

Does Compulsory School Attendance Affect Schooling and Earnings? Revisited

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Abstract

Following Angrist and Krueger (1991) this paper investigates whether compulsory schooling laws are still effective and if so, to what extent compulsory schooling laws continue to impact the educational attainment as well as earnings in the 2005 American Community Survey. Differences in quarter of birth create a natural experiment that enables us to study the effect of school compulsion on schooling and earnings. Hence, individuals born in the beginning of the year usually start school at an older age than that of their classmates, they are allowed to drop out of school after attaining less education. I implement instrumental variable strategy to estimate the impact of compulsory schooling on earnings using quarter of birth as an instrument. We observe that for the older cohorts, compulsory schooling laws still explain differences in the educational attainment across individuals. However, it appears that these laws are no longer binding for more recent cohorts and therefore does not serve as a mechanism that helps us to exploit educational attainment across individuals.

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1. Introduction

The literature on the returns to education is undoubtedly one of the largest in labor economics. Economists and other social scientists have been reluctant, however, to interpret as purely causal the relationship between education and earnings. Education attainment is not randomly distributed across population. Rather, individuals who do well at school or are from privileged backgrounds are much more likely to continue their education. Therefore, it is likely that the observed association might overstate the causal effect of educational attainment on earnings.

Even though the endogeneity of educational attainment has long been recognized, plausible instruments for education that would allow for estimation of the causal effect of education on earnings have been difficult to find. In the well-known paper, “Does Compulsory School Attendance Affect Schooling and Earnings?” by Angrist and Krueger (1991, QJE), they take the advantage of variation in the schooling of individuals that is due to the compulsory schooling laws and construct instruments for educational attainment by using quarter of birth information. The idea behind their empirical strategy relies on the fact that according to compulsory schooling laws, the student is allowed to drop out school on her/his 17th birthday. Individuals born in the beginning of the year start school at an older age, and therefore drop out after completing less schooling than individuals born near the end of the year. Thus, they exploit the difference in schooling of individuals born in first quarter and other quarters and employ the instrumental variable of quarter of birth to examine the impact of the compulsory schooling on earnings. In Angrist and Krueger (1991), it appears that the instrumental variable estimate of the return to education is close to the ordinary least square estimates, suggesting that there is a little bias in conventional estimates.

This paper attempts to investigate to what extent compulsory schooling laws continue to impact the educational attainment following Angrist and Krueger (1991). In this study, I analyze

the returns to education for 30-49 year-old men born in U.S. using 2005 American Community Survey data. This new data allows us to answer whether the returns to education has changed over time. Is the return to education higher for the more recent cohorts relative to the older cohorts as suggested by Acemoglu, 2002 or were the older cohorts earning more for given years of schooling? There is substantial evidence suggesting that the earnings of high school dropouts has been declining over the last few decades and earnings inequality is increasing in U.S. (Juhn et al.,1993). Finally, the comparison of OLS and 2SLS estimates of the returns to education with one another and with the estimates provided in Angrist and Krueger (1991) would expand our knowledge about the extent of the upward bias caused by conventional ordinary least squares estimation.

The remainder of the paper is organized as follows. Section 2 briefly reviews previous papers. Section 3 describes the data in detail. Section 4 discusses whether the compulsory schooling laws increase educational attainment of both old and young cohorts. Section 5 presents the main empirical strategy and the main results of the returns to education using both OLS and 2SLS estimates. Section 6 concludes.

2. Literature Review

An extensive literature has clearly established that the identification of the causal relationship between schooling and earnings requires an exogenous source of variation in educational choices. The intuition that compulsory schooling laws provide a natural experiment was put forward first by Angrist and Krueger (1991). They argue that hence, compulsory schooling laws forced individuals to stay in school until a certain age, those born in later quarter would stay in school longer. Margo and Finegan (1996) make similar analyses using the more detailed information on month of birth available in the 1900 census. Both studies find that the compulsory schooling laws were effective. However, the idea of using quarter of birth as an

instrument for education was criticized (Bound, Jaeger and Baker (1995) and Bound, Jaeger (1996)). These two studies discuss whether quarter (month) of birth affects education only because of compulsory schooling laws. Bound and Jaeger (1996) argue that the association between quarter of birth and both educational attainment and earnings are too strong to be explained solely by the compulsory schooling laws. They find that the observed relationship between educational attainment and quarter of birth is weaker in more recent cohorts that were less likely to have been constrained by the compulsory schooling laws. On the other hand, they also show that the strength of the association between quarter of birth and earnings is somewhat larger for more recent cohorts suggesting that factors other than compulsory schooling laws might explain the association between quarter of birth and earnings.

Despite the controversy about whether quarter of birth affects education only through compulsory schooling laws, handful of studies employed the quarter of birth as an instrument for the educational attainment. These studies investigated the impact of education on both pecuniary and non-pecuniary outcomes using quarter of birth and compulsory schooling laws. Angrist and Acemoglu (2000) use differences in school leaving laws across the United States and over time to exploit the differences in educational attainment across individuals. Students compelled to take an extra year experienced an average increase of 10.3 percent in adult earnings. Another study by Llenas-Muney (2002) examines the impact of earlier compulsory schooling laws in U.S on educational attainment and finds that legally requiring a child to attend school for one more year, either by increasing the age required to obtain a work permit or by lowering the entrance age, increased educational attainment by about 5%. Similarly, Oreopoulos (2003) investigated the long run consequences of leaving school early using changes in minimum school leaving ages and compare results across the United States, Canada and the United Kingdom. He shows that dropping out one year later increases present value income by more than 10 times forgone earnings and more than 2 times the maximum life time annual wage.

Other studies also examine non-pecuniary outcomes. Lochner and Moretti (2003) find school compulsion lowers the likelihood of committing crime or ending up in prison. And Lleras-Muney (2001) uses compulsory schooling laws to examine the effect of education on mortality. She estimates that additional year of education substantially lowers the probability of dying among elderly people. In addition, Lefgren and McIntyre (2006) using quarter of birth instruments have addressed that women's education may have positive causal effect on husband's earnings, though not on probability of marriage.

3. Data Description and Sources

The empirical analysis relies on the individual-level data from 2005 American Community Survey, which is the 1 percent random sample of the population. This is a large data set that provides information regarding poverty status, labor force participation as well as disability outcomes measures. The 2005 ACS is attractive primarily due to its massive sample size, which allows us to gauge association between (log) earnings and years of education using instrumental variables strategy. Another attractive feature of the 2005 ACS is that it is the first data set after 1980 Census Public Use Microdata Samples (PUMS, Ruggles et al., 2004) that contains information regarding quarter of birth of individuals. U.S Censuses after 1980 do not include information related to quarter of birth. Therefore, this new data sets enables us to investigate the returns to education exploiting possible seasonal differences in years of education due to compulsory schooling laws and whether these compulsory schooling laws are still effective in explaining differences in earnings across individuals.

My sample includes all white and black persons born in the United States, that are between 30 and 74 years of age in the 2005 ACS with no missing values for completed years of education. I coded the schooling variable for individuals in the 2005 ACS as highest grade

completed. The earning variable, log weekly wage, was calculated by dividing annual wage and salary income by weeks worked, and taking logs.

4. The Effect of School-Leaving Laws on School Attainment

If the fraction of students who desire to leave school before they reach the legal dropout age is constant across birthdays, a student's birthday should be expected to influence his or her ultimate educational attainment. This relationship would be expected because, in the absence of rolling admissions to school, students born in different months of the year start school at different ages. This fact, in conjunction with compulsory schooling laws, which require students to attend school until they reach a specified birthday, produces a correlation between date of birth and years of schooling.

Students who are born early in the calendar year are typically older when they enter school than children born late in the year. Because children born in the first quarter of the year enter school at an older age, they attain the legal dropout age after having attended school for a shorter period of time than those born near the end of the year. Hence, if a fixed fraction of students is constrained by the compulsory attendance law, those born in the beginning of the year will have less schooling, on average, than those born near the end of the year.

According to Angrist and Krueger (1991), using 1980 U.S Census average education is generally higher for individuals born near the end of the year than for individuals born early in the year. Furthermore, men born in the fourth quarter of the year tend to have even more education than the men born in the beginning of the following year. The third quarter births also often have a higher average number of years of education than the following year's first quarter births. Moreover, this seasonal pattern in the years of education is exhibited by the cohorts of men that experienced a secular decline in the educational levels, as well as by the cohorts that

experienced a secular increase in educational level. Using 2005 ACS, I also find the similar educational attainment results for men born between 1930 and 1949.

To further examine the seasonal pattern in the education, it is useful to remove the trend in years of education across cohorts. A flexible way to detrend the series is by subtracting off a moving average of the surrounding birth cohort's average education. For each quarter, Angrist and Krueger define a two-period, two-sided moving average, $MA (+2,-2)$, as the average education of men born in the two preceding and two succeeding quarters. Specifically, for the cohort of men born in year c and quarter j , the $MA (+2,-2)$, denoted by MA_{cj} , is

$$MA_{cj} = (E_{-2} + E_{-1} + E_{+1} + E_{+2})/4,$$

where E_q is the average years of education attained by the cohort born q quarters before or after cohort c, j . The “detrended” education series is simply $E_{cj} - MA_{cj}$.

To quantify the effect of season of birth on a variety of educational outcome variables, Angrist and Krueger estimated regressions of the form,

$$(E_{cj} - MA_{cj}) = \alpha + \sum_j \beta_j Q_{icj} + \varepsilon_{icj}$$

for $i=1, \dots, N_c$; $c=1, \dots, 10$; $j=1, 2, 3$

where E_{icj} is the educational outcome variable for individual i in cohort c (i.e. years of education, graduated high school, graduated college, or years of post-high school education). MA_{cj} is the $MA (+2,-2)$ trend for the education and Q_{icj} is a dummy variable indicating whether person i was born in the j th quarter of the year. Because the dependent variable in these regressions is purged of $MA (+2,-2)$ effects, it is necessary to delete observations born in the first two quarters and last two quarters of the sample.

Table 1 presents estimates of each quarter of birth (main) effect (β_j) relative to the fourth quarter, for the men in the 2005 American Community Survey who were born in 1930s, 1940s, 1950s, 1970s respectively. The F -tests reported in the last column of the table indicate that, after removing trend, the small within-year-of-birth differences in average years of education are highly statistically significant. Through this paper, the estimation results for the older cohorts,

men born in 1930s and 1940s, are also provided. Angrist and Krueger (1991) conducted their empirical strategy using men born in 1930s and 1940s in 1980 U.S Census. For that reason, it might be interesting to explore whether we observe the similar effects of the compulsory schooling laws on the cohorts used by Angrist and Krueger using different data set. Although, these older cohorts are more inclined to be retired by now, we still expect to observe to what extent the compulsory schooling laws had impacted their years of education depending on the quarter of birth they were born. Using 2005 ACS, I find that for the older cohorts, men born in 1930s and 1940s, the average number of completed years of schooling is about 0.1 years lower for men born in the first quarter of the year than for men born in the last quarter of the year as in Angrist and Krueger (1991) and Bound and Jaeger (1996). However, for the relatively younger cohorts, it seems that the compulsory schooling laws are not binding since we do not observe statistically significant differences between the average number of completed years of schooling of men born in the first and last quarter.

Correspondingly, from Table 1, it appears that for the 1930s cohort, men born in the first quarter of the year are 1.42 percentage points less likely to graduate from high school than men born in the last quarter of the year. For the 1940s cohort, the gap in the high school graduation rate between first and last quarter is 1.6 percentage points. The high school dropout rate is 20 percent for men born in the 1930s and 10 percent for men born in the 1940s, the first quarter births are roughly 10 percent more likely to drop out of high school than fourth quarter births. The seasonal differences in years of education and in high school graduation are smaller for men born in the 1940s than the men born in the 1930s, but the quarter- of-birth effects are still statistically significant. However, for more recent cohorts, the quarter- of-birth effects are no longer statistically significant. One potential explanation for this attenuation of the seasonal pattern in educational over time is that compulsory schooling laws are less likely to be binding for more recent cohorts.

To further explore whether the difference in education by season of birth are caused by compulsory schooling laws, the bottom part of Table 1 estimates the same set of equations for post-secondary school achievement, particularly college graduation. This specification enables us to test whether the season of birth influence education even for those who are not constrained by compulsory schooling laws since compulsory schooling laws exempt students who have graduated from high school. Therefore, if the compulsory schooling is responsible for the seasonal pattern in education, one would not expect to find such a pattern for individuals who have some post secondary education.

The quarter of birth effect in years of education is much less pronounced and quite different for the subsample of individuals who have at least a high school graduation. In this subsample for all cohorts, second quarters are more likely to have college degree than the first quarter born. The gap in college graduation between men born the second quarter and men born in the fourth quarter is statistically significant. However, in the view of enormous sample sizes (around 100,000), the F-tests are close to classical critical values for the null hypothesis that season of birth is unrelated to post-high school educational outcomes.

Although the empirical findings suggest that compulsory schooling laws are not as binding for more recent cohorts as in older cohorts, it is still worthwhile to investigate whether compulsory schooling laws have any effect on years of education of more disadvantageous groups. To do so, I generated two subsamples, one consists of black males between 30 and 50 years of age born in United States and second constitutes Hispanic males between 30 and 50 years of age born in U.S. Table 2 displays the estimates of each quarter of birth (main) effect (β_j) relative to the fourth quarter, for the black men who were born between 1955 and 1974. Table 2, overall points out that compulsory schooling laws are not binding any more for even more disadvantageous groups. In addition, low *F- statistics* reported in the last column of Table 2 supports the fact that compulsory schooling laws are not statistically significant in explaining

differences in education across individuals. Hence, similar results are obtained from the second subsample that comprises of Hispanic males; I do not report these findings.

5. The Effect of Compulsory Schooling on Earnings

Do the small differences in education for men born in different months of the year translate into differences in earnings? In Table 3, following Angrist and Krueger (1991), I use the seasonal pattern in education to calculate the rate of return to a year of education based on an application of Wald's (1940) method of fitting straight lines for men born in the 1930s, 1940s, 1950s and 1970s respectively. This estimator simply measures the returns to education as the ratio of the difference in earnings by quarter of birth to the difference in years of years of education by quarter of birth. I present estimates that compare earnings and education between men born in the first quarter of the year and men born in the last three quarters of the year.

In general, the results of the Wald estimates are greater than the OLS estimates of the return the education. For example, for 1940-1949 cohort, men born in the first quarter of the year earned a 3 percent lower weekly wage and had completed 0.053 fewer years of education than the men born in the last three quarters of the year. The ratio of two numbers is 0.612, is a consistent estimate of the return to education provided that season of birth is uncorrelated with earnings determinants other education. Furthermore, the Wald estimate is likely to provide a consistent estimate in this case because unobserved earnings determinants (e.g. ability) are likely to be uniformly distributed across people born on different dates of the year. Finally, note however that, the Wald estimates of the returns to education for two younger cohorts are not statistically significant and even has a negative sign for men between 30 and 39 years of age in 2005 ACS.

The last row of each panel in Table 3 provides the OLS estimate of the return to education. The OLS estimate is the coefficient on education from a bivariate regression of the log weekly wage on years of education. For the first two cohorts, although the Wald estimates are

higher compared to the OLS estimates, both estimates show that there is a positive association between years of education and earnings. On the other hand, for the younger cohort, the signs of the Wald estimates and OLS estimates are no longer similar and the Wald estimate is basically statistically insignificant. Once again, this empirical finding suggest that for more recent cohorts, compulsory schooling laws are no longer effective in explaining the earnings differences across individuals. Moreover, for the younger cohorts, unless the effect of age on earnings is taken into account, simple Wald estimates will be biased downward because the younger person is more likely to be on the upward sloping portion of the age-earnings profile.

A. TSLS Estimates

To improve efficiency of the estimates and control for age-related trend in earnings, Angrist and Krueger estimated the following TSLS model:

$$(1) \quad E_i = X_i\pi + \sum_c Y_{ic}\delta_c + \sum_c \sum_j Y_{ic}Q_{ij}\theta_{jc} + \varepsilon_i$$

$$(2) \quad \text{Ln } W_i = X_i\beta + \sum_c Y_{ic}\xi_c + \rho E_i + \mu_i$$

where E_i is the education of the i th individuals, X_i is a vector of covariates, Q_{ij} is dummy variable indicating whether the individual was born in quarter j ($j=1,2,3$), and Y_{ic} is a dummy variable indicating whether the individual was born in year c ($c=1,\dots,10$) and W_i is the weekly wage. The coefficient ρ is the return to education. If the residual in the wage equation, μ , is correlated with years of education due to, say omitted variables, OLS estimates of the return to education will be biased.

The excluded instruments from the wage equation in the 2SLS estimates are three quarter-of-birth dummies interacted with nine year-of-birth dummies. Because year-of-birth dummies are also included in the wage equations, the effect of education is identified by variation in education across quarters of birth within each birth year. Quarter of birth is legitimate instrument if it is uncorrelated with μ and correlated with education.

Tables 4 and 5 provide a series of 2SLS estimates of equation (2) using 2005 ACS for the 1955-1964 cohort and for the 1965-1974 cohort, respectively. For comparison, the OLS and 2SLS estimates of the each specification are presented. For example, column (1) of table 4 shows that the OLS estimate of return to education for 40-49 year old men in 2005 ACS is 0.1273, holding year-of-birth effects constant. Column (2) shows that when the same model is estimated by 2SLS using quarter-of-birth dummies as instruments for years of education, the return to education is 0.2144 percentage points. In columns (3) and (4), quadratic age term to OLS and 2SLS equations is added. This variable, which is measured up to the quarter of year, is included to control for within-year-of-birth age effects on earnings.

The remaining columns repeat the first four columns, but also include race dummies, a dummy for residence in a SMSA, a marital status dummy, and eight region-of-residence dummies. In general, the magnitude of 2SLS estimates is greater than that of OLS estimates. The reason for this finding might be three-fold. First, the classical measurement error in the variables will lead to a downward bias in the OLS estimates. Secondly, the compulsory schooling laws might be affecting individuals on the margin. It might be that for the individuals on the margin, even a single year of more schooling will lead to a huge return in terms of earnings. Therefore, 2SLS results might basically reflect the effect of compulsory schooling law on these individuals on the margin. Another possible explanation for the higher 2SLS estimate of the return to education may be the nonlinearity in the return to education. It might be that compulsory schooling laws pushes some student to graduate high school, thus the part of the 2SLS estimate might reflect a high school “completion” effect. Nevertheless, using 1980 Census data, Angrist and Krueger (1992) find a little evidence of nonlinearity in the return to education for middle-aged men with three to fifteen years of education.

Comparison of estimates presented in Table 4 with estimates provided in Angrist and Krueger (1991) suggests that for men between 40 and 49 years of age, the returns to education has increased in the 2005 ACS compare to 1980 U.S Census. For example, Angrist and Krueger

(1991) find that an OLS estimate of the returns to education is 0.0711 for the first specification. When the same model is estimated by 2SLS using quarter of birth dummies interacted with year of birth dummies as instruments for educational attainment, the returns to education is 0.0891. Similarly, in all specifications, for men between 40 and 49 years of age, the magnitude of both OLS and 2SLS estimates are higher when using 2005 ACS compared to the 1980 U.S Census.

Table 5 displays estimates of the same set of models using 30-39 year-old men from 2005 ACS. From Table 5, the OLS estimates of the returns to education for 30-39 year-old men is 0.1185. Column (2) of Table 5 illustrates that the returns to education is 0.1348 when we use a full set of quarter-of-birth dummies interacted with year-of-birth as an instrument for years of schooling. In the following columns of Table 5, same model specifications are presented as in Table 4 for 30-39 year-old-men in 2005 ACS. The empirical findings from Table 4 and Table 5 suggest that for 30-39 year-old men, the magnitude of 2SLS estimates of the returns to education declines considerably compared to older cohort. Therefore, there is reason to believe that the compulsory schooling laws are not binding any more for recent cohorts. Indeed, the return to extra year of education due to compulsory schooling laws is decreasing over time. Moreover, Table 5 implies that regardless of the set of included regressors, the 2SLS and OLS estimates of the return to education for younger sample are close in magnitude and the difference is never statistically significant. Although, the Wald estimates of 1965-1974 cohort is negative and statistically insignificant, the 2SLS estimate of the return to education is positive and statistically significant.

In addition to the log weekly wage, I have also examined the impact of compulsory schooling on the log of annual salary and on weeks worked. The 2SLS estimates of the returns to education remain virtually unchanged when using the log of annual salary as a measure of earnings. However, I do find that 2SLS estimates of the returns to education are not statistically significant any more when weeks worked is used as a dependent variable. For example, for the model presented in column (8) of Table 4 and 5, the 2SLS estimate of the return to education is

0.2031 with a standard error of 0.6726 when weeks worked is the dependent variable instead of log of weekly wage.

B. Allowing the Seasonal Pattern in Education to Vary by State of Birth

Although most of the schools admit students born in the beginning of the year at an older age, school start age policy varies across states and across school districts within many states. Since compulsory schooling constrains some students to remain in school until their birthday, the relationship between education and quarter of birth is expected to vary among states that have different start age policies. Despite the fact that including too many instruments cast doubt on the implementation of instrumental variable strategy due to weak instrument challenge (Bound, Jaeger and Baker ,1995) , it is still worthwhile to examine the returns to education allowing the seasonal pattern in education to vary by state of birth.

To exploit the cross-state-seasonal variation in education, following Angrist and Krueger, I computed 2SLS estimates that use a set of three quarter of birth dummies interacted with fifty one states dummies, in addition to the three quarter-of-birth dummies interacted with nine year of-birth dummies. The estimates also include fifty state-of-birth dummies in the wage equation, so variability in education used to identify the return to education in 2SLS estimates is truly due to differences by season of birth. In this new specification, season of birth is allowed to vary by state as well as by birth year.

Table 6 shows the 2SLS and OLS estimates of the returns to education of this new specification for 40-49 year old men in 2005 ACS. This is the same sample used in estimation of Table 4. Table 6 reveals that including state of birth interacted with quarter-of-birth as an instrument and state-of-birth as a control in the wage equation, the standard errors of the 2SLS declines approximately 50 percent relative to the 2SLS standard errors in Table 4. In addition, in all specifications presented in Table 6, estimated return to education in 2SLS models is greater

than the corresponding 2SLS estimates in Table 4, whereas the estimated returns to education using OLS estimation remain virtually unchanged when using state of birth. Moreover, unlike Table 4, in Table 6, the estimates of returns to education obtained using 2SLS are slightly greater than the corresponding OLS estimates and 2SLS and OLS estimates are not statistically significantly different from each other.

6. Conclusion

This paper uses information regarding quarter of birth to gauge the returns to education due to compulsory schooling laws. To do so, following Angrist and Krueger (1991), I exploit the educational attainment differences across individuals due to compulsory schooling laws using 2005 American Community Survey. I investigate whether these laws are still effective and if so, to what extent they impact future earnings. Differences in quarter of birth create a natural experiment that enables us to study the effect of school compulsion on schooling and earnings. Hence, due to the compulsory schooling laws, individuals born later in a given year are forced to stay longer in school and that creates variation in educational attainment across individuals. The exploration of the relationship between quarter of birth and educational attainment suggest that for the older cohorts, men born between 1930 and 1949, the compulsion in schooling leads to a remarkable increase in both schooling and earnings for men born in the last quarter relative to men born in the first quarter. However, analysis for the younger cohorts, men born between 1955 and 1974, suggests that compulsory attendance laws are not binding any more so that these laws no longer serve as a mechanism that assists us in explaining the differences in individuals' educational attainment.

Using quarter of birth as an instrument for education in an earnings equation for men between 30 and 49 years of age, I find that returns to education has increased in 2005 ACS data compared to the 1980 U.S Census. However, the weak association between quarter of birth and

years of schooling cast doubt on using quarter of birth as an instrument for educational attainment. Therefore, it is likely that the higher estimates of the returns to education obtained using 2005 ACS might be due to the omitted variables.

The empirical results point out that the compulsory schooling laws are not effective for recent cohorts. On the other hand, these laws compelled older cohorts to stay longer in school and this extra schooling contributed to their future earnings. These findings yet shed some light on the effectiveness of compulsory schooling particularly for developing countries. A large fraction of developing countries either lack compulsory schooling laws or have school compulsion less than 12 years. Although, a complete answer requires additional research on the social and private cost of compulsory school attendance, the results suggest that compulsory schooling will be beneficiary for developing countries in enhancing education and earnings.

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