma_u\phi(c)] \\ & + \lambda_i[(\Delta - \gamma Z)\Phi(c) + \sigma_u\phi(c)] + \beta_i X, \end{aligned} \tag{23}$$

where the two terms in brackets are expected schooling, $E(s_\tau)$, and expected (potential) work experience, $E(t_W)$, at the time of the test, respectively. Using Equation (23) we can express each test score as follows:

$$\tau_i = f_i(s_P)\psi + \theta_i E(s_\tau) + \lambda_i E(t_W) + \beta_i X + \xi_i, \tag{24}$$

where $E(\xi_i) = 0$. Since $E(s_\tau)$ and $E(t_W)$ are uncorrelated with the error term, consistent estimates of the parameters of Equation (24) can be obtained by OLS if we can construct estimates of expected schooling and expected work experience at the time of the test. To this end we employ a two-step procedure that uses the information on completed schooling.

From Equation (20) we obtain that:

$$\begin{aligned} \text{Prob}(I = 1) &= \text{Prob}(s \leq \Delta) \\ &= \text{Prob}\,(u/\sigma_u \leq (\Delta - \gamma Z)/\sigma_u) = \Phi(c), \\ \text{Prob}(I = 0) &= 1 - \Phi(c). \end{aligned} \tag{25}$$

8. Again, this is easy to imagine for English skills, but it may well apply to other areas as well.

9. Again this assumes that individuals begin their schooling at the typical age of 6. We did, however, adjust Δ for whether an individual began school earlier or later than age 6.

The first-stage of our procedure is to estimate the probit given by Equation (25) to obtain $\widehat{\gamma}$ and $\widehat{\sigma}_u$. We use these estimates to construct $\Phi(\widehat{c})$ and $\phi(\widehat{c})$, and then substitute them into Equation (23) and estimate it by OLS. This procedure provides us with consistent coefficient estimates, and the standard errors are corrected using a bootstrap technique.

IV. DATA

The data used in this study are from the NLSY79. Much of the early work on earnings and English proficiency relied on Census data or the 1976 Survey of Income and Education (SIE)—the former because of its large sample size and the latter because of its richness of language-related questions. To our knowledge, the NLSY79 has not been used in economics to study the effects of language background. The singular exception to this is Bleakley and Chin (2008) who use it as a robustness check to the results obtained using data from the Census.[10] We focus our attention on a set of Hispanics who were either born in the United States or migrated here before they were age 7.[11] Our set of Hispanics include Cubans, Mexicans (i.e., Chicanos, Mexicans, and Mexican-Americans), Puerto Ricans, and other Hispanics (i.e., other Hispanics and other Spanish).

The two outcome variables of interest in our analysis are the completed level of schooling and the ASVAB test scores. We consider four of the ASVAB tests which assess an individual's math and verbal skills: (1) arithmetic reasoning; (2) math knowledge; (3) word knowledge; and (4) paragraph comprehension.[12] The primary variable of interest in our empirical implementation is whether a respondent spoke Spanish at home as a child. We constructed this variable by first noting if an individual indicated speaking a language other than English at home as a child, and then if this language was Spanish. The other key explanatory variables of interest are parental schooling levels. Appendix A explains the construction of the data in greater detail and discusses other variables and data sets used in the analysis.

The final sample we use in the empirical strategy is comprised of 1,312 Hispanics—612 males and 700 females. This sample omits non-Hispanics along with Hispanics who migrated to the United States after age 6, as well as any other individuals who were missing information for the relevant variables. A subsample of 624 Hispanics for whom both parents were born in the United States was also used for some of the analysis.

Table 1 provides descriptive statistics for some of the key variables for the selected sample. Descriptive statistics for the entire set of variables are contained in Table A1. Hispanic males (females) comprise 46.6% (53.4) of the overall sample. The majority (65%) of the sample is Mexican. The second largest ethnicity is Puerto Rican (19.4%). Cubans are the smallest group represented (5.4%). About 86% of the sample reports speaking Spanish at home as a child. On average, both parents have completed a little more than 8 years of schooling. On average, the individuals themselves report completing 12.7 years of schooling; 11.2 years of which were completed at the time the ASVAB tests were administered. Those individuals who report speaking Spanish at home as a child complete slightly less school (12.7 years) than those who do not speak Spanish at home (13.1 years), and about the same as those whose parents were born in the United States. Similarly for the ASVAB tests, those who indicate speaking Spanish at home score lower than those who do not. Specifically, there is a 11.3, 9.6, 13.7, and 10.7 percentage point differential for the arithmetic reasoning, math knowledge, word knowledge, and paragraph comprehension tests between the non-Spanish and Spanish speakers. Test scores for those whose parents were both born in the United States were between

10. Other possible data sets include the Early Childhood Longitudinal Study of Kindergartners (ECLS-K), the National Education Longitudinal Study (NELS-88), the Education Longitudinal Study (ELS-02), and the National Adult Literacy Survey (NALS). While these data sets may offer some advantages such as better measures of English fluency, they also have some drawbacks. Among these are that the individuals involved may be very young, or that completed schooling is not observed, or that there is no variability in the age at which respondents were administered the aptitude tests, thus not allowing us to estimate structural test score equations. Nevertheless, in future work it may be valuable to explore such data sets.

11. This latter condition eliminates any complications that may arise from an individual receiving part or all of his education abroad, and from the decision of whether to become fluent in English. For the purposes of this article, we consider Puerto Rico to be a "foreign" country because English is not the primary language.

12. Since 1989 the Department of Defense has used these four tests in constructing a percentile score for the overall Armed Forces Qualification Test (AFQT) and they are also the only four tests used by Hansen, Heckman, and Mullen (2004).

TABLE 1
Select Descriptive Statistics

	Hispanics (Nobs. = 1,312)		Hispanics Who Spoke Spanish at Home as a Child (Nobs. = 1,124)		Hispanics Who Did Not Speak Spanish at Home as a Child (Nobs. = 188)		Hispanics Whose Parents Were Both Born in the United States (Nobs. = 624)		Whites (Nobs. = 2,940)	
Variable	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Academic achievement										
Schooling										
Completed schooling	12.718	2.227	12.662	2.227	13.053	2.198	12.623	2.039	13.288	2.415
Completed schooling at time of test	11.232	1.769	11.184	1.749	11.521	1.860	11.298	1.675	11.797	1.780
Test scores										
Arithmetic reasoning (max = 30)	14.011	6.273	13.524	6.031	16.920	6.895	14.345	6.312	18.594	6.978
Math knowledge (max = 25)	10.621	5.650	10.268	5.450	12.734	6.342	10.601	5.614	14.027	6.229
Word knowledge (max = 35)	21.866	8.013	21.171	7.889	26.021	7.492	22.516	7.874	27.030	6.857
Paragraph comprehension (max = 15)	9.368	3.507	9.145	3.489	10.702	3.322	9.681	3.419	11.303	3.133
Home language background										
1 If spoke Spanish at home as a child	0.857	0.351	1.000	0.000	0.000	0.000	0.764	0.425	0.000	0.000
Ethnicity										
1 If Cuban	0.054	0.226	0.052	0.223	0.064	0.245	0.029	0.168	0.000	0.000
1 If Puerto Rican	0.194	0.396	0.211	0.408	0.096	0.295	0.014	0.119	0.000	0.000
1 If other Hispanic	0.136	0.343	0.099	0.298	0.356	0.480	0.170	0.376	0.000	0.000
1 If Mexican	0.650	0.477	0.676	0.468	0.495	0.501	0.813	0.391	0.000	0.000
Parental schooling										
Mother's schooling	8.368	4.015	7.889	3.969	11.230	2.966	9.378	3.555	11.954	2.311
Father's schooling	8.659	4.413	8.166	4.352	11.609	3.550	9.694	3.913	12.247	3.302
Average parents' schooling	8.514	3.847	8.028	3.769	11.419	2.921	9.536	3.361	12.100	2.517
1 If average parents' schooling < 9	0.479	0.500	0.540	0.499	0.112	0.316	0.349	0.477	0.085	0.278
1 If $9 \leq$ average parents' schooling < 12	0.301	0.459	0.286	0.452	0.388	0.489	0.385	0.487	0.292	0.455
1 If average parents' schooling ≥ 12	0.220	0.415	0.173	0.379	0.500	0.501	0.266	0.442	0.623	0.485

Notes: For the full set of descriptive statistics, see Table A1.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE 2
First-Stage Probit: Select Regression Results for Hispanics

Dependent Variable	**Completed Schooling**		
Estimation Technique	**Probit**		
	(1)	**(2)**	**(3)**
1 If spoke Spanish at home as a child	−0.230 (0.428)	0.004 (0.447)	—
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	0.0694 (0.676)
1 If spoke Spanish at home as a child × 1 If 9 ≤ average parents' schooling <12	—	—	−0.221 (0.498)
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	0.291 (0.572)
Mother's schooling	0.038 (0.060)	0.036 (0.063)	0.033 (0.069)
Father's schooling	0.164*** (0.049)	0.186*** (0.047)	0.186*** (0.057)
1 If mother born abroad × Mother's schooling	0.019 (0.075)	—	—
1 If father born abroad × Father's schooling	−0.068 (0.071)	—	—
Pseudo R^2	0.383	0.430	0.432
Log-likelihood	−554.220	−240.100	−239.112
Nobs.	1,312	624	624

Notes: For full regression results, see Table A2, columns 1, 2, and 3. Standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.

those who spoke Spanish at home and those who spoke only English, but they were closer to the former than the latter. In terms of parental schooling, the parents of those who did not speak Spanish at home average three more years of schooling than those who did. Once again, those whose parents were U.S. born had average parental schooling in between those of the two language groups.

For purposes of comparison, Table 1 also provides information on a selected sample of non-Hispanic whites (for sake of brevity, we will refer to this group as "whites"). This group is comprised of individuals who: (1) are classified as white by the interviewer; (2) report no Hispanic ancestry; (3) are born in the United States and whose parents were born in the United States as well; (4) report only speaking English at home as a child; and (5) lived in a county that included at least one respondent from our Hispanic sample. Whites score higher on all four tests, and have more completed schooling (as do their parents) than not only Hispanics, in general, but also Hispanics who did not speak Spanish at home.

V. ESTIMATION AND RESULTS

The entire set of estimated parameters for the completed schooling Equation (20) obtained from the first-stage estimation of Equation (25), can be found in Table A2, column 1. Our discussion will be limited to the primary variables of interest, namely, speaking Spanish at home as a child and levels of parental schooling. Table 2 presents the coefficient estimates for speaking Spanish at home and parental schooling. Speaking Spanish at home reduces completed schooling, but the effect is small and it is not statistically significant. Similarly for the mother's schooling level, an additional year of maternal schooling increases the respondent's completed schooling by only 0.04 years, and it is also not statistically significant. The effects are quite different for father's schooling. For every additional year of paternal schooling, the respondent's completed schooling rises by 0.16 years, and is statistically significant at the 1% level.[13]

The entire second-stage results corresponding to Equation (23) are contained in Table A3. For each aptitude test we estimated two versions of Equation (23). In the first version, we

13. The effect of parents' schooling in Table 2 refers to the schooling of parents who were born in the United States and who were present when the respondent was aged 14. Table 2 also shows mother's and father's schooling interacted with whether they were born abroad. The interaction of mother's and father's schooling and whether they were absent when the respondent was aged 14 can be found in Table A2, column 1.

set $f_i(s_p) = \alpha_{i0}$, implying that any effect of speaking Spanish at home on test scores would be independent of parental schooling levels.[14] This version was estimated on the entire sample and on a subsample consisting of respondents for whom both parents were born in the United States. In the second version we allow the effect of speaking Spanish at home to vary by parental schooling levels.[15] For reasons given below, this version was estimated only for the subsample of individuals for whom both parents were born in the United States. Highlights of the results are presented in Table 3. The dependent variable in each regression is the standardized test score.[16] For each test the first column presents the selected results for the entire sample when the effect of speaking Spanish at home does not vary by parental schooling level. For the entire sample more schooling at the time the test is administered results in higher test scores for all four tests. An additional year of schooling increases test scores by 0.076–0.118 standard deviations. For potential work experience, however, the results for the math tests are markedly different than for the verbal tests. An additional year of post-schooling experience has little effect on the math scores, whereas it increases the word knowledge and paragraph comprehension test scores by about 0.09 and 0.08 standard deviations, respectively, and both are statistically significant at the 1% level. These results imply that math skills for Hispanics stop improving with the completion of formal schooling, while verbal skills continue to improve at nearly the same pace after entering the labor force as during the schooling/home period.

For parental schooling, we first consider the results when the effects of speaking Spanish at home do not vary with the level of parents' education (see Table 3, columns 1, 4, 7, and 10). The effect of mother's schooling is statistically significant and similar in magnitude (0.03–0.06) across all four tests. Similarly for father's schooling, the coefficients vary little (0.05–0.06) across all four tests and are always statistically significant.[17]

Turning to the variable of most interest, we see from Table 3 that speaking Spanish at home reduces test scores, with the effects being statistically significant at conventional levels for the math tests—arithmetic reasoning and math knowledge—and for word knowledge, but statistically insignificant for paragraph comprehension.[18] To give some sense of the magnitude of these effects, speaking Spanish at home reduces test scores by more than a reduction of 2 years of schooling for the arithmetic reasoning, math knowledge, and word knowledge tests and a little over 1 year for the paragraph comprehension test. To check whether our results were due to the way we treated endogenous schooling in the second-stage regressions, we estimated the same test equations substituting the respondent's age at the time the tests were taken for the expected years of schooling and potential work experience. The results are shown in Table A4. As can be seen, the estimated coefficients on speaking Spanish at home are extremely close to those reported in Table 3 for each of the four tests.

We turn now to investigating the interaction of parental schooling levels with speaking Spanish at home. We believe that during the relevant period individuals of high ability living abroad would have been more likely to be hindered in obtaining education by financial considerations than comparable persons in the United States. It seems likely, therefore, that schooling is a better indicator of ability for those individuals educated in the United States than those educated abroad. For this reason, when looking at the interaction of parental schooling with language spoken at home, we restrict the analysis to individuals whose parents were both born in the United States. A second, and perhaps more important reason for restricting the sample to individuals with U.S.-born parents, is that by doing so we essentially control for the English fluency of the parents. U.S.-born parents are presumably fluent in English.

For purposes of comparison with the results using the entire sample, we estimated both completed schooling and test score equations for

14. The corresponding first-stage probit, whose estimated coefficients are shown in column 1 of Table A2, also does not allow for the effect of speaking Spanish at home to vary with parental schooling levels.

15. The corresponding first-stage probit results are shown in column 3 of Table A3 that allows for the coefficient on speaking Spanish at home to vary by parental schooling levels.

16. The test scores are standardized by the overall mean and standard deviations for the combined Hispanic and white sample.

17. In comparison, Currie and Thomas (1999) using a different data set find a larger effect of maternal schooling than paternal schooling on children's test scores.

18. For paragraph comprehension the coefficient on speaking Spanish at home as a child is statistically significant at the 11% level.

TABLE 3

Second-Stage OLS: Select Regression Results For Hispanics: Exogenous Choice of Home Language

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Expected schooling at time of test	0.118*** (0.030)	0.057 (0.040)	0.049 (0.040)	0.076** (0.030)	0.066 (0.042)	0.055 (0.042)	0.114*** (0.031)	0.062 (0.044)	0.066 (0.043)	0.107*** (0.033)	0.026 (0.046)	0.026 (0.045)
Expected potential experience at time of test	0.025 (0.021)	0.042 (0.027)	0.042 (0.027)	0.012 (0.021)	0.014 (0.027)	0.017 (0.026)	0.086*** (0.023)	0.101*** (0.029)	0.099*** (0.029)	0.077*** (0.022)	0.097*** (0.029)	0.096*** (0.029)
1 If spoke Spanish at home as a child	−0.255*** (0.069)	−0.318*** (0.092)	—	−0.171** (0.070)	−0.146 (0.094)	—	−0.264*** (0.080)	−0.227** (0.097)	—	−0.124 (0.077)	−0.115 (0.102)	—
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	−0.032 (0.131)	—	—	0.087 (0.121)	—	—	−0.244 (0.153)	—	—	−0.059 (0.165)
1 If spoke Spanish at home as a child × 1 If 9 ≤ average parents' schooling <12	—	—	−0.319*** (0.098)	—	—	−0.155 (0.098)	—	—	−0.270** (0.107)	—	—	−0.108 (0.117)
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	−0.444*** (0.126)	—	—	−0.233* (0.136)	—	—	−0.162 (0.123)	—	—	−0.152 (0.122)
Mother's schooling	0.028*** (0.011)	0.031** (0.014)	0.047*** (0.014)	0.038*** (0.011)	0.037*** (0.013)	0.050*** (0.014)	0.058*** (0.012)	0.067*** (0.015)	0.065*** (0.016)	0.046*** (0.013)	0.053*** (0.016)	0.056*** (0.016)
Father's schooling	0.046*** (0.011)	0.047*** (0.013)	0.066*** (0.015)	0.055*** (0.011)	0.058*** (0.014)	0.074*** (0.015)	0.057*** (0.011)	0.073*** (0.015)	0.071*** (0.017)	0.056*** (0.011)	0.069*** (0.014)	0.073*** (0.016)
1 If mother born abroad × Mother's schooling	−0.004 (0.012)	—	—	−0.006 (0.013)	—	—	−0.023* (0.014)	—	—	−0.022 (0.014)	—	—
1 If father born abroad × Father's schooling	−0.031*** (0.011)	—	—	−0.033*** (0.012)	—	—	−0.033*** (0.013)	—	—	−0.025** (0.013)	—	—
R^2	0.200	0.219	0.230	0.188	0.226	0.233	0.259	0.226	0.303	0.199	0.216	0.216
Nobs.	1,312	624	624	1,312	624	624	1,312	624	624	1,312	624	624

Notes: Test scores are standardized. For full regression results, see Table A3. Bootstrapped standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

the subsample of respondents for whom both parents were born in the United States. The complete first-stage estimates, under the assumption that the effects of speaking Spanish at home are independent of parents' schooling levels, appear in column 2 of Table A2, and selected results in column 2 of Table 2. As can be seen, the results are similar for both samples. The complete second-stage results appear in columns 2, 5, 8, and 11 of Table A3, and selected results in Table 3. With the exception of years of schooling, the coefficients reported in the respective columns of Table 3 estimated using the subsample are similar in magnitude to their counterparts estimated using the entire sample. For both samples the coefficients corresponding to speaking Spanish at home as a child are negative for all four tests. When the sample is restricted to children of U.S.-born parents the magnitude is somewhat greater for arithmetic reasoning, and slightly lower for the other three tests.[19] If speaking Spanish at home is serving as a proxy for the lack of fluency in English of parents, we would expect the coefficients on speaking Spanish at home to be significantly smaller in magnitude for the subsample of children whose parents are U.S. born. They are not. Schooling appears to be less important for the subsample of respondents whose parents were born in the United States than for the entire sample, suggesting that schooling is relatively more important for children whose parents may be deficient in English. The exception is years of schooling, which appears to be less important for the subsample of respondents whose parents were born in the United States than for the entire sample.

To investigate how the effect of speaking Spanish at home varies with parents' schooling we let $f_i(s_p)$ in Equation (21) take on distinct values depending on whether the average of both parents' schooling levels s_p is strictly less than 9 years, greater than or equal to 9 but strictly less than 12 years, and greater than or equal to 12 years.[20] The complete first-stage results from this estimation using the subsample of respondents with U.S.-born parents appears in column 3 of Table A2 and selected results in column 3 of Table 2. For the second-stage the complete results appear in columns 3, 6, 9, and 12 of Table A3. The same columns in Table 3 show the selected results. For arithmetic reasoning, math knowledge, and paragraph comprehension, the negative effect on test scores of speaking Spanish at home increases with parents' education. The increase is more pronounced for the two math tests.[21] For word knowledge the effect of speaking Spanish at home as a child is similar for all levels of parents' schooling, though the point estimate is smallest for the highest parental schooling category.[22]

We can also assess the magnitude of the effects of speaking Spanish at home by seeing how much of the white-Hispanic test score differentials it explains. We perform this comparison by first estimating the equivalent of Equation (23) for our sample of whites, and use the results to calculate Blinder-Oaxaca type decompositions.[23] For each test let φ_i represent the parameters of test score Equation (21), and let κ represent the parameters of the probit for the schooling Equation (25).[24] Following the analysis in Bauer and Sinning (2008), we decompose the white-Hispanic test score differentials as follows:

$$
\begin{aligned}
(26)\quad & E_{\varphi_{w_i},\kappa_w}(\tau_{w_i}|Z_w, X_w, \Delta_w) \\
& - E_{\varphi_{h_i},\kappa_h}(\tau_{h_i}|Z_h, X_h, \Delta_h, s_p, \psi) \\
& = [E_{\varphi_{w_i},\kappa_w}(\tau_{w_i}|Z_w, X_w, \Delta_w) \\
& \quad - E_{\varphi_{w_i},\kappa_h}(\tau_{h_i}|Z_h, X_h, \Delta_h, s_p, \psi)] \\
& \quad + [E_{\varphi_{w_i},\kappa_h}(\tau_{h_i}|Z_h, X_h, \Delta_h, s_p, \psi) \\
& \quad - E_{\varphi_{h_i},\kappa_h}(\tau_{h_i}|Z_h, X_h, \Delta_h, s_p, \psi)]
\end{aligned}
$$

19. Not surprisingly, standard errors are larger, and statistical significance lower, in the subsample as it contains less than 50% of the number of observations in the unrestricted sample.

20. Note that we used alternative definitions of parental schooling levels (i.e., minimum, maximum) and the results are virtually unchanged.

21. It is also the case that the differences between the two higher parental schooling levels and the lowest one are statistically significant only for the math tests.

22. The reader may have noticed that when we interact father's and mother's schooling with speaking Spanish at home we first take the average of the two, and then convert it into a categorical variable, while elsewhere in the test score regressions and the schooling equation that we estimate with a probit, father's and mother's schooling appear separately and are continuous. This was done simply to reduce the number of parameters that we needed to estimate. Similar results are obtained if only categorical or continuous versions of parental schooling are instead used throughout.

23. A description of the procedure used for estimating Equation (23) for whites appears in Appendix B. The only difference from the approach used for Hispanics is that for whites we correct for censoring.

24. κ also includes the parameters from the probits used to correct for censoring for whites. See Appendix B for further details.

where the subscripts w and h stand for white and Hispanic, respectively, and the subscripts on the expectation operator show the parameters used when computing an expectation. The first term on the right-hand side of Equation (26) is the difference due to covariates, and the second term is the difference due to parameters.

Table 4 shows the decomposition of white-Hispanic standardized test score differentials into differences due to covariates and parameters. The decomposition shown in the first panel is based on the model that was estimated for the entire sample and that does not allow the effect of speaking Spanish at home to vary with parental schooling levels. As can be seen, differences in covariates account for most of the white advantage in test scores. Most of the difference due to covariates is in turn accounted for by parental schooling. Differences in parameters are small and for two tests—math knowledge and paragraph comprehension—actually favor Hispanics. On all four tests, speaking Spanish at home handicaps Hispanics from 0.11 to 0.23 standard deviations. It accounts for 34% of the white-Hispanic differential for arithmetic reasoning, 33% for word knowledge, 27% for math knowledge, and 19% for paragraph comprehension. Parameter differences, excluding speaking Spanish at home, actually favor Hispanics on all four tests. The second decomposition shown in Table 4 is based on coefficients estimated using the subsample of respondents whose parents were both born in the United States. The most notable change from the previous decomposition is that parental schooling accounts for a smaller share of the difference due to covariates than when the entire sample is used. This is to be expected, as the schooling levels of U.S.-born parents is on average higher. The third panel in Table 4 shows the decompositions based on estimates derived from the subsample, and allowing the effect of speaking Spanish to vary by parental schooling levels.[25] As can be seen, for the math tests the importance of speaking Spanish at home is reduced. The reason for this is a combination of a negative effect of speaking Spanish at home that increases in magnitude with the level of parental schooling for both math tests, and schooling parameter differences that are evaluated at Hispanic means, which for parental schooling are much lower for Hispanics than for whites.[26]

25. Panel three shows only those decompositions that differ from those shown in panel. Since differences due to covariates depend on white parameters and Hispanic weights, they are the same in both decompositions, as are the total differences due to parameters.

VI. ENDOGENOUS CHOICE OF HOME LANGUAGE

So far we have treated whether a family speaks Spanish at home as exogenous. The concern is that the main variable of interest may be related to some unobserved characteristic of families that negatively impacts test scores, and that we have misattributed its effects to speaking Spanish at home. It is possible, for example, that families who in the 1960s and 1970s were more concerned with the education of their children, tended to speak only English at home. If this was the case, then the effect of this unobserved, heightened concern for education would be incorrectly attributed to the language spoken at home.[27] The reverse, of course, is just as plausible. It may well be that families that emphasize education are also more likely to value their children being able to speak a second language, or have stronger loyalty to their ancestral culture. If this was the case, then we may well have underestimated the negative effects on test scores of speaking Spanish at home. In this section, we develop and implement a model where speaking Spanish at home is endogenous.

Without altering the human capital acquisition process of our model, if families are going to speak Spanish at home even when it reduces their children's human capital, it must be because they place some value on doing so. Let $v(s, \psi; Z_h)$ be the net present value of income introduced in Section IIB, where Z_h is a vector of variables other than ψ that can affect the acquisition of human capital. In that section we treated ψ ($\psi = 1$ if Spanish was spoken at home) as exogenous. Suppose now that the family values income and speaking Spanish. It is then interested in choosing s and ψ so as to maximize a more general utility function:

$$U(\psi, v(s, \psi; Z_h); Z_s), \tag{27}$$

where Z_s is a vector of variables that affects a family's tastes for speaking Spanish at home.

26. This is the well-known index problem with the Blinder-Oaxaca decomposition method.

27. This raises the question of why such families wished to avoid speaking Spanish in the first place. Did they believe that doing so would handicap their children in some way? It also suggests that speaking Spanish at home would have a stronger effect on years of completed schooling than on test scores, which is not what we found in the previous section.

TABLE 4

Blinder-Oaxaca Decompositions for Standardized Test Scores: Exogenous Choice of Language

	Arithmetic Reasoning	Math Knowledge	Word Knowledge	Paragraph Comprehension
	(1)	**(4)**	**(7)**	**(10)**
Based on Regressions for Entire Hispanic Sample Where Effect of Speaking Spanish at Home Does Not Vary with Parental Schooling				
Covariates				
Parental schooling	0.328	0.350	0.384	0.320
Other covariates	0.244	0.329	0.249	0.260
Total covariates	0.573	0.679	0.633	0.580
Parameters				
Speaking Spanish at home	0.218	0.147	0.226	0.106
Parental foreign birth	−0.148	−0.248	−0.280	−0.193
Other parameters	0.004	−0.034	0.100	0.082
Total parameters	0.074	−0.135	0.046	−0.006
Total	0.647	0.545	0.679	0.574
	Arithmetic Reasoning	**Math Knowledge**	**Word Knowledge**	**Paragraph Comprehension**
	(2)	**(5)**	**(8)**	**(11)**
Based on Regressions for Hispanic Subsample with Both Parents Born in the United States and Where Effect of Speaking Spanish at Home Does Not Vary with Parental Schooling				
Covariates				
Parental schooling	0.218	0.231	0.225	0.181
Other covariates	0.238	0.316	0.225	0.232
Total covariates	0.456	0.548	0.450	0.413
Parameters				
Speaking Spanish at home	0.243	0.111	0.173	0.088
Other parameters	−0.099	−0.110	−0.030	−0.019
Total parameters	0.143	0.001	0.143	0.068
Total	0.600	0.549	0.593	0.481
	Arithmetic Reasoning	**Math Knowledge**	**Word Knowledge**	**Paragraph Comprehension**
	(3)	**(6)**	**(9)**	**(12)**
Based on Regressions for Hispanic Subsample with Both Parents Born in the United States and Where Effect of Speaking Spanish at Home Does Vary with Parental Schooling				
Parameters				
Speaking Spanish at home	0.168	0.051	0.182	0.073
Other parameters	−0.025	−0.050	−0.039	−0.005

Notes: For full regression results, see Tables A3 and A6.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

The solution to the maximization of Equation (27) is a pair of equations, $s(Z)$ and $\psi(Z)$, where $Z = (Z_h, Z_s)$.

For the empirical implementation, we maintain as much of the previous structure as possible. Essentially, this means that ψ is replaced with $P[\psi = 1]$ in Equation (23). Let us assume that:

$$\psi(Z) = \begin{cases} 1, & \text{if } \delta Z + u_s \geq 0 \\ 0, & \text{if } \delta Z + u_s < 0. \end{cases} \tag{28}$$

Then the probability Spanish is spoken at home is

$$P[\psi(Z) = 1] = P[u_s \geq -\delta Z] = 1 - \Phi(-\delta Z), \tag{29}$$

where we have assumed that $u_s \sim N(0, 1)$. The schooling equation, which takes on the same form as before, is

$$s(Z) = \gamma Z + u_h. \tag{30}$$

Thus, the probability that an individual has completed his schooling at the time the test is given remains:

$$P[s(Z) \leq \Delta] = P\left[u_h/\sigma_h \leq (\Delta - \gamma Z)/\sigma_h\right] = \Phi(c). \tag{31}$$

The expected test score for test i is now given by:

$$\begin{aligned} E(\tau_i) = {} & f_i(s_p)[1 - \Phi(-\delta Z)] \\ & + \theta_i[\Delta(1 - \Phi(c)) + \gamma Z \Phi(c)] \\ & + \lambda_i[(\Delta - \gamma Z)\Phi(c) + \sigma_h \phi(c)] + \beta_i X. \end{aligned} \tag{32}$$

Our first-stage procedure now consists of estimating Equations (29) and (31) as a bivariate probit to obtain $\widehat{\delta}$, $\widehat{\gamma}$, and $\widehat{\sigma}_h$. We then use these to construct $\phi(\widehat{c})$ and $\Phi(\widehat{c})$ and substitute them into Equation (32), which we estimate by OLS. As before, the standard errors are corrected using a bootstrap technique.

To prevent our identification from relying solely on functional forms, we need to have some variables that affect a family's taste for speaking Spanish at home, but do not directly affect the test scores. That is, there need to be some variables in Z_s that are not included in Z_h. We use three variables to this end. The first is the percent of Hispanics residing in the county where the respondent lived at age 17. The idea is that families in which the parents have poor English skills or put more value on their children growing up in areas with a greater Hispanic influence are more likely to settle in communities with a large Hispanic population. A concern with excluding the percent Hispanic variable from the test score equations is that it may be correlated with community attributes that directly affect test scores. It may be the case, for example, that Hispanics tend to live in poorer communities that have lower quality schools. To investigate this possibility, we included the percent Hispanic in the test score regressions for our sample of whites. We found that the coefficient on percent Hispanic was virtually 0 for arithmetic reasoning, math knowledge, and paragraph comprehension, and it was positive and significant at the 10% level for word knowledge. It does not appear to be the case, therefore, that percent Hispanic is a proxy for lower quality of schools or for some other community attribute that would directly lower test scores. A second variable we use is one that we believe captures how closely an individual identifies with his Hispanic ancestry. We have termed this measure "Hispanicity." The NLSY79 allowed respondents to list up to six ethnic identities. For this study we classified an individual as Hispanic if he or she listed a Hispanic ethnicity among the first four. Individuals reporting only Hispanic ethnicities, or reporting them earlier on the list, were considered more Hispanic. For example, an individual who only reports being Mexican is considered "more" Hispanic than an individual who first reports being Irish and then indicates being Mexican. It is less clear than with the variable percent Hispanic how the Hispanicity variable would directly affect the test scores, but perhaps it is correlated with family resources, even after controlling for other covariates. We investigated this possibility by regressing the log of family income on the indicator variables "moderately Hispanic" and "more Hispanic," and the family characteristic variables included in the test score equations, using a sample of Hispanics who were aged 16 or younger at the start of the NLSY79.[28] The coefficients on the two Hispanicity variables were small, statistically insignificant, and not even of consistent sign. Finally, for the third

28. When the NLSY79 began in 1979, the respondents were between ages 14 and 22. Consequently, many respondents could have been living on their own at this point and so questions referring to an individual's family are somewhat ambiguous. In our attempts to ensure that the family income measures corresponded to individuals who were still living with their families, we focused our attention on individuals aged 16 and younger. This exercise greatly reduces the sample size, however.

variable we constructed an indicator variable that takes on the value of "1" if either the mother or father was born abroad, "0" otherwise. We believe that whether Spanish is spoken at home depends more on the level of fluency of the parent with the poorest English skills, as opposed to the average level of fluency of the parents. Presumably, parents who are foreign-born are more likely to have poorer English skills. Since we are already controlling for foreign birth of the parents in the test score equations, we saw no reason to be concerned about this new indicator variable having a direct effect on test scores.[29] For more detail on the construction of these variables, please refer to Appendix A.

Since we are now treating speaking Spanish at home as an endogenous variable, the first-stage results of the bivariate probit are of less interest. The complete results can be seen in columns 4–7 of Table A2. Columns 4 and 6 show the coefficients for the schooling and probability of speaking Spanish at home equations, respectively, estimated using the entire sample. Columns 5 and 7 show the corresponding results when the subsample of respondents whose parents were born in the United States is used. We simply point out here that in the probability of speaking Spanish at home, Equation (29), the percent Hispanic in the county of residence at age 17 and the measures of the degree of Hispanicity are of the expected sign and statistically significant at the 1% level.

Table 5 presents selected independent variables of interest for Equation (32); the entire second-stage results can be found in Table A5. Once again, we estimated two versions of the aptitude test score equations: one where we did not allow the effect of speaking Spanish at home to vary by parental schooling levels, and one where it did. The first version was estimated using both the entire sample (columns 1, 4, 7, and 10 in Tables 5 and A5), and the subsample of respondents whose parents were both born in the United States (columns 2, 5, 8, and 11 in Tables 5 and A5). The second version was estimated only on the subsample. For variables not involving the probability of speaking Spanish at home as a child, the estimated coefficients in Table 5 are quite similar in magnitude and statistical significance to the corresponding estimates in Table 3, where the choice of home language was treated as exogenous. Treating home language as endogenous has a substantial effect on the coefficient estimates for those variables that include speaking Spanish at home as a child, however. A comparison of the estimates in Table 5 with those in Table 3 shows that treating home language as endogenous amplifies the effect on test scores of speaking Spanish at home.

When we use the entire sample and do not allow the effect of speaking Spanish at home to vary by parents' schooling levels, the coefficients on speaking Spanish at home in Table 5 are from two to over three times the magnitude of their counterparts in Table 3, and they are all statistically significant at conventional levels.[30] Speaking Spanish at home is now estimated to reduce test scores by the equivalent of 4.3 to 6.2 fewer years of schooling.[31] When the subsample is used, the coefficient estimates for speaking Spanish at home as a child are similar in magnitude to those estimated on the entire sample, though statistical significance levels tend to be lower.[32] Table 6 presents the Blinder-Oaxaca decompositions. As can be seen, speaking Spanish at home accounts for somewhere between 59 and 97% of the white-Hispanic differential when the entire sample is used.[33]

When we allow the effect of speaking Spanish at home to vary with parents' schooling, we also obtain that speaking Spanish at home has a stronger negative effect on all four test scores and for all three parental schooling levels than when we treated speaking Spanish as exogenous. For arithmetic reasoning, math knowledge, and paragraph comprehension, we find once again that the negative effects of speaking Spanish at home rise with the level of parents' schooling, but the increase is more moderate than when home language was treated as exogenous.[34]

29. Note also that Equation (29) omits the male interactions with absent father and number of siblings. The decision to speak Spanish at home depends on the characteristics of the family, and not necessarily on a child's sex.

30. In Table 3 the estimated coefficient on speaking Spanish at home for paragraph comprehension was only statistically significant at the 11% level.

31. For arithmetic reasoning, 6.2; for math knowledge, 4.7; for word knowledge, 4.5; and for paragraph comprehension, 4.3 years.

32. Once again, the similarity in the coefficients on speaking Spanish at home suggests that it is not a proxy for the English fluency of the parents.

33. For arithmetic reasoning, 97%; for math knowledge, 62%; for word knowledge, 65%; and for paragraph comprehension, 62% of the gap is explained.

34. The difference between the second highest parental education category and the lowest is statistically significant at the 5% level for arithmetic reasoning and at the 10% for math knowledge. For arithmetic reasoning, the difference between the highest and lowest parental schooling levels is also statistically significant at the 10% level.

TABLE 5

Second-Stage OLS: Select Regression Results for Hispanics—Endogenous Choice of Home Language

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Expected schooling at time of test	0.118***	0.062	0.056	0.080***	0.073*	0.070*	0.114***	0.062	0.064	0.097***	0.022	0.020
	(0.029)	(0.039)	(0.039)	(0.030)	(0.039)	(0.039)	(0.031)	(0.043)	(0.043)	(0.032)	(0.044)	(0.044)
Expected potential experience at time of test	0.021	0.032	0.033	0.007	0.008	0.007	0.082***	0.097***	0.096***	0.081***	0.096***	0.096***
	(0.020)	(0.026)	(0.026)	(0.021)	(0.026)	(0.026)	(0.022)	0.029)	(0.029)	(0.022)	(0.028)	(0.028)
1 If spoke Spanish at home as a child	−0.731***	−0.882***	—	−0.379**	−0.274	—	−0.518***	−0.516**	—	−0.413**	−0.434*	—
	(0.165)	(0.214)		(0.176)	(0.221)		(0.173)	(0.238)		(0.180)	(0.231)	
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	−0.591**	—	—	−0.069	—	—	−0.511*	—	—	−0.380
			(0.250)			(0.241)			(0.291)			(0.288)
1 If spoke Spanish at home as a child × 1 If 9 ≤ average parents' schooling <12	—	—	−0.877***	—	—	−0.307	—	—	−0.543**	—	—	−0.430*
			(0.216)			(0.222)			(0.243)			(0.240)
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	−0.947***	—	—	−0.258	—	—	−0.471*	—	—	−0.451*
			(0.240)			(0.250)			(0.257)			(0.244)
Mother's schooling	0.018	0.019	0.035**	0.033***	0.034**	0.043***	0.052***	0.061***	0.060***	0.040***	0.047***	0.050***
	(0.011)	(0.015)	(0.015)	(0.011)	(0.014)	(0.014)	(0.013)	(0.016)	(0.018)	(0.013)	(0.017)	(0.017)
Father's schooling	0.039***	0.040***	0.058***	0.051***	0.056***	0.067***	0.053***	0.070***	0.069***	0.054***	0.066***	0.070***
	(0.011)	(0.014)	(0.016)	(0.012)	(0.014)	(0.015)	(0.012)	(0.016)	(0.017)	(0.011)	(0.014)	(0.018)
1 If mother born abroad × Mother's schooling	0.006	—	—	−0.001	—	—	−0.018	—	—	−0.016	—	—
	(0.013)			(0.013)			(0.015)			(0.015)		
1 If father born abroad × Father's schooling	−0.024**	—	—	−0.030**	—	—	−0.029**	—	—	−0.021*	—	—
	(0.012)			(0.012)			(0.013)			(0.013)		
R^2	0.204	0.226	0.233	0.188	0.226	0.230	0.257	0.302	0.302	0.201	0.219	0.219
Nobs.	1,312	624	624	1,312	624	624	1,312	624	624	1,312	624	624

Notes: Test scores are standardized. For full regression results, see Table A5. Bootstrapped standard error in Parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE 6

Blinder-Oaxaca Decompositions for Standardized Test Scores: Endogenous Choice of Language

	Based on Regressions for Entire Hispanic Sample Where Effect of Speaking Spanish at Home Does Not Vary with Parental Schooling			
	Arithmetic Reasoning	**Math Knowledge**	**Word Knowledge**	**Paragraph Comprehension**
	(1)	**(4)**	**(7)**	**(10)**
Covariates				
Parental schooling	0.328	0.350	0.384	0.320
Other covariates	0.244	0.329	0.249	0.260
Total covariates	0.573	0.679	0.633	0.580
Parameters				
Speaking Spanish at home	0.626	0.324	0.443	0.354
Parental foreign birth	−0.170	−0.257	−0.291	−0.207
Other parameters	−0.382	−0.201	−0.106	−0.152
Total parameters	0.074	−0.135	0.046	−0.006
Total	0.647	0.545	0.679	0.574
	Based on Regressions for Hispanic Subsample with Both Parents Born in the United States and Where Effect of Speaking Spanish at Home Does Not Vary with Parental Schooling			
	Arithmetic Reasoning	**Math Knowledge**	**Word Knowledge**	**Paragraph Comprehension**
	(2)	**(5)**	**(8)**	**(11)**
Covariates				
Parental schooling	0.218	0.231	0.225	0.181
Other covariates	0.238	0.316	0.224	0.231
Total covariates	0.456	0.547	0.450	0.413
Parameters				
Speaking Spanish at home	0.672	0.209	0.393	0.331
Other parameters	−0.529	−0.208	−0.249	−0.262
Total parameters	0.144	0.001	0.143	0.069
Total	0.600	0.548	0.593	0.481
	Based on Regressions for Hispanic Subsample with Both Parents Born in the United States and Where Effect of Speaking Spanish at Home Does Vary with Parental Schooling			
	Arithmetic Reasoning	**Math Knowledge**	**Word Knowledge**	**Paragraph Comprehension**
	(3)	**(6)**	**(9)**	**(12)**
Parameters				
Speaking Spanish at home	0.587	0.150	0.392	0.315
Other parameters	−0.443	−0.149	−0.249	−0.246

Notes: For full regression results, see Tables A5 and A6.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

For word knowledge, the effect of speaking Spanish at home continues to show no trend with respect to parental schooling levels.

As can be seen from the Blinder-Oaxaca decompositions in the third panel of Table 6 for arithmetic reasoning, math knowledge, and paragraph comprehension, speaking Spanish at home has a smaller effect on tests scores when the effect of that variable is allowed to vary with parents' schooling, than when it is not. The reason for this is once again that those are the three tests for which the negative effect of speaking Spanish at home increases in magnitude with parental schooling, and parameter differences are weighted by the lower average education of Hispanic parents.

VII. HISPANIC SELF-IDENTIFICATION ACROSS GENERATIONS

In a series of papers, Duncan and Trejo (2009, 2011a, 2011b, 2011c) argue that as Hispanics intermarry with non-Hispanics their offspring are less likely to identify themselves as being of Hispanic ancestry. Furthermore, at least among Hispanics of Mexican ancestry, those who intermarry, as well as their offspring, have substantially higher levels of education. Consequently, some of the most successful individuals of Mexican ancestry are systematically not identifying themselves as such, giving us the impression that the American descendants of Mexican immigrants have made less progress than they in fact have.

The NLSY79 did not rely exclusively on self-identification to determine a person's Hispanic background. An individual was classified as Hispanic if he or she identified himself or herself as Hispanic, or if the householder or the householder's spouse reported speaking Spanish at home as a child, or if the family surname appeared on the Census list of Spanish surnames. The NLSY79 also allowed respondents to list up to six ethnicities, which along with the supplemental ways of identifying Hispanics should have helped reduce the tendency to underreport more distant Hispanic ancestries.[35] A rough comparison of summary data from the follow-up interview to the 1970 Census, as reported in Duncan and Trejo (2011a) with our sample suggests that this is in fact the case.

35. We defined as Hispanic anyone listing one of the first four ethnicities as a Hispanic one.

The re-interview survey for the 1970 Census obtained detailed information on ancestors from Spanish-speaking countries for a small sample of persons.[36] It identified 369 persons as being of Hispanic ancestry. Of these, 77 were born abroad, leaving 292 second- and later-generation Hispanics. Assuming that all Hispanics born abroad (first generation) had Hispanic ancestry on both sides of the family, we can further subdivide the U.S.-born individuals into those with Hispanic ancestry on both sides of the family (189), and those with Hispanic ancestry on only one side (103).[37] In the re-interview following the 1970 Census, 35% of U.S.-born Hispanics had Hispanic ancestry on only one side of the family. Virtually all those with Hispanic ancestry on both sides of the family identified themselves as Hispanics in the Census (97%), but only 21% of those with Hispanic ancestry on only one side did. Had Hispanic identity been based purely on self-identification as in the Census, we would have expected a sample of 183 persons with Hispanic ancestry on both sides of the family, and just 22 persons with Hispanic ancestry on only one side. The latter would be expected to account for under 11% of U.S.-born Hispanics in the sample. In the NLSY79 we are not able to determine if an individual has Hispanic ancestry on only one side of the family, because the NLSY79 does not report the ethnicity of the parents. The closest we can get to this notion seems to be whether or not an individual reports a non-Hispanic ethnicity. Of the 1,127 U.S.-born Hispanics in our sample, 236 or 21%, report a non-Hispanic ethnicity. This number is roughly between the 35% with Hispanic ancestry on only one side of the family reported in the follow-up interview to the 1970 Census, and the 11% that would have been estimated if Hispanic ancestry had been determined purely on the basis of self-identification.

For U.S.-born Hispanics in our sample, Table 7 shows parental schooling levels and home language environment according to whether the individual was exclusively Hispanic or reported a non-Hispanic ethnicity. As can be seen, those with some non-Hispanic ancestry had substantially higher levels of parental

36. All information concerning the re-interview survey for the 1970 Census was obtained from Duncan and Trejo (2011a).

37. The micro data that would allow us to make the exact calculations is no longer available (Duncan and Trejo, 2011a).

TABLE 7
Parental Schooling, Home Language, and Ethnic Background

Ethnic Background	Nobs.	Mother's Schooling (%)	Father's Schooling (%)	Spoke Spanish at Home as a Child (%)
Hispanic exclusively	891	7.87	8.07	93
Hispanic and non-Hispanic	236	11.35	11.71	50

Source: NLSY79.

schooling, a finding that is consistent with those of Duncan and Trejo (2011a) for Mexican-Americans of mixed heritage families. They were also much less likely to have spoken Spanish at home as children. These are the types of individuals we found performed best on the aptitude tests.

We can think of interpreting our results vis-à-vis Duncan and Trejo's (2011a) finding that much economic progress and assimilation among Hispanics takes place through intermarriage with non-Hispanics in the following way: A non-Hispanic parent makes it much less likely that Spanish will be spoken in the home. Consequently, an important way by which intermarriage with non-Hispanics increases acculturation and raises achievement is by making it less likely that Spanish will be spoken at home. One could counter that the process of intermarriage with non-Hispanics selects Hispanics of higher ability, and that not speaking Spanish at home is simply an indicator for such intermarriages. This explanation, however, would be insufficient as even among those who report non-Hispanic ethnicities parental education levels and test scores are higher for those who did not speak Spanish at home as children than those who did. A selection explanation would require that even among Hispanics who intermarry with non-Hispanics, those who are of higher (unobserved) ability tend to be the ones who form households where Spanish is not spoken.[38] Their children would proceed to perform better on aptitude tests because of their superior inheritance, not their home language environment.[39] We are skeptical that a selection explanation can account for the large effects we found in the previous section, especially in light of the fact that we found that speaking Spanish at home was not associated with higher levels of schooling. Data limitations of the NLSY79, however, do not allow us to pursue this further.

VIII. SUMMARY AND CONCLUSIONS

In this article we have provided a formal model of the accumulation of traditional human capital and English fluency which leads to the joint determination of aptitude test scores and years of schooling. In our model, speaking Spanish at home when parents are capable of speaking English will slow down the acquisition of English fluency and traditional human capital. This will result in lower aptitude test scores that we interpret as measures of various types of human capital. The implications for completed schooling levels are ambiguous, since lowering the rate at which an individual can accumulate human capital reduces both the marginal benefits and costs of remaining in school.

Our primary empirical findings are consistent with our theoretical model. When treating the choice of home language as exogenous we find negative and statistically significant effects of speaking Spanish at home for three of the four test scores: arithmetic reasoning, math knowledge, and word knowledge. The magnitude of the effects are equivalent to a reduction of about 2 years of schooling, and can account for between 19% and 34% of the gap between whites and Hispanics in these three test scores. We also find that the magnitude of the effect increases with parents' schooling for three of the tests. This result is consistent

38. By unobserved we mean not measured by observables such as parents' years of schooling.

39. Kao and Tienda (1995) actually find (using a data set comprised of eighth graders) that second-generation immigrants perform better on a math and reading aptitude test than later generations (1.2 and 1.0 points better for comparison, Hispanics scored 3.7 points less than whites, and blacks 6.0 less). The results are weaker for Hispanics where the second generation scored 0.8 points higher on the math test and 0.2 points lower on the reading test than later-generation Hispanics. Both differences are small and are not statistically significant. The results of Kao and Tienda (1995) suggest that speaking English exclusively is not a proxy for higher ability, later-generation individuals.

with the notion that more-educated parents face higher opportunity costs of speaking Spanish at home.

When we treat choice of home language as endogenous, the estimated effects of speaking Spanish at home remain negative, increase substantially in magnitude, and are statistically significant at conventional levels for all four aptitude tests. This is consistent with the notion that those families that were particularly concerned with their children's education and skills were more likely to speak Spanish at home. Consequently, treating the choice of home language as exogenous understates the negative effects of speaking Spanish at home. Modeling the choice of home language as endogenous, we find that speaking Spanish at home reduces test scores by the equivalent of between 4.3 and 6.2 years of schooling, and can account for between 59% (math knowledge) and 97% (arithmetic reasoning) of the gap in test scores between whites and Hispanics. All our results on the impact on test scores and years of schooling pertain only to the speaking of Spanish at home. Similar effects may not exist for the learning of a second language outside the home, whether during or after the critical period.

Although not the primary focus of this article, we found some interesting similarities and differences between the math and verbal tests. Contrary to our initial expectations, speaking Spanish at home does not seem to have a uniformly larger effect on either the math or verbal test scores.[40] In other respects the impact of home language on test scores differs noticeably. First, for Hispanics the accumulation of math skills seems to end with formal schooling, while the rate of accumulation of verbal skills appears to continue at nearly the same pace after entering the labor force.[41] Second, the magnitude of the reduction in test scores from speaking Spanish at home rises more sharply with parents' schooling for math than for verbal tests. We believe these two findings are consistent with each other. They suggest that the acquisition of verbal skills is less dependent than the acquisition of math skills on formal education, which can be more deeply affected by speaking Spanish at home.

40. We suspect most people, like ourselves, would have expected a stronger effect for the verbal than for the math tests.

41. Or alternatively, perhaps for most occupations, the returns to learning additional math are much lower than the returns to learning additional English.

All empirical work is constrained by data limitations, and ours is no different. We are particularly concerned that the NLSY79 does not contain any direct measures of the English fluency of the parents or the relevant household income. The problem with the latter arises because some individuals first appear in the NLSY79 when they are already living independently of their parents. The household incomes of such individuals are not comparable to those still living with their parents. This is the main reason we chose not to use household income as an explanatory variable. Furthermore, our measure of Spanish-language background is rather crude. For example, we do not know how intensively Spanish was spoken at home and by whom, nor the fluency in English and Spanish of the parents. There are many ways of speaking Spanish at home, and they may have different effects on aptitude test scores. It may make a significant difference, for example, if Spanish is spoken exclusively, or if both languages are spoken at home. Of less concern, at least to us, is that the NLSY79 is an older data set, and it is conceivable that the relationship between home language, schooling, and test scores among Hispanics has changed over time. The remedy for these shortcomings may be to use one of the more recent data sets mentioned in Section V. As we stated previously, those data sets have their own drawbacks but they would at least allow us to determine if our results are due to the shortcomings of the NLSY79. We leave this for future work.

Finally, in this article we have not addressed the interesting question of the effect of home language on labor market earnings. Even if speaking Spanish at home reduces aptitude test scores, as we have found in this paper, it still may be the case that there is a positive return in terms of higher wages for bilingual individuals. This is the finding of Saiz and Zoido (2005), who estimate that recent college graduates who have a "conversational knowledge" of a foreign language have gross earnings that are 2% to 3% higher than those who do not. What the net effect of speaking Spanish at home is on labor market earnings is a question for which the NLSY79 is well suited and one which we also leave for future investigation.

APPENDIX A: DATA

As stated above, the primary data used for the analysis come from the NLSY79. The NLSY79 consists of 12,686

young men and women, living in the United States, who were between the ages of 14 and 22 when the survey was first conducted in 1979. We focus our analysis on a set of Hispanics who were born in the United States or migrated to the United States before the age of 7. The NLSY79 respondents are asked their ethnicity in a series of six questions which identify their first (or only) through sixth ethnic identity. We focus on the first four questions which should account for paternal and maternal grandparents. We have constructed these ethnic variables such that they are mutually exclusive categories and we have identified an individual's Hispanic ethnicity as the first one indicated. We also created a variable to measure one's degree of "Hispanicity." An individual is classified as being "very" Hispanic if the only ethnicity he or she reports is Hispanic or if his or her first and second ethnic identities are Hispanic, "moderately" Hispanic if either of his or her first two ethnicities are Hispanic, and "less" Hispanic if only his or her third or fourth ethnicity indicated is Hispanic. The first category is intended to mainly include individuals for whom both parents are Hispanic, but also would include individuals whose only known parent is Hispanic. The second category is intended to include individuals for whom only one of the two known parents is Hispanic. The third category is intended to include those not in the first two categories, for whom at least one grandparent is Hispanic. Respondents are asked if they were born in the United States or outside the United States. For those individuals who were born abroad, there is a question eliciting year of entry into the United States. This, coupled with the respondent's birth year, helped us identify individuals who moved here before the age of 7.

As stated earlier in the paper, the two outcome variables of interest in our analysis are the completed level of schooling and the ASVAB test scores. The final schooling level is constructed using the longitudinal data on highest grade completed, highest degree earned, enrolment status, and age. We followed Hansen, Heckman, and Mullen (2004) in the construction of this variable. Final schooling levels were constructed primarily using information on highest degree ever received in the most recent year such information was recorded. This question was asked beginning in 1988.[42] For individuals who were aged 25 and above, if the highest degree ever received was: (1) an associate's degree, the individual was assigned 14 years of schooling; (2) a bachelor's degree, the individual was assigned 16 years of schooling; (3) a master's degree, the individual was assigned 18 years of schooling; and (4) a doctoral or professional degree, the individual was assigned 20 years of schooling. For individuals who indicated earning a high school diploma, but completed more than 12 years of schooling, we assigned them the years of completed schooling (provided it was less than 16 years). For individuals lacking degree information but who completed at least 12 years of school, we assigned them the highest grade completed. For individuals who were aged 21 and above, if they indicated holding a high school diploma then they were assigned 12 years of schooling. For individuals who were missing degree information and completed less than 12 years of schooling, we assigned them the years of schooling completed. There were 36 people who remained; we were able to make reasonable judgments on 22 of these cases, and assigned them a number for the years of schooling completed.[43,44]

The second, and primary, outcome variables of interest are the ASVAB test scores. The ASVAB test was administered to 11,914 (i.e., 94%) civilian and military NSLY79 respondents in 1980 and consists of 10 sections.[45] We standardize these test scores using the pooled Hispanic and white sample averages and standard deviations, and focus our attention on two math tests (arithmetic reasoning and math knowledge) and two verbal tests (word knowledge and paragraph comprehension) for reasons mentioned previously.

The other controls used in our analysis are as follows:[46] Family background measures include maternal and paternal schooling, the number of siblings, and whether an individual came from a "broken" home.[47] In order to maintain as large a sample as possible, we impute values for parental schooling when it is missing. We do so by regressing father's (mother's) schooling on his (her) spouse's schooling (to address the possibility of assortive mating), variables indicating being born abroad, and interactions with the ethnic indicators, along with some other controls. The predicted value is then imposed when information is missing on the father's (mother's) schooling level. A broken home is defined as one in which, at age 14, a respondent lived with someone other than his or her mother and father.[48] We also control for whether a respondent's mother or father was absent when he or she was aged 14.[49] We control for parental country of birth with a variable indicating whether the birth was in a foreign country.[50] Our regional controls include

42. Note that the NLSY79 was an annual survey from 1979–1994 and from 1996–2000 the interviews were conducted biennially.

43. For example, we encountered an individual who was age 21 in 1979 when the survey began. For years 1979–1987 he or she indicated having completed 9 years of schooling. From 1988–1991, he or she reported 11 years. In 1992 he or she noted 13 years and from 1993-2000 he or she indicated 12 years. The information on highest degree completed was always missing. He or she also indicated not having a high school diploma or its equivalent for all years in the survey. Accordingly, we assigned this individual 12 years of schooling.

44. Similarly for the whites, we were able to reasonably eyeball 186 of 318 cases and assign a level of completed schooling.

45. Many researchers proxy for ability in their regressions with the AFQT score which is a composite score derived from the tests listed above. Currie and Thomas (1999), however, argue that the AFQT score may be a better indicator of socioeconomic status than of intelligence. The AFQT is used by the Armed Forces and is designed to determine eligibility for enlistment and to assess an individual's trainability for service.

46. Our control variables are similar to those employed by Hansen, Heckman, and Mullen (2004).

47. While Hispanic parents may or may not choose to speak Spanish to their children, the children often speak English to each other. Of course the number of siblings can directly impact test scores in several ways such as through the resources invested in each child.

48. A recent paper investigating the effect of divorce on cognitive and socioemotional development is Aughinbaugh, Pierret, and Rothstein (2005).

49. Flouri and Buchanan (2004) find that parent involvement at age 7 is an independent predictor of a child's educational attainment at age 20.

50. Unlike for the children, we are unable to distinguish whether a parent was born in Puerto Rico or born in the rest of the United States, and so any such births are considered domestic.

a dummy variable for a southern residence and an urban residence at age 14. We also attempt to address any enclave-effects with the inclusion of the percent Hispanic living in an individual's county of residence at age 17. We use the figures provided in the 1980 Census in constructing this measure.

We control for the direct and opportunity costs of schooling with measures drawn from the 1980 Integrated Public Use Microdata Sample (IPUMS) and from the Department of Education's Integrated Postsecondary Education Data System (IPEDS) "Institutional Characteristics" 1980 survey. These variables are collected for the county in which an individual lives when he or she is age 17, which was obtained from the NLSY79 Geocode files. Local labor market variables are constructed from the 5% sample of the IPUMS for prime-age (i.e., age 18–60) civilian, wage/salary employees. The IPUMS allows us to construct measures of the unemployment and wage rates by gender and schooling level.[51] Specifically, we consider the corresponding rates for individuals completing at least 12 years of school and for those who complete more than 12 years. The most detailed geographic identifier available in the IPUMS is a county group which is comprised of contiguous areas with a combined population of 100,000 or more residents; they may consist of actual county groups, but may also be single counties, cities, or Census-designated places. In order to construct unemployment rates that most reflected an individual's county of residence at age 17, we created a population-based weighted average of all the county groups in which an individual county was located. Our regressions include the difference between the average unemployment rate for individuals with more than 12 years of schooling and the average unemployment rate for individuals with 12 years of schooling or less. The wage rates are constructed by dividing the total income from wages and salary by the annual hours worked and averaging across individuals in a given county group. The annual hours worked are just the product of the weeks worked last year and the usual hours worked per week. These figures are again adjusted for the population of each county in the corresponding county group. Our analysis considers the difference between the average wage rate for individuals with more than 12 years of schooling and the average wage rate for individuals with 12 or less years of schooling. We used the IPEDS to obtain information on the location of all 2- and 4-year colleges, both public and private, in the United States in 1980.[52] Also included is the average in-state county and state tuition for public colleges. Specifically, we include the difference between the county and state tuition at each respective education level as in Cameron and Heckman (2001).

51. The dollar figures are expressed in constant 1980 US$.

52. The dummy variable corresponding to a 2-year private college is omitted from the analysis because it is highly correlated with the variable indicating a 2-year public college.

APPENDIX B: TECHNICAL

On all four tests the number of Hispanics who achieved the maximum score was sufficiently low that we did not correct for censoring. This was not the case for the non-Hispanics, however. Let J_i if an individual's test score equals the maximum score on test i, $\overline{\tau}_i$. The observed test score of an individual, the equivalent of Equation (22) in Section III, now becomes:

$$\text{(A1)} \qquad \tau_i = \begin{cases} \theta_i \Delta + \beta_i X + \varepsilon_i \text{ if } I = 0, J = 1 \\ \theta_i \gamma Z + \lambda_i (\Delta - \gamma Z) + \beta_i X \\ \quad + (\theta_i - \lambda_i) u + \varepsilon_i \text{ if } I = 1, J = 1 \\ \overline{\tau}_i \text{ if } J = 0. \end{cases}$$

Assume that $P(J = 1) = P(\delta_i Z + \xi \leq 0) = \Phi(m_i)$, where $\xi \sim N(0, 1)$ and $m_i = -\delta_i Z$. The expected test score can be written as:

(A2)

$$\begin{aligned} E(\tau_i) = {} & \theta_i [\Delta \Phi(m_i) + (\gamma Z - \Delta) \Phi(c, m; \rho_{u\xi_i})] \\ & + \beta_i X [\Phi(m_i) + \lambda_i (\Delta - \gamma Z) \Phi(c, m_i; \rho_{u\xi i}) \\ & - \rho_{\varepsilon\xi_i} \phi(m_i) \sigma_{i\varepsilon} - \sigma_u (\theta_i - \lambda_i) \phi(c) \\ & \times ((1 - (\rho_{u\xi_i} \phi(m_i) / \Phi(m_i))) + \overline{\tau_i} (1 - \Phi(m_i)], \end{aligned}$$

where $\Phi(c, m_i; \rho_{u\xi_i})$ is the bivariate normal distribution, $c = (\Delta - \gamma Z)/\sigma_u$ as before, $\rho_{\varepsilon\xi_i}$ is the correlation between ε_i and ξ_i, and $\rho_{u\xi_i}$ is the correlation between u and ξ_i. Estimation of $\Phi(c, m_i; \rho_{u\xi_i})$ for each combination of test score and schooling level would give rise to four distinct estimates of the parameters of c. To avoid this we carried out the following four-step procedure: First, we estimated each bivariate probit $\Phi(c, m_i; \rho_{u\xi_i})$ to obtain estimates of the correlation coefficient, $\rho_{u\xi_i}$. Next we then estimated the probits given by $\Phi(m_i)$ for each of the four tests and the probit given by $\Phi(c)$ for schooling. Third, we calculated the first-order Taylor series approximation to the probit given by $\Phi(c, m_i; \rho_{u\xi_i})$ as,

$$\begin{aligned} \text{(A3)} \qquad \Phi(c, m_i; \rho_{u\xi_i}) \approx {} & \Phi(c) \Phi(m_i) \\ & - \rho_{u\xi_i} \phi(c) \phi(m_i)) / \Phi(c) \Phi(m_i). \end{aligned}$$

We used our results from the first two steps to obtain estimates of $\rho_{u\xi_i}$, $\Phi(c)$, and $\Phi(m_i)$, and substituted these into Equation (A1) to obtain an estimate of $\Phi(c, m_i; \rho_{u\xi_i})$. And finally, we substituted all of the estimated values into Equation (A2) and estimated the equation by OLS.

TABLE A1
Descriptive Statistics

Variable	Hispanics (Nobs. = 1,312)		Hispanics Who Spoke Spanish at Home as a Child (Nobs. = 1,124)		Hispanics Who Did Not Speak Spanish at Home as a Child (Nobs. = 188)		Hispanics Whose Parents Were Both Born in the United States (Nobs. = 624)		Whites (Nobs. = 2,940)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Personal characteristics										
Male	0.466	0.499	0.467	0.499	0.463	0.500	0.431	0.496	0.494	0.500
Age in 1979	17.460	2.292	17.469	2.264	17.410	2.462	17.566	2.285	17.802	2.251
Hispanicity										
"Very" Hispanic	0.800	0.400	0.880	0.325	0.319	0.467	0.721	0.449	—	—
"Moderately" Hispanic	0.139	0.347	0.095	0.294	0.404	0.492	0.178	0.383	—	—
"Less" Hispanic	0.060	0.238	0.025	0.156	0.271	0.446	0.099	0.299	—	—
Country of birth										
1 If mother born abroad	0.440	0.497	0.493	0.500	0.122	0.329	0.000	0.000	—	—
1 If father born abroad	0.423	0.494	0.470	0.499	0.144	0.352	0.000	0.000	—	—
1 If mother or father born abroad	0.338	0.473	0.387	0.487	0.048	0.214	0.000	0.000	—	—
1 If born abroad	0.141	0.348	0.155	0.362	0.059	0.235	0.013	0.113	—	—
Family background variables										
Number of siblings	4.349	2.827	4.496	2.856	3.468	2.474	4.112	2.719	3.176	2.011
1 If "broken" home	0.309	0.462	0.315	0.465	0.271	0.446	0.295	0.456	0.242	0.428
1 If mother absent at age 14	0.043	0.202	0.039	0.194	0.064	0.245	0.048	0.214	0.050	0.217
1 If father absent at age 14	0.289	0.453	0.298	0.458	0.234	0.425	0.274	0.446	0.212	0.409
Regional variables										
1 If lived in an urban residence at age 14	0.887	0.316	0.895	0.307	0.840	0.367	0.875	0.331	0.831	0.375
1 If lived in the south at age 14	0.275	0.447	0.286	0.452	0.207	0.407	0.304	0.461	0.229	0.420
% Hispanic in county of residence at age 17	0.255	0.225	0.279	0.230	0.114	0.125	0.261	0.234	0.065	0.089
Schooling cost variables										
Wage rates										
Hourly wage rate, schooling $\leq$12 years	7.466	1.253	7.480	1.229	7.386	1.390	7.334	1.312	7.562	1.543
Hourly wage rate, schooling >12 years	8.922	1.551	8.949	1.548	8.762	1.562	8.690	1.529	9.013	1.732
Difference in hourly wage rate	1.456	0.879	1.469	0.886	1.376	0.830	1.356	0.943	1.451	1.063

TABLE A1
Continued

Variable	Hispanics (Nobs. = 1,312)		Hispanics Who Spoke Spanish at Home as a Child (Nobs. = 1,124)		Hispanics Who Did Not Speak Spanish at Home as a Child (Nobs. = 188)		Hispanics Whose Parents Were Both Born in the United States (Nobs. = 624)		Whites (Nobs. = 2,940)	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
Unemployment rates										
Unemployment rate, schooling ≤12 years	0.088	0.031	0.089	0.031	0.079	0.030	0.086	0.032	0.084	0.034
Unemployment rate, schooling >12 years	0.041	0.014	0.041	0.014	0.037	0.016	0.039	0.014	0.040	0.017
Difference in unemployment rate	0.047	0.022	0.048	0.023	0.042	0.021	0.047	0.023	0.044	0.023
2- and 4-year colleges										
1 If 2-year public college in county of residence at age 17	0.233	0.423	0.220	0.414	0.314	0.465	0.298	0.458	0.293	0.455
1 If 2-year college in county of residence at age 17	0.221	0.415	0.209	0.407	0.293	0.456	0.293	0.456	0.265	0.441
1 If 4-year public college in county of residence at age 17	0.296	0.457	0.290	0.454	0.335	0.473	0.364	0.481	0.361	0.480
1 If 4-year college in county of residence at age 17	0.236	0.425	0.238	0.426	0.223	0.418	0.300	0.458	0.200	0.400
Average public, state 2-year college tuition (per semester)	352.850	293.973	343.381	292.527	409.468	297.011	295.627	240.114	485.171	286.818
Average public, state 4-year college tuition (per semester)	592.869	263.463	578.978	259.521	675.925	272.156	543.365	228.957	761.777	276.845
Difference in average public state 2-year college tuition	−56.936	308.080	−43.625	306.188	−136.524	308.167	−102.478	299.314	−157.374	284.599
Difference in average public state 4-year college tuition	−161.679	310.483	−151.847	291.447	−220.461	402.082	−207.996	336.061	−280.822	438.381

Notes: Wage and unemployment rates are gender-specific and population-weighted averages. Dollar figures are in 1980 constant US$.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE A2
First-Stage Probit/Bivariate Probit: Full Regression Results for Hispanics

Estimation Technique	**Probit**			**Bivariate Probit**			
Dependent Variable	**Completed Schooling**			**Completed Schooling**	**Spoke Spanish at Home as a Child**	**Completed Schooling**	**Spoke Spanish at Home as a Child**
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**
Potential schooling at time of test (σ_u)	2.076***	1.839***	1.832***	2.065***	—	1.809***	—
	(0.072)	(0.091)	(0.091)	(0.072)		(0.090)	
1 If male	−0.611	−0.868	−0.93	−0.556	—	−0.853	—
	(0.522)	(0.689)	(0.692)	(0.519)		(0.674)	
1 If spoke Spanish at home as a child	−0.230	0.004	—	—	—	—	—
	(0.428)	(0.447)					
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	0.0694	—	—	—	—
			(0.676)				
1 If spoke Spanish at home as a child × 1 If 9 ≤ average parents' schooling <12	—	—	−0.221	—	—	—	—
			(0.498)				
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	0.291	—	—	—	—
			(0.572)				
Mother's schooling	0.038	0.036	0.033	0.042	−0.058**	0.035	−0.066**
	(0.060)	(0.063)	(0.069)	(0.060)	(0.025)	(0.062)	(0.028)
Father's schooling	0.164***	0.186***	0.186***	0.165***	−0.054**	0.183***	−0.034
	(0.049)	(0.047)	(0.057)	(0.048)	(0.023)	(0.046)	(0.026)
1 If mother born abroad	0.854	—	—	0.831	0.090	—	—
	(0.789)			(0.787)	(0.433)		
1 If father born abroad	0.708	—	—	0.715	−0.294	—	—
	(0.784)			(0.783)	(0.379)		
1 If mother or father born abroad	0.090	—	—	0.137	0.110	—	—
	(0.679)			(0.684)	(0.320)		
1 If mother born abroad × Mother's schooling	0.019	—	—	0.013	0.051	—	—
	(0.075)			(0.075)	(0.036)		
1 If father born abroad × Father's schooling	−0.068	—	—	−0.070	0.050	—	—
	(0.071)			(0.071)	(0.032)		
1 If mother absent	−0.503	2.055	1.923	−0.632	0.256	2.039	0.183
	(1.946)	(2.988)	(2.971)	(1.956)	(0.954)	(3.025)	(1.157)

TABLE A2
Continued

Estimation Technique	Probit			Bivariate Probit			
Dependent Variable	Completed Schooling			Completed Schooling	Spoke Spanish at Home as a Child	Completed Schooling	Spoke Spanish at Home as a Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
1 If father absent	1.011	1.580	1.581	1.025	0.293	1.475	0.217
	(0.707)	(1.049)	(1.047)	(0.704)	(0.385)	(1.033)	(0.534)
1 If mother absent × Mother's schooling	0.011	−0.158	−0.146	0.026	−0.055	−0.152	−0.074
	(0.210)	(0.297)	(0.295)	(0.210)	(0.094)	(0.299)	(0.114)
1 If father absent × Father's schooling	−0.146*	−0.168	−0.167	−0.147*	−0.001	−0.154	0.001
	(0.075)	(0.108)	(0.107)	(0.075)	(0.037)	(0.107)	(0.049)
1 If father absent × Male	−0.082	−0.061	−0.063	−0.117	—	−0.079	—
	(0.573)	(0.737)	(0.736)	(0.571)		(0.726)	
Number of siblings	−0.068	−0.097	−0.101	−0.064	−0.024	−0.093	−0.002
	(0.071)	(0.096)	(0.096)	(0.070)	(0.024)	(0.094)	(0.031)
Number of siblings × Male	−0.020	0.085	0.098	0.017	—	0.088	—
	(0.092)	(0.127)	(0.127)	(0.092)		(0.124)	
1 If Cuban	0.326	−0.486	−0.506	0.324	0.287	−0.471	0.213
	(0.667)	(1.042)	(1.042)	(0.664)	(0.258)	(1.030)	(0.345)
1 If Puerto Rican	−0.958*	−1.782	−1.866	−0.909*	0.257	−1.842	−0.118
	(0.496)	(1.908)	(1.892)	(0.497)	(0.197)	(1.898)	(0.440)
1 If Other Hispanic	−0.016	0.091	0.087	0.011	−0.059	0.102	−0.235
	(0.435)	(0.514)	(0.512)	(0.448)	(0.149)	(0.519)	(0.170)
% Hispanic in county of residence at age 17	—	—	—	1.018	2.216***	1.133	2.531***
				(0.818)	(0.386)	(0.990)	(0.491)
"Moderately" Hispanic	—	—	—	0.025	−0.949***	0.075	−0.739***
				(0.439)	(0.142)	(0.504)	(0.171)
"Less" Hispanic	—	—	—	0.504	−1.313***	0.352	−1.124***
				(0.617)	(0.190)	(0.652)	(0.219)
1 If lived in an urban residence at age 14	−0.465	−0.105	−0.09	−0.428	0.346**	−0.092	0.178
	(0.431)	(0.515)	(0.514)	(0.430)	(0.163)	(0.508)	(0.197)
1 If lived in the south at age 14	−0.014	0.005	0.015	−0.152	0.130	−0.100	0.157
	(0.365)	(0.539)	(0.541)	(0.382)	(0.141)	(0.539)	(0.173)
Difference in hourly wage rate	−0.174	−0.042	−0.031	−0.191	—	−0.058	—
	(0.161)	(0.182)	(0.182)	(0.161)		(0.180)	

TABLE A2
Continued

Estimation Technique	Probit			Bivariate Probit			
Dependent Variable	Completed Schooling			Completed Schooling	Spoke Spanish at Home as a Child	Completed Schooling	Spoke Spanish at Home as a Child
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Difference in unemployment rate	7.697	9.967	9.892	5.780	—	8.300	—
	(6.766)	(8.380)	(8.416)	(6.898)		(8.343)	
1 If 2-year public college in county of residence at age 17	−0.076	−0.444	−0.469	−0.083	—	−0.464	—
	(0.474)	(0.561)	(0.564)	(0.474)		(0.553)	
1 If 4-year public college in county of residence at age 17	0.056	0.104	0.031	0.053	—	0.038	—
	(0.883)	(1.038)	(1.040)	(0.884)		(1.032)	
1 If 4-year college in county of residence at age 17	−0.655	−0.503	−0.526	−0.761	—	−0.572	—
	(0.737)	(0.835)	(0.864)	(0.747)		(0.833)	
Average public state 2-year college tuition (per semester)	0.001	0.003***	0.003***	0.001	—	0.002**	—
	(0.000)	(0.001)	(0.001)	(0.001)		(0.001)	
Average public state 4-year college tuition (per semester)	−0.002	−0.003	−0.003	−0.001	—	−0.002	—
	(0.004)	(0.006)	(0.006)	(0.003)		(0.005)	
Difference in average public state 2-year college tuition	−0.001	−0.000	0.000	−0.001	—	−0.000	—
	(0.002)	(−0.195)	(0.002)	(0.002)		(0.002)	
Difference in average public state 4-year college tuition	−0.001	−0.001	−0.001	−0.001	—	−0.001	—
	(0.002)	(0.003)	(0.003)	(0.002)		(0.003)	
Constant	11.734***	10.954***	10.994***	10.989***	1.508***	10.430***	1.390***
	(0.484)	(1.406)	(1.496)	(1.146)	(0.358)	(1.375)	(0.424)
Pseudo R^2	0.383	0.430	0.432				
Log-likehood	−554.220	−240.100	−239.112	−888.068	−888.068	−470.883	−470.883
Nobs.	1,312	624	624	1,312	1,312	624	624

Note: Standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE A3
Second-Stage OLS: Full Regression Results for Hispanics—Exogenous Choice of Home Language

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Expected schooling at time of test	0.118***	0.057	0.049	0.076**	0.066	0.055	0.114***	0.062	0.066	0.107***	0.026	0.026
	(0.030)	(0.040)	(0.040)	(0.030)	(0.042)	(0.042)	(0.031)	(0.044)	(0.043)	(0.033)	(0.046)	(0.045)
Expected schooling at time of test × 1 If mother or father born abroad	−0.011	—	—	−0.015	—	—	−0.023*	—	—	−0.014	—	—
	(0.010)			(0.010)			(0.012)			(0.012)		
Expected potential experience at time of test	0.025	0.042	0.042	0.012	0.014	0.017	0.086***	0.101***	0.099***	0.077***	0.097***	0.096***
	(0.021)	(0.027)	(0.027)	(0.021)	(0.027)	(0.026)	(0.023)	(0.029)	(0.029)	(0.022)	(0.029)	(0.029)
Male	0.463***	0.542***	0.509***	0.326***	0.313**	0.283**	0.357***	0.377***	0.373***	0.142	0.143	0.138
	(0.093)	(0.128)	(0.129)	(0.094)	(0.134)	(0.136)	(0.098)	(0.142)	(0.143)	(0.101)	(0.144)	(0.146)
1 if spoke Spanish at home as a child	−0.255***	−0.318***	—	−0.171**	−0.146	—	−0.264***	−0.227**	—	−0.124	−0.115	—
	(0.069)	(0.092)		(0.070)	(0.094)		(0.080)	(0.097)		(0.077)	(0.102)	
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	−0.032	—	—	0.087	—	—	−0.244	—	—	−0.059
			(0.131)			(0.121)			(0.153)			(0.165)
1 If spoke Spanish at home as a child × 1 If 9≤ average parents' schooling <12	—	—	−0.319***	—	—	−0.155	—	—	−0.270**	—	—	−0.108
			(0.098)			(0.098)			(0.107)			(0.117)
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	−0.444***	—	—	−0.233*	—	—	−0.162	—	—	−0.152
			(0.126)			(0.136)			(0.123)			(0.122)
Mother's schooling	0.028***	0.031**	0.047***	0.038***	0.037***	0.050***	0.058***	0.067***	0.065***	0.046***	0.053***	0.056***
	(0.011)	(0.014)	(0.014)	(0.011)	(0.013)	(0.014)	(0.012)	(0.015)	(0.016)	(0.013)	(0.016)	(0.016)
Father's schooling	0.046***	0.047***	0.066***	0.055***	0.058***	0.074***	0.057***	0.073***	0.071***	0.056***	0.069***	0.073***
	(0.011)	(0.013)	(0.015)	(0.011)	(0.014)	(0.015)	(0.011)	(0.015)	(0.017)	(0.011)	(0.014)	(0.016)
1 If mother born abroad	0.239*	—	—	0.370***	—	—	0.540***	—	—	0.445***	—	—
	(0.140)			(0.137)			(0.159)			(0.164)		
1 If father born abroad	0.261**	—	—	0.350***	—	—	0.321**	—	—	0.218	—	—
	(0.124)			(0.123)			(0.143)			(0.148)		
1 If mother born abroad × Mother's schooling	−0.004	—	—	−0.006	—	—	−0.023*	—	—	−0.022	—	—
	(0.012)			(0.013)			(0.014)			(0.014)		
1 If father born abroad × Father's schooling	−0.031***	—	—	−0.033***	—	—	−0.033***	—	—	−0.025**	—	—
	(0.011)			(0.012)			(0.013)			(0.013)		
1 If mother absent	−0.242	−0.079	−0.034	−0.182	−0.084	0.049	−0.796**	−0.296	−0.328	−0.675**	−0.641	−0.627
	(0.200)	(0.509)	(0.543)	(0.222)	(0.477)	(0.468)	(0.325)	(0.559)	(0.531)	(0.327)	(0.594)	(0.577)
1 If father absent	0.163	0.244	0.151	0.086	0.198	0.133	0.078	0.449*	0.450*	0.177	0.439	0.416
	(0.113)	(0.198)	(0.198)	(0.115)	(0.193)	(0.195)	(0.140)	(0.264)	(0.267)	(0.140)	(0.271)	(0.274)

TABLE A3
Continued

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
1 If mother absent × Mother's schooling	0.012	−0.003	−0.006	0.006	0.005	0.003	0.078**	0.046	0.049	0.070**	0.082	0.081
	(0.025)	(0.053)	(0.055)	(0.025)	(0.047)	(0.046)	(0.033)	(0.053)	(0.051)	(0.035)	(0.057)	(0.056)
1 If father absent × Father's schooling	−0.032***	−0.046**	−0.038**	−0.034***	−0.054***	−0.048**	−0.029**	−0.066***	−0.066***	−0.031**	−0.061***	−0.059**
	(0.012)	(0.019)	(0.019)	(0.012)	(0.019)	(0.020)	(0.014)	(0.025)	(0.025)	(0.014)	(0.026)	(0.026)
1 If father absent × Male	0.070	0.181	0.212	0.117	0.294**	0.317**	0.052	0.215	0.213	−0.099	0.039	0.044
	(0.099)	(0.148)	(0.148)	(0.097)	(0.139)	(0.139)	(0.117)	(0.166)	(0.165)	(0.117)	(0.172)	(0.173)
Number of siblings	0.008	0.011	0.009	0.004	0.002	0.001	−0.009	0.010	0.011	−0.004	0.001	0.000
	(0.010)	(0.016)	(0.016)	(0.012)	(0.016)	(0.017)	(0.013)	(0.019)	(0.019)	(0.013)	(0.020)	(0.020)
Number of siblings × Male	−0.052***	−0.079***	−0.076***	−0.057***	−0.075***	−0.072***	−0.071***	−0.074***	−0.073***	−0.059***	−0.064**	−0.063**
	(0.015)	(0.022)	(0.022)	(0.016)	(0.022)	(0.023)	(0.018)	(0.027)	(0.027)	(0.018)	(0.027)	(0.028)
1 If Cuban	0.263**	0.215	0.251	0.194	0.091	0.117	0.181*	−0.024	−0.028	0.099	−0.240	−0.232
	(0.113)	(0.202)	(0.201)	(0.118)	(0.233)	(0.232)	(0.106)	(0.207)	(0.206)	(0.127)	(0.270)	(0.268)
1 If Puerto Rican	−0.212***	−0.073	−0.076	−0.183**	0.075	0.060	−0.295***	0.263	0.264	−0.305***	0.228	0.229
	(0.072)	(0.265)	(0.256)	(0.077)	(0.212)	(0.206)	(0.085)	(0.234)	(0.237)	(0.091)	(0.227)	(0.231)
1 If other Hispanic	−0.021	−0.050	−0.047	−0.049	0.034	0.037	0.015	0.042	0.044	−0.008	−0.027	−0.026
	(0.070)	(0.093)	(0.093)	(0.073)	(0.099)	(0.100)	(0.079)	(0.105)	(0.105)	(0.083)	(0.114)	(0.114)
1 If lived in an urban residence at age 14	−0.037	−0.015	−0.008	−0.151**	−0.067	−0.062	−0.129	0.038	0.042	−0.140*	−0.059	−0.058
	(0.072)	(0.099)	(0.097)	(0.076)	(0.098)	(0.097)	(0.080)	(0.101)	(0.100)	(0.082)	(0.116)	(0.116)
1 If lived in the south at age 14	−0.037	−0.083	−0.096	0.045	0.067	0.056	−0.094*	−0.127	−0.129	−0.077	−0.106	−0.108
	(0.052)	(0.073)	(0.073)	(0.053)	(0.072)	(0.073)	(0.056)	(0.079)	(0.080)	(0.059)	(0.086)	(0.087)
Constant	−2.297***	−1.660***	−1.972***	−1.859***	−1.855***	−2.062***	−2.472***	−2.460***	−2.448***	−2.224***	−1.666***	−1.744***
	(0.311)	(0.391)	(0.396)	(0.307)	(0.398)	(0.399)	(0.334)	(0.419)	(0.432)	(0.341)	(0.471)	(0.481)
R^2	0.200	0.219	0.230	0.188	0.226	0.233	0.259	0.302	0.303	0.199	0.216	0.216
Nobs.	1,312	624	624	1,312	624	624	1,312	624	624	1,312	624	624

Notes: Test scores are standardized. Bootstrapped standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE A4
Full Regression Results for Hispanics Using Respondent's Age Instead of Expected Schooling at Time of Test: Exogenous Choice of Home Language

	Arithmetic Reasoning	Math Knowledge	Word Knowledge	Paragraph Comprehension
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**
Age at time of test	0.057***	0.033***	0.092***	0.085***
	(0.010)	(0.010)	(0.011)	(0.011)
Male	0.433***	0.309***	0.349***	0.132
	(0.091)	(0.094)	(0.096)	(0.099)
1 If spoke Spanish at home as a child	−0.258***	−0.174**	−0.267***	−0.126
	(0.073)	(0.074)	(0.078)	(0.078)
Mother's schooling	0.032***	0.040***	0.059***	0.047***
	(0.011)	(0.011)	(0.012)	(0.012)
Father's schooling	0.055***	0.061***	0.060***	0.059***
	(0.010)	(0.010)	(0.011)	(0.010)
1 If mother born abroad	0.250**	0.334***	0.437***	0.390***
	(0.124)	(0.124)	(0.145)	(0.147)
1 If father born abroad	0.231**	0.288**	0.199	0.142
	(0.113)	(0.116)	(0.133)	(0.135)
1 If mother born abroad × Mother's schooling	−0.006	−0.006	−0.023	−0.022
	(0.013)	(0.013)	(0.014)	(0.014)
1 If father born abroad × Father's schooling	−0.033***	0.035***	0.033**	−0.025**
	(0.011)	(0.012)	(0.013)	(0.013)
1 If mother absent	−0.290	−0.217	0.785**	−0.668**
	(0.180)	(0.200)	(0.326)	(0.331)
1 If father absent	0.239**	0.135	0.111	0.212
	(0.113)	(0.117)	(0.140)	(0.143)
1 If mother absent × Mother's schooling	0.006	0.003	−0.010	−0.005
	(0.010)	(0.012)	(0.012)	(0.013)
1 If father absent × Father's schooling	0.014	0.007	0.075**	0.067*
	(0.024)	(0.024)	(0.033)	(0.035)
1 If father absent × Male	−0.041***	−0.040***	−0.032**	−0.034**
	(0.012)	(0.012)	(0.013)	(0.014)
Number of siblings	0.050	0.103	0.038	−0.112
	(0.098)	(0.098)	(0.115)	(0.117)
Number of siblings × Male	0.051***	0.057***	−0.070***	−0.058***
	(0.015)	(0.016)	(0.018)	(0.018)
1 If Cuban	0.262**	0.190	0.175*	0.097
	(0.116)	(0.120)	(0.102)	(0.126)
1 If Puerto Rican	−0.271***	−0.222***	−0.306***	−0.320***
	(0.067)	(0.069)	(0.079)	(0.081)
1 If other Hispanic	−0.032	−0.058	0.014	−0.008
	(0.070)	(0.075)	(0.078)	(0.084)
1 If lived in an urban residence at age 14	−0.075	−0.178**	−0.154*	−0.164*
	(0.073)	(0.078)	(0.081)	(0.084)
1 If lived in the south at age 14	−0.029	0.053	−0.089	−0.074
	(0.052)	(0.054)	(0.058)	(0.060)
Constant	−2.079***	−1.650***	−2.776***	−2.508***
	(0.235)	(0.240)	(0.258)	(0.268)
R^2	0.193	0.185	0.254	0.196
Nobs. = 1,312				

Notes: Test scores are standardized. Standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79.

TABLE A5
Second-Stage OLS: Full Regression Results for Hispanics—Endogenous Choice of Home Language

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
Expected schooling at time of test	0.118***	0.062	0.056	0.080***	0.073*	0.070*	0.114***	0.062	0.064	0.097***	0.022	0.020
	(0.029)	(0.039)	(0.039)	(0.030)	(0.039)	(0.039)	(0.031)	(0.043)	(0.043)	(0.032)	(0.044)	(0.044)
Expected schooling at time of test × 1 If mother or father born abroad	−0.010	—	—	−0.015	—	—	−0.022*	—	—	−0.013	—	—
	(0.011)			(0.010)			(0.012)			(0.012)		
Expected potential experience at time of test	0.021	0.032	0.033	0.007	0.008	0.007	0.082***	0.097***	0.096***	0.081***	0.096***	0.096***
	(0.020)	(0.026)	(0.026)	(0.021)	(0.026)	(0.026)	(0.022)	(0.029)	(0.029)	(0.022)	(0.028)	(0.028)
Male	0.453***	0.532***	0.505***	0.323***	0.314**	0.290**	0.350***	0.371***	0.367***	0.131	0.133	0.129
	(0.092)	(0.127)	(0.128)	(0.093)	(0.135)	(0.136)	(0.097)	(0.141)	(0.141)	(0.101)	(0.143)	(0.145)
1 If spoke Spanish at home as a child	−0.731***	−0.882***	—	−0.379**	−0.274	—	−0.518***	−0.516**	—	−0.413**	−0.434*	—
	(0.165)	(0.214)		(0.176)	(0.221)		(0.173)	(0.238)		(0.180)	(0.231)	
1 If spoke Spanish at home as a child × 1 If average parents' schooling <9	—	—	−0.591**	—	—	−0.069	—	—	−0.511*	—	—	−0.380
			(0.250)			(0.241)			(0.291)			(0.288)
1 If spoke Spanish at home as a child × 1 If 9≤ average parents' schooling <12	—	—	−0.877***	—	—	−0.307	—	—	−0.543**	—	—	−0.430*
			(0.216)			(0.222)			(0.243)			(0.240)
1 If spoke Spanish at home as a child × 1 If average parents' schooling ≥12	—	—	−0.947***	—	—	−0.258	—	—	−0.471*	—	—	−0.451*
			(0.240)			(0.250)			(0.257)			(0.244)
Mother's schooling	0.018	0.019	0.035**	0.033***	0.034**	0.043***	0.052***	0.061***	0.060***	0.040***	0.047***	0.050***
	(0.011)	(0.015)	(0.015)	(0.011)	(0.014)	(0.014)	(0.013)	(0.016)	(0.018)	(0.013)	(0.017)	(0.017)
Father's schooling	0.039***	0.040***	0.058***	0.051***	0.056***	0.067***	0.053***	0.070***	0.069***	0.054***	0.066***	0.070***
	(0.011)	(0.014)	(0.016)	(0.012)	(0.014)	(0.015)	(0.012)	(0.016)	(0.017)	(0.011)	(0.014)	(0.018)
1 If mother born abroad	0.207	—	—	0.353***	—	—	0.521***	—	—	0.436***	—	—
	(0.141)			(0.137)			(0.159)			(0.165)		
1 If father born abroad	0.227*	—	—	0.335***	—	—	0.304**	—	—	0.200	—	—
	(0.126)			(0.123)			(0.144)			(0.148)		
1 If mother born abroad × Mother's schooling	0.006	—	—	−0.001	—	—	−0.018	—	—	−0.016	—	—
	(0.013)			(0.013)			(0.015)			(0.015)		
1 If father born abroad × Father's schooling	−0.024**	—	—	−0.030**	—	—	−0.029**	—	—	−0.021*	—	—
	(0.012)			(0.012)			(0.013)			(0.013)		
1 If mother absent	−0.230	−0.158	−0.102	−0.167	−0.100	−0.083	−0.790**	−0.334	−0.350	−0.686**	−0.687*	−0.675
	(0.206)	(0.445)	(0.439)	(0.207)	(0.451)	(0.440)	(0.323)	(0.453)	(0.452)	(0.326)	(0.564)	(0.568)
1 If father absent	0.148	0.192	0.130	0.075	0.180	0.132	0.070	0.424	0.420	0.180	0.418*	0.407
	(0.114)	(0.202)	(0.199)	(0.115)	(0.193)	(0.195)	(0.140)	(0.266)	(0.267)	(0.141)	(0.271)	(0.272)
1 If mother absent × Mother's schooling	0.009	−0.005	−0.008	0.004	0.004	0.004	0.076**	0.045	0.046	0.069**	0.082**	0.081
	(0.026)	(0.048)	(0.048)	(0.025)	(0.044)	(0.043)	(0.033)	(0.045)	(0.045)	(0.034)	(0.054)	(0.054)

TABLE A5
Continued

	Arithmetic Reasoning			Math Knowledge			Word Knowledge			Paragraph Comprehension		
Dependent Variable	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**	**(10)**	**(11)**	**(12)**
1 If father absent × Father's schooling	−0.029**	−0.041**	−0.036*	−0.032***	−0.052***	−0.048**	−0.028**	−0.064**	−0.063**	−0.031**	−0.059**	−0.058**
	(0.012)	(0.020)	(0.019)	(0.012)	(0.019)	(0.019)	(0.014)	(0.025)	(0.025)	(0.014)	(0.026)	(0.026)
1 If father absent × Male	0.086	0.226	0.254*	0.125	0.307**	0.327**	0.062	0.241	0.242	−0.092	0.061	0.066
	(0.099)	(0.150)	(0.149)	(0.096)	(0.141)	(0.140)	(0.118)	(0.168)	(0.168)	(0.117)	(0.176)	(0.177)
Number of siblings	0.007	0.013	0.012	0.004	0.003	0.003	−0.009	0.011	0.011	−0.005	0.001	0.001
	(0.010)	(0.016)	(0.016)	(0.012)	(0.016)	(0.016)	(0.013)	(0.018)	(0.018)	(0.013)	(0.019)	(0.019)
Number of siblings × Male	−0.050***	−0.078***	−0.075***	−0.056***	−0.075***	−0.072***	−0.069***	−0.073***	−0.072***	−0.057***	−0.063**	−0.063**
	(0.015)	(0.022)	(0.022)	(0.015)	(0.023)	(0.023)	(0.018)	(0.027)	(0.027)	(0.018)	(0.027)	(0.028)
1 If Cuban	0.230*	0.136	0.168	0.179	0.075	0.100	0.162	−0.065	−0.062	0.078	0.287	−0.281
	(0.120)	(0.222)	(0.222)	(0.122)	(0.239)	(0.237)	(0.108)	(0.216)	(0.215)	(0.130)	(0.276)	(0.276)
1 If Puerto Rican	−0.227***	−0.150	−0.153	−0.185**	0.077	0.081	−0.302***	0.214	0.219	−0.326***	0.157	0.155
	(0.073)	(0.432)	(0.420)	(0.076)	(0.410)	(0.405)	(0.085)	(0.380)	(0.382)	(0.091)	(0.379)	(0.384)
1 If other Hispanic	−0.108	−0.212*	−0.198*	−0.086	−0.002	0.009	−0.031	−0.041	−0.040	−0.063	−0.119	−0.116
	(0.076)	(0.110)	(0.110)	(0.081)	(0.114)	(0.114)	(0.086)	(0.124)	(0.125)	(0.092)	(0.135)	(0.135)
1 If lived in an urban residence at age 14	0.000	0.019	0.023	−0.133*	−0.058	−0.054	−0.108	0.056	0.057	−0.124	−0.041	−0.041
	(0.074)	(0.104)	(0.102)	(0.077)	(0.100)	(0.099)	(0.083)	(0.102)	(0.103)	(0.084)	(0.118)	(0.118)
1 If lived in the south at age 14	−0.013	−0.042	−0.058	0.055	0.075	0.059	−0.082	−0.105	−0.108	−0.061	−0.081	−0.083
	(0.053)	(0.076)	(0.076)	(0.054)	(0.074)	(0.075)	(0.057)	(0.081)	(0.081)	(0.060)	(0.087)	(0.089)
Constant	−1.784***	−1.113**	−1.433***	−1.664***	−1.777***	−1.997***	−2.195***	−2.158***	−2.159***	−1.826***	−1.294**	−1.354**
	(0.348)	(0.449)	(0.472)	(0.350)	(0.450)	(0.463)	(0.377)	(0.456)	(0.497)	(0.377)	(0.505)	(0.538)
R^2 Nobs = 2, 940	0.204	0.226	0.233	0.188	0.226	0.230	0.257	0.302	0.302	0.201	0.219	0.219
Nobs.	1,312	624	624	1,312	624	624	1,312	624	624	1,312	624	624

Notes: Test scores are standardized. Bootstrapped standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

TABLE A6
Second-Stage OLS: Full Regression Results for Whites

Dependent Variable	Arithmetic Reasoning	Math Knowledge	Word Knowledge	Paragraph Comprehension
	(1)	(2)	(3)	(4)
Expected schooling at time of test	0.058***	0.035***	0.133***	0.085***
	(0.014)	(0.013)	(0.014)	(0.015)
Expected potential experience at time of test	0.035**	0.030**	0.099***	0.062***
	(0.014)	(0.012)	(0.015)	(0.016)
Male	0.180**	0.052	0.109*	−0.175**
	(0.071)	(0.069)	(0.063)	(0.074)
Mother's schooling	0.054***	0.064***	0.075***	0.068***
	(0.011)	(0.010)	(0.011)	(0.012)
Father's schooling	0.054***	0.051***	0.077***	0.062***
	(0.009)	(0.011)	(0.008)	(0.009)
1 If mother absent	−0.130	−0.083	−0.617	−0.800*
	(0.342)	(0.334)	(0.406)	(0.477)
1 If father absent	−0.123	−0.260*	−0.142	−0.209
	(0.151)	(0.149)	(0.167)	(0.170)
1 If mother absent × Mother's schooling	−0.001	−0.005	0.040	0.057
	(0.030)	(0.030)	(0.034)	(0.040)
1 If father absent × Father's schooling	−0.004	0.011	−0.002	0.003
	(0.013)	(0.012)	(0.013)	(0.014)
1 If father absent × Male	0.032	−0.059	0.041	−0.024
	(0.082)	(0.081)	(0.083)	(0.092)
Number of siblings	−0.026**	−0.021*	−0.030**	−0.039***
	(0.011)	(0.011)	(0.012)	(0.015)
Number of siblings × Male	−0.007	−0.015	−0.042**	−0.024
	(0.017)	(0.016)	(0.017)	(0.017)
1 If lived in an urban residence at age 14	−0.061	−0.058	−0.060	0.009
	(0.044)	−(0.044)	(0.043)	(0.046)
1 If lived in the south at age 14	−0.086**	−0.120***	−0.090**	−0.046
	(0.040)	(0.041)	(0.039)	(0.041)
Φ(m)	0.821**	1.663***	−0.623**	−0.453
	(0.342)	(0.503)	(0.260)	(0.427)
Constant	−1.812***	−1.676***	−3.028***	−2.162***
	(0.186)	(0.164)	(0.249)	(0.210)
R^2	0.177	0.188	0.240	0.178

Notes: Test scores are standardized and are corrected for censoring. Standard error in parentheses.
*Significant at 10%; **significant at 5%; ***significant at 1% level.
Source: NLSY79, 1980 Census, 1980 IPUMS, 1980 IPEDS.

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