Will Receiving More Education Make People Healthier?

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Abstract

This paper studies the effect of education on people's health conditions. Normal OLS estimation is confounded by omitted variable bias, such as people's time preference and discount value for the future. So, instrument variables and two-stage least squares are applied. The instrument is the minimum number of years required before dropping from school. It varies at the state-year level. The outcome variable is the hours of sickness absence in 1968. The results do not show that education has a significant effect on health. But the insignificant effect could stem from the weak correlation between instruments and endogenous variables.

1 Introduction

Literature shows that education has a positive correlation with health. But whether there is a causal relation between them is still unclear. Endogeneity is a serious problem. Omitted variables, such as time preference or discount rate for the future, will make the causal estimation biased. So, this paper uses an instrument variable, years of compulsory schooling, and the two-stage least square method to study if receiving more education could make people healthier. The results do not show that education has a significant effect on the individual health condition.

Katz (1976) shows that, between 1900 and 1930, compulsory schooling laws were implemented strictly in each state and by 1920, more than 85% of children eligible for schooling were enrolled in schools."In 1900 the mean legal age for leaving school was 14 years and five months in states with such laws. By the 1920s, this age had risen to 16 years and three months, and thirty-one of the forty-eight state required school attendance until age 16."(Katz (1976)). Kotin & Aikman (1980) argues that compulsory schooling laws make it legitimate for children to receive the proper education because several mechanisms can guarantee the implementation of these laws. Kotin & Aikman (1980) claims that the Fair Labor Standards Act of 1938 requires children cannot leave school until they reach the compulsory schooling age. Thus, combined with child labor laws, mandatory schooling laws prevent children from employment during schooling age.

Grossman (2000) suggests that there is a strong correlation between education and individual health. There are three possible explanations. First, a good education does causally make people have better health. People with higher education levels could understand and trust medical technology better (Grossman (2000)). Second, education does not determine health. Instead, health can causally determine education (Grossman (2000)). Healthier people are more likely to receive more education. If someone is unhealthy during his childhood, he may be absent or even drop from school. Third, both of the above two arguments are unreasonable. There is no causal relation between education and health (Grossman (2000)). There is a serious omitted variable bias in this problem. The most popular omitted variable is time preference. Farrell & Fuchs (1982) argues that a low discount rate for the future will make people value the future more and invest more in education and health. So, the low discount rate of future utility makes people receive more education and become healthier because education and health will make one have a better life in a more extended period. Thus, the effect of schooling on health is biased if one fails to solve the endogeneity problem.

Berger & Leigh (1989) uses two-stage least squares to estimate the causal relationship between education and health. The instrument Berger & Leigh (1989) used are "average per-capita disposable income and expenditures on education from the year of birth to age six for each individual". Leigh & Dhir (1997) later uses similar instruments [1] to estimate the relationship between schooling and health.

However, there are some problems with the instruments used in the above studies. Parents' income and parents' years of schooling are very likely to be correlated with their children's time preference. The correlation between average actual per capita expenditures on education in the state is expected to be weakly correlated with one's years of schooling because the state's spending on education could be used in anything related to education. It may not increase people's education directly.

Acemoglu & Angrist (1999) used two instruments, "minimum years required before dropping from school and minimum years required before working", to estimate social returns to education. This paper adopts the first instrument they use. Both these two instruments are measured from the state-year when the individual is 14-year-old. Since sometimes they cannot find the detailed record of the instrument variables and the values from different records could contradict each other, they construct the Years of Compulsory Schooling (minimum years required before dropping from school). It is "the larger of schooling required before dropping out and the difference between the minimum dropout age and the maximum enrollment age"(Acemoglu & Angrist (1999)),

$$YCS = max\{reg\_sch; drop\_age - enroll\_age\}^{2} \tag{1}$$

In their paper, since YCS is concentrated in the 8 - 12 range, they classify YCS into 4 categories: (0, 8], 9, 10, [11, 12]. However, to capture the variation more explicitly, this paper does not follow its classification and uses its original instrument's values instead. The distribution of the instrument's value can be seen from figure 6.

In their first-stage estimation, the baseline level of compulsory schooling year is eight or fewer years. So, compared with baseline, people will receive more 0.117, 0.095, and 0.167 years of educa-

[1] The instruments Leigh & Dhir (1997) uses are "mother's and father's years of completed schooling, measures of the parents' wealth when the subject was young and state of residence when young".

[2] This is the formula used by Acemoglu & Angrist (1999) to construc YCS.

tion if compulsory schooling years are 9, 10, and above 11, respectively. Their first-stage estimation results are robust across different specifications.

Lleras-Muney (2005) used a similar instrument as this paper, the years of education required in each state's compulsory schooling law, to estimate the relationship between education and adult mortality. Her first-stage results show that the general trend between years of compulsory schooling and education is increasing. However, it is not constantly increasing because individuals in the sample are very unequally distributed, and compliance with the law is not guaranteed. Her two-staged least square estimation shows that one more year of schooling will decrease the probability of death by 3.7%. However, death is so extreme, and it may not reflect one's general health condition. This paper uses the absent hour caused by illness, which is supposed to measure one's health condition better.

2 Data

Table 1: Summary Statistics

	Individual Years of Education		Hours of Sickness Absence		
	Mean	Standard Error	Mean	Standard Error	N
Years of Compulsory Schooling					
0	3.26	0.27	21.05	12.35	38
4	3.25	0.39	84.00	43.85	16
5	1.63	0.78	15.00	15.00	8
6	2.20	0.11	127.89	23.20	238
7	2.65	0.07	100.10	8.66	657
8	3.87	0.07	96.82	9.05	947
9	3.86	0.04	91.70	4.55	2687
10	3.55	0.08	99.14	11.56	477
11	5.00	0.45	44.63	12.81	19
12	4.29	0.05	65.16	4.75	1062
Sex & Race					
Female	3.63	0.06	85.31	6.62	856
Male	3.73	0.03	90.85	3.34	5293
Black	2.83	0.04	107.01	5.66	1992
White	4.14	0.03	81.97	3.53	4157

The main data source is the 1968 longitudinal survey of The Panel Study of Income Dynamics (PSID). I choose the year 1968 because most respondents in that survey experienced the change of compulsory schooling law during 1910 - 1930 in the US. I used the years of compulsory schooling at each state each year as an instrument for people's years of schooling. The data of the instrument is from Acemoglu and Angrist(1999). I used people's absent hours caused by illness in 1968 as the outcome variable to measure health conditions. The main independent variable is people's years of schooling. Since both years of compulsory schooling and individual schooling years are categorical variables, I did the regression treating YCS as categorical and continuous variables separately. All the regressions in this paper include born-state and year-fixed effects. I also include sex and race fixed effects in some regressions to check the robustness of the results. The standard errors of all regression are clustered at state-year level [3]. Table 1 shows the summary statistics.

3 Research Design

Inspired by Lleras-Muney (2005), the instrument I used is years of compulsory schooling. It is from the year when an individual is 14-year-old. So, I will first check the validity of the instrument variable.

$$E_{iut} = \beta(IV_{ut}) + state_u + year_t + state_u t + sex_i + race_i + \epsilon_{uit} \tag{2}$$

In the above equation, E_{iut} is the number of years of schooling completed by individual i born in state u and was 14-year-old in year t. $state_u$ and $year_t$ are the state and time fixed effects. $state_u t$ is the state-specific linear time trend and is intended to capture the differential trends in each state over time. sex_i and $race_i$ are the fixed effect of sex and race of individual i.

IV_{ut} refers to the years of compulsory schooling in state u at year t. Since IV_{ut} is an integer and not continuous, I report the results treating it as a series of dummy variables and continuous variables separately.

I also estimate the reduced form - regressing the number of compulsory years of schooling directly on health outcomes, which serves as the baseline result of this paper.

$$H_{iut} = \alpha(IV_{ut}) + state_u + year_t + state_u t + sex_i + race_i + \epsilon_{uit} \tag{3}$$

H_{iut} is individual i's hours of sickness absence. He was born in state u and 14-year-old in year t.

The main two-stage least square regressions are,

$$E_{iut} = \beta(IV_{ut}) + state_u + year_t + state_u t + sex_i + race_i + \epsilon_{uit} \tag{4}$$

$$H_{iut} = \gamma(\widehat{E_{iut}}) + state_u + year_t + state_u t + sex_i + race_i + \epsilon_{uit} \tag{5}$$

$\widehat{E_{iut}}$ is from the prediction value from the first stage. To test the robustness and hetergeneous effect of education, I will also estimate 2SLS for different income groups.

The key identifying assumptions are the below,

1. Exogeneity($Cov(IV, \epsilon) = 0$). The instrument variable should not be correlated with the error term. That is to say, the implementation of compulsory education law should be random across different states. This can hard be satisfied. Katz (1976) shows that more industrialized and wealthy states are more likely to enact such law since those states have a higher demand for well-educated labor forces. Also, it is reasonable to think that parents in more developed

[3] state refers to the born-state. Year refers to the year when the individual is 14-year-old

countries are inclined to let their children receive more education. So, the instrument is not perfectly exogenous. However, since the state and year fixed effect are included, we exclude the time-invariant factors, such as developed condition. What we need to worry about is if there are any time-variant variables which are correlated with the IV and the outcome variable simultaneously. Such variables would make the exogeneity assumption violated.

2. Exclusive restriction assumption. The instrument variable, years of compulsory schooling, should only affect the individual's health condition through individual actual years of schooling. This assumption should be satisfied, since compulsory schooling law only affects children's years of schooling. It does not affect any other factors.

3. No spillover effect. I assume that students are only affected by the law in the state where they live. For example, if one child lives in the boundary of state A and B. He lives in state A but chooses to go to school in state B. So, it is the law of state B that affects his education status. If B's law require more years of schooling, then the child will receive more education than her friends living in state A. This is the spillover effect. I assume children will just receive education from where they live in.

4 Model

4.1 Baseline Model

The below model corresponds to an individual's adulthood instead of childhood. Inspired by Becker (2007), the individual maximizes,

$$U[h(\beta, e), x, l] \tag{6}$$

subjected to the income constraint,

$$h(\beta, e) + x = (1 - l)w(e) \tag{7}$$

h represents the expenditure on health. β is the exogenous time preference (i.e., discount rate for future). If β is high, the individual can delay gratification and value future utility more. Thus, he will be more willing to invest in health and live longer. In the two periods model later, β will be correlated with education level. We assume that, $\frac{\partial h}{\partial \beta} > 0$. e is the years of completed education. Since individuals do not pay for their tuition fee (their parents will pay for it), the cost of education is not included in the individual budget constraint. One important assumption is that receiving more education will make people spend more on their health ($\frac{\partial H}{\partial e} > 0$) because people will understand medicine knowledge better and trust modern medicine more if they have higher education. This is a very strong assumption and will be relaxed in the two-period model later. x is numeraire good, and the cost is normalized to one. l is leisure time. w is the wage and it is increasing with education ($\frac{\partial w}{\partial e} > 0$). So,$1 - l$ means the time that an individual can spend on work.

Individual's utility is determined by his investment in health, consumption of other numeraire goods, and leisure time. Time preference and education level will determine his health expenditure.

Solving the above maximization problem will give us,

$$\frac{\partial U}{\partial x} = -\lambda \tag{8}$$

$$\frac{\partial U}{\partial l} = -\lambda w(e) \tag{9}$$

$$\frac{\partial U}{\partial h}\frac{\partial h}{\partial e} + \lambda\frac{\partial h}{\partial e} - \lambda(1-l)w'(e) = 0 \tag{10}$$

If we do some simple rearrangement of equation 10, we will get,

$$\frac{\frac{\partial U}{\partial h}}{\frac{\partial U}{\partial x}} = \frac{(l-1)w'(e)}{\frac{\partial h}{\partial e}} + 1 \tag{11}$$

Equation 11 gives us the marginal rate of substitution between health expenditure and numeraire good. I define this as individual's marginal willingness to pay for health. It means , given the utility fixed, the amount of consumption of numeraire good that individual is willing to give up to purchase one unit of health. I define the MWTP as $MWTP_{hx}$. So, equation 11 gives us $MWTP_{hx}$. To figure out the effect of education on individual's MWTP for health, I calculate the partial derivative of both sides of equation 11 regarding e (i.e.$\frac{\partial MWTP_{hx}}{\partial e}$),

$$\frac{\partial MWTP_{hx}}{\partial e} = \frac{(l-1)(w''(e)h'(e) - w'(e)h''(e))}{(h'(e))^2} \tag{12}$$

Now, we make two assumptions,

$$|w''(e)| > |h''(e)| \tag{13}$$

$$w'(e) < h'(e) \tag{14}$$

It is natural to assume that $w''(e) < 0$ and $h''(e) < 0$ because the marginal utility of receiving more education is decreasing for wage and health expenditure.

The interpretation of equation 13 is that the variation of the marginal effect of education on wage is greater than the variation of the marginal effect of education on health expenditure. For example, for students who already have a bachelor degree, the marginal impact of a master or even a Ph.D. degree on their final income is not high. But, for students only with a middle school degree, the marginal effect of a high school degree or a bachelor degree is so huge. Thus, the variation of the marginal effect of education on wage is huge. However, the variation of the marginal effect of education on health expenditure is not that great. One more year of schooling will increase your understanding of medical knowledge, and that marginal effect on health expenditure does not vary significantly.

The interpretation of equation 14 is that the effect of one more year of schooling on income is less than the effect of one more year of education on health expenditure. The impact of education on income only matters for some critical education stage, such as the graduation year of middle school, high school, and college, because you will achieve a higher and new degree. Within each education stage, the effect of education on income is not so significant because your highest degree obtained does not change. However, no matter which education stage you are in, when people have one more year of education, their cognition ability will increase to understand medicine better and invest more in the future.

So, with equation 13 and 14, we can conclude that $\frac{\partial MWTP_{hx}}{\partial e} > 0$. This means that when people receive higher education, their marginal willingness to pay for health is higher.

4.2 Two-Period Model

Based on the model of Becker (2007), The individual two-period utility is below,

$$U_0(x_0, l_0) + \beta(e)s_1(h)U_1(x_1, h_1) \tag{15}$$

U_0 is an individual's utility in period 0. It can be interpreted as childhood time. x_0 and l_0 are the numeraire good and leisure time then. s_1 is the surviving probability in period 1. It measures the probability that an individual can live to period one from period 0. It is increasing with the expenditure on health, $\frac{s_1}{h} > 0$. U_1 is an individual's utility in period 1. $\beta(e)$ means the time preference is related to years of completed schooling. When β is high, it means people value future utility more. $\beta'(e) > 0$ and $\beta''(e) < 0$. People with higher education can delay gratification and value the future more than people with less education. I also assume $w'(e) > 0$ and $w''(e) < 0$. Wage is increasing with an individual's education level.

The budget constraint is,

$$x_0 + \frac{s_1 x_1}{1+r} + h + e = w_0(1 - l_0) + \frac{s_1 w_1(e)(1 - l_1)}{1+r} \tag{16}$$

r is the risk-free rate. It can be understood as the interest rate in the bank. All future utility should be discounted by the interest rate to now. The LHS of equation 16 is the total consumption in period 0 and period 1. The RHS is the total income in period 0 and period 1.

Thus, the individual maximizes,

$$U_0(x_0, l_0) + \beta(e)s_1(h)U_1(x_1, h_1) + \lambda(x_0 + \frac{s_1 x_1}{1+r} + h + e - w_0(1 - l_0) + \frac{s_1 w_1(e)(1 - l_1)}{1+r}) \tag{17}$$

The FOC regarding education, e, gives us,

$$\beta'(e)s_1(h)U_1(x_1, h_1) + \lambda - \frac{\lambda(1 - l_1)}{1+r} s_1 w_1(e)' = 0 \tag{18}$$

After rearrangement, we get,

$$s_1 = \frac{\partial U_0}{\partial x_0} \frac{1}{\beta'(e)U_1(x_1, l_1) + \frac{\partial U_0}{\partial x_0}\frac{1-l_1}{1+r}w_1'(e)} \tag{19}$$

$$\frac{\partial s_1}{\partial e} = -\frac{\partial U_0}{\partial x_0} \times \frac{\beta''(e)U_1(x_1, l_1) + \frac{\partial U_0}{\partial x_0}\frac{1-l_1}{1+r}w_1''(e)}{[\beta'(e)U_1(x_1, l_1) + \frac{\partial U_0}{\partial x_0}\frac{1-l_1}{1+r}w_1'(e)]^2} \tag{20}$$

Since $\beta''(e) < 0$ and $w_1''(e) < 0$, the RHS of above equation is positive. Thus, we get,

$$\frac{\partial s_1}{\partial e} > 0 \tag{21}$$

This is the key conclusion of this model that the surviving probability from period 0 to period one increases with one's education level. If you receive more education, you are more willing to invest in health to live longer.

In equation 17, I do not include years of schooling into the surviving function, s, directly. In the below model, I assume $s'(e) > 0$,

$$U_0(x_0, l_0) + \beta(e)s_1(e, h)U_1(x_1, h_1) + \lambda(x_0 + \frac{s_1 x_1}{1+r} + h + e - w_0(1 - l_0) - \frac{s_1 w_1(e)(1 - l_1)}{1+r}) \tag{22}$$

The FOC regarding e gives us,

$$U_1[\beta'(e)s_1(e) + \beta(e)s_1'(e)] = U_{0x}\frac{1}{1+r}[x_1 s_1'(e) - (1 - l_1)(s_1'(e)w_1(e) + s_1(e)w_1'(e))] \tag{23}$$

The above equations define the optimal level of education when time preference and survival probability are both affected by education level. The LHS of equation 23 is the marginal utility brought by one unit of increased education investment. It is caused by the marginal increase in the survival probability and discount rate for future utility. The RHS of equation 23 is the marginal cost of increasing education expenditure in period 0. Since the LHS is always positive, the RHS is also positive. Thus,

$$x_1 s_1'(e) - (1 - l_1)[s_1'(e)w_1(e) + s_1(e)w_1'(e)] > 0 \tag{24}$$

We define $\triangle w_1$ as the increased income caused by the increased education investment in period 0. The interpretation is that, in period 1, the increased income, $\triangle w_1$, is not sufficient to pay for the increased $\triangle x_1$ he consumed. That gap divided by the interest rate is the marginal cost of increasing one unit of education investment in period 0. Since the first term in the RHS of equation 23 is the marginal utility of consuming one more unity of numeraire good in period 0, $\frac{\partial U_0}{\partial x}$(i.e.$U_{0x}$). Thus, the marginal cost of increasing one additional unit of education in period 0 (RHS of equation 23) is measured by the opportunity cost of purchasing numeraire good, x, in period 0. Since the individual knows he will have a higher surviving probability after investing more in education, he will consume less in period 0 and save some money for period 1 for the additional consumption of numeraire good in period 1.

So, the key conclusions from all the above models are that MWTP for the health of highly educated people is large, and they will have a higher surviving probability. Because the number of observations with non-missing values for health expenditure is so small in my dataset, I cannot empirically test the first conclusion. The following paper will test the second conclusion, people with higher education will be healthier (i.e.$\frac{\partial s_1}{\partial e} > 0$).

5 Empirical Results

5.1 The Validity of Instrument

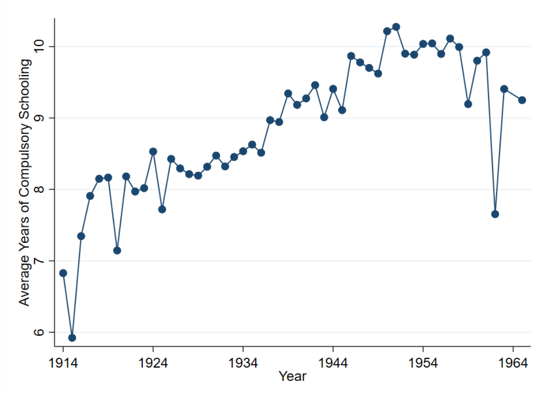

Figure 1: Years of Compulsory Schooling and Time of Implementation

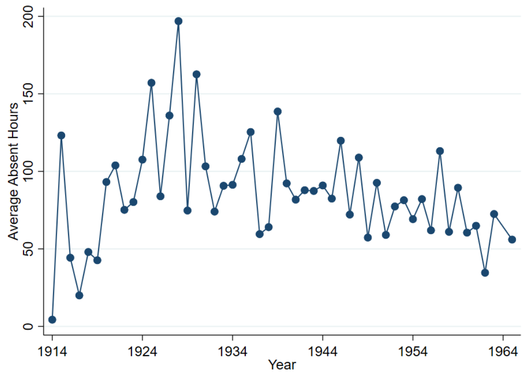

Figure 2: Hours of Sickness Absence and Time. The value on y-axis is calculated from the average hours of absence of people who are 14-year-old in the corresponding year in x-axis.

Figure 1 shows that from 1914 to 1964, the years of compulsory schooling are increasing. Figure 2 shows that, within the same period, people's hours of sickness absence is decreasing, but the trend has great fluctuation. Combining the above two figures shows that the general trend between people's hours of absence and years of compulsory schooling decreases but with significant variation between 1924 and 1934.

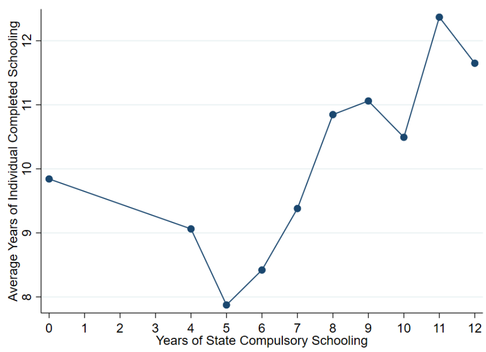

Figure 3: Average Years of Individual Completed Schooling and Years of Compulsory Schooling

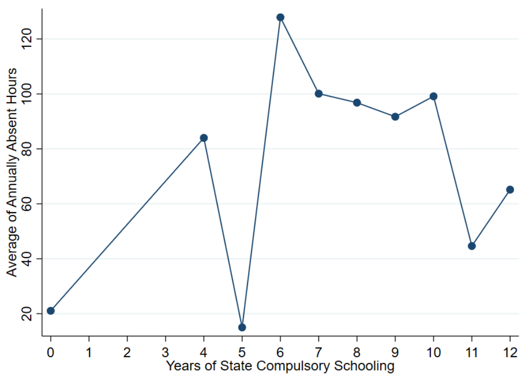

Figure 4: Average Hours of Absence and Years of Compulsory Schooling

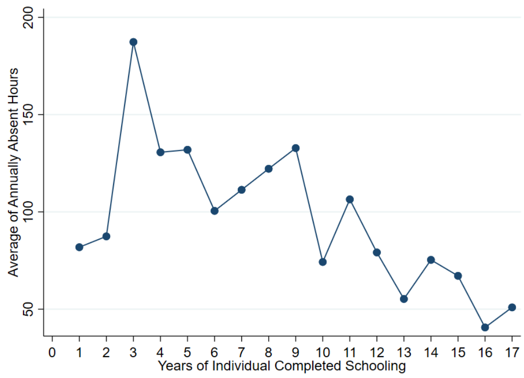

Figure 5: Average Hours of Absence and Years of Individual Completed Schooling

Figure 4 and figure 5 show that the hours of absence does not decrease monotonically by increasing years of compulsory schooling or individual completed education. The general trend is decreasing but with great fluctuation.

Figure 3 shows that if the years of compulsory schooling are greater than 5, then there is a strong positive correlation between the instrument and endogenous variable. However, if it is less than 5, there is a converse relationship between them. We can see a similar trend in figure 4. Before five years, the hours of absence varies significantly with years of compulsory schooling. Such inconsistent trends greatly reduce the correlation between IV and the endogenous variable. In the following analysis, I also checked the results, which do not include the data with less than five years of compulsory schooling. The instrument variable should be more valid in that situation.

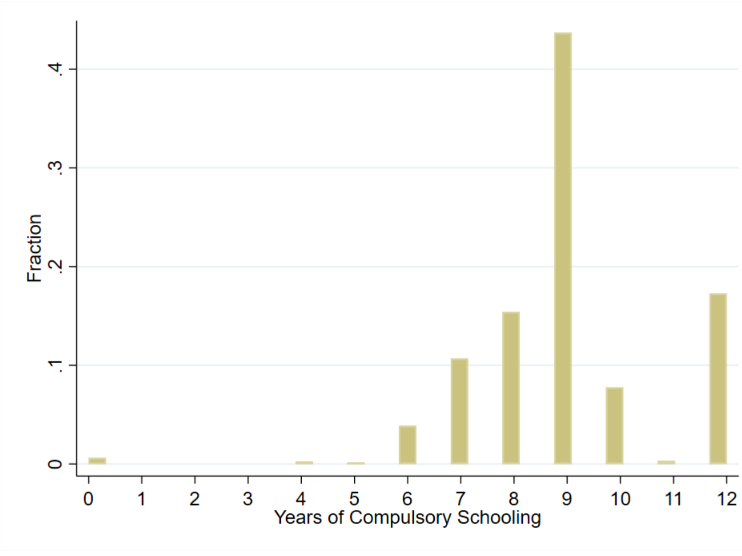

Figure 6: Distribution of Years of Compulsory Schooling

Figure 6 shows that the value of years of compulsory schooling is mainly concentrated around 6 - 12 years. Since the variation is not so significant, this is may make it hard for us to detect the effect of years of compulsory schooling on an individual actual education level.

Table 2 shows the result of first-stage treating instrument as categorical variables and continuous variables. All the columns include born-state and year when the respondent is a 14-year-old fixed effect. Column 2 and column 3 include race and sex fixed effect. None of the coefficients are statistically significant in both panel A and panel B. All four results in panel A are less than 0.1, and the standard error is almost the same. Panel A shows that with the inclusion of born-state and year fixed effect, years of compulsory schooling almost does not affect individual real years of schooling. The F-test values of all four columns in panel B are less than 3, indicating that the instruments are not collectively significant. Column 1 and column 2 of panel B also show that all the coefficients except 11 years are negative. Since the baseline level is 0 years of compulsory schooling, column 1 and column 2 show that more years of compulsory schooling do not significantly affect one's actual year of schooling. Such results are robust when observations with YCS less than five are excluded. Although none of the coefficient values are significant in column 3 and column 4 of panel B, most of them are positive. In a word, table 2 shows that the instrument, years of compulsory schooling, cannot determine the endogenous variable, individual years of schooling.

Table 2: First Stage: Effect of Years of Compulsory Schooling(YCS) on Individual Actual Years of Schooling

	(1)	(2)	(3)	(4)
A.Years of Compulsory Schooling (Continuous)				
YCS	0.018	0.027	0.053	0.062
	(0.037)	(0.036)	(0.042)	(0.041)
N	6,149	6,149	6,095	6,095
B.Years of Compulsory Schooling (Categorical)				
4	-0.696	-0.139		
	(0.885)	(0.864)		
5	-1.200	-0.892		
	(0.925)	(0.901)		
6	-0.978	-0.823	0.063	-0.043
	(0.640)	(0.649)	(0.947)	(1.078)
7	-0.721	-0.614	0.337	0.176
	(0.641)	(0.656)	(0.909)	(1.056)
8	-0.543	-0.412	0.505	0.374
	(0.638)	(0.656)	(0.909)	(1.057)
9	-0.260	-0.147	0.801	0.653
	(0.612)	(0.631)	(0.902)	(1.053)
10	-0.325	-0.126	0.743	0.678
	(0.627)	(0.647)	(0.923)	(1.066)
11	1.183	1.443	2.263*	2.267*
	(1.053)	(1.000)	(1.246)	(1.314)
12	-0.494	-0.338	0.570	0.468
	(0.627)	(0.645)	(0.913)	(1.057)
F-value	1.89	2.10	2.31	2.97
N	6,149	6,149	6,095	6,095
Race & Sex		Yes		Yes
Without YCS < 5			Yes	Yes

Notes: YCS are treated as a series of categorical variables. The outcome variable for each column is individual actual years of schooling. Race & Sex includes sex and race fixed effect. All the columns include born-state and year-fixed effect. *Without YCS<5* indicates whether the regression of this column excludes data that has YCS < 5. Because Figure 3 shows that when YCS < 5, individual years of schooling is decreasing with years of compulsory schooling, excluding the data with YCS less than 5 could increase the validity of the instrument. The baseline level for columns 1 and 2 in panel B are YCS $= 0$. Since YCS < 5 is excluded in column 3 and column 4 of panel B, the baseline level are YCS $= 5$. Standard errors are clustered at the state-year level. The regression follows equation 2.

5.2 Reduced Form

Table 3 shows the reduced form's results. Reduced form (Equation 3) estimates the effect of compulsory education on individual's health condition. It may incorporate the effect that from compulsory education but not from individual actual education level. All the four columns here include born-state and year-fixed effects. All the coefficients in Panel A are negative and almost not significant. In Panel A, the drop of observation with YCS less than five makes the coefficient larger. In panel B, although some values are significant, the value itself are quite large. It makes no sense to think that, compare with zero years of compulsory schooling, 12 years of compulsory schooling can increase people's absent hour 28 or 90 in expectation.

Table 3: Reduced Form: Effect of Years of Compulsory Schooling(YCS) on Individual Hours of Absence

	(1)	(2)	(3)	(4)
A. Years of Compulsory Schooling (Continuous)				
YCS	-2.750	-2.869	-7.994*	-8.135*
	(3.568)	(3.568)	(4.627)	(4.632)
N	6,149	6,149	6,087	6,087
B. Years of Compulsory Schooling (Categorical)				
4	96.207	89.756		
	(72.239)	(70.304)		
5	-48.618	-52.755		
	(90.257)	(90.091)		
6	84.859**	83.441**	143.778	145.535
	(41.727)	(41.831)	(114.057)	(113.431)
7	60.721	59.591	120.712	122.903
	(38.912)	(38.599)	(108.452)	(107.846)
8	78.711**	77.352**	140.477	142.312
	(38.140)	(37.812)	(110.351)	(109.773)
9	77.536**	76.374**	139.350	141.373
	(34.742)	(34.469)	(111.715)	(111.124)
10	87.353**	85.094**	149.430	150.419
	(34.640)	(34.539)	(112.685)	(112.088)
11	91.153**	88.152*	154.491	154.643
	(45.702)	(45.375)	(115.271)	(114.569)
12	28.161	26.379	90.626	92.010
	(38.755)	(38.553)	(110.140)	(109.534)
N	6,149	6,149	6,095	6,095
Race & Sex		Yes		Yes
Without YCS < 5			Yes	Yes

Notes: The regression models follow equation 3. Race & Sex includes sex and race fixed effect. *YCS < 5* indicates whether the regression of this column excludes data which has YCS < 5. Because Figure 3 shows that when YCS < 5, individual years of schooling is decreasing with years of compulsory schooling, excluding the data with YCS less than 5 could increase the validity of the instrument. Standard errors are clustered at the state-year level. All columns include born-state and year fixed effect.

5.3 IV Estimate of the Effect of Education on Health

Table 4 shows the 2SLS results of the effect of years of compulsory schooling on the individual health condition. All the coefficients in panel A are negative but insignificant. The large standard error indicates that the estimation is very inaccurate. All the coefficients in panel B are also negligible. But the standard error is smaller compared with panel A. Due to the large standard error and insignificant coefficient values, we cannot conclude that individual years of schooling have a causal impact on his/her health condition.

Table 5 shows the 2SLS estimation of education on individual health within different income groups using the instrument as a continuous variable. None of the coefficients are statistically significant in these two panels. The standard errors of column 2 in panel A and panel B are 3189 and 77, respectively. This probably indicates the sample can not represent the whole population. In a word, table 5 shows that there is no heterogeneous effect among different income groups.

Table 4: 2SLS: Effect of Years of Compulsory Schooling(YCS) on Individual Hours of Absence

	(1)	(2)	(3)	(4)
A. Years of Compulsory Schooling (Continuous)				
Years of Schooling	-150.784	-106.928	-153.831	-133.561
	(329.985)	(180.414)	(146.466)	(112.059)
N	6,149	6,149	6,087	6,087
B. Years of Compulsory Schooling (Categorical)				
Years of Schooling	25.647	27.762	34.864	33.462
	(29.821)	(29.516)	(31.529)	(30.379)
N	6,149	6,149	6,087	6,087
Race & Sex		Yes		Yes
Without YCS < 5			Yes	Yes

Notes: The regression models follow equation 4 and 5. Race & Sex includes sex and race fixed effect. $YCS < 5$ indicates whether the regression of this column excludes data which has YCS < 5. Because Figure 3 shows that when YCS < 5, individual years of schooling is decreasing with years of compulsory schooling, excluding the data with YCS less than 5 could increase the validity of the instrument. Standard errors are clustered at the state-year level. All columns include born-state and year fixed effect.

Table 5: 2SLS: Hetergeneous Effect of Education on Health Within Different Income Groups

	(1) <2000	(2) 2000 - 4000	(3) 4000 - 6000	(4) 6000 - 8000	(5) 8000 -
A. Full Dataset					
Years of Schooling	84.828	-657.347	225.155	54.300	-140.395
	(306.097)	(3,189.845)	(352.299)	(96.453)	(195.786)
N	801	1,090	1,352	1,164	1,688
B. Dataset Without YCS < 5					
Years of Schooling	-4.695	-22.756	145.608	70.144	-135.641
	(74.418)	(77.042)	(213.015)	(99.758)	(203.455)
N	821	1,106	1,361	1,168	1,693
Race & Sex	Yes	Yes	Yes	Yes	Yes

Notes: The dependent variable is individual hours of sickness absence and the instrument is years of compulsory schooling. The instrument is treated as a continuous variable. All the regressions in this table include sex, race, the year, and the born-state fixed effect. Standard errors are clustered at the state-year level. Each Column represents a different income group. The first panel includes all the data and the second panel only uses data without YCS less than 5 years.

6 Conclusion

This paper uses two-stage least squares to estimate the effect of schooling on people's health. The result does not show that higher education people are healthier compared with lower education people.

There are some limits to this paper. The converse relation between the instrument and endogenous variable in Figure 3 before 5-year show that the instrument do not have a strong correlation with the endogenous variable. However, even if we exclude that part of the data, we still do not find a significant causal relationship between education and health.

Another concern is that, even though compulsory schooling law directly affects children's years of schooling, the instrument does not vary significantly across states and years. Figure 6 shows that most of the values are concentrated around 6 - 12 years. Ideally, I should focus on the generation born around the years when the US states started implementing compulsory schooling law. So, I will compare people born before implementing any compulsory schooling and born right after that law is implemented. Such instruments would have more significant variation and thus produce a more accurate estimate.

References

Acemoglu, D., & Angrist, J. (1999). *How large are the social returns to education? evidence from compulsory schooling laws* (Tech. Rep.). National bureau of economic research.

Becker, G. S. (2007). Health as human capital: synthesis and extensions. *Oxford Economic Papers*, *59*(3), 379–410.

Berger, M. C., & Leigh, J. P. (1989). Schooling, self-selection, and health. *Journal of human resources*, 433–455.

Farrell, P., & Fuchs, V. R. (1982). Schooling and health: the cigarette connection. *Journal of health economics*, *1*(3), 217–230.

Grossman, M. (2000). The human capital model. In *Handbook of health economics* (Vol. 1, pp. 347–408). Elsevier.

Katz, M. S. (1976). A history of compulsory education laws. fastback series, no. 75. bicentennial series.

Kotin, L., & Aikman, W. F. (1980). *Legal foundations of compulsory school attendance.* Associated Faculty PressInc.

Leigh, J. P., & Dhir, R. (1997). Schooling and frailty among seniors. *Economics of Education review*, *16*(1), 45–57.

Lleras-Muney, A. (2005). The relationship between education and adult mortality in the united states. *The Review of Economic Studies*, *72*(1), 189–221.