Does Education Improve Cognitive Abilities? Evidence from the Cultural Revolution in China

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Abstract

The association between education and cognitive abilities has been fascinating researchers. Using the Cultural Revolution (1966-1976) as a natural experiment, this study instruments education with the decisive role of Chinese Communist Party (CCP) membership in school enrollment during the turmoil period, to overcome the endogenous problem and examine the effect of education on cognitive abilities and its variation across gender. The retrospective questions in China Health and Retirement Longitudinal Survey (CHARLS) provide rich information about the historical background. The empirical results show that education has a positive effect on cognitive abilities, and women benefit more from education than men. However, in contrast to previous research, postestimation tests suggest that education may not be an endogenous variable as many think it is, at least when estimating its effect on cognitive abilities. With the assistance of CCP membership as a valid instrumental variable for education, it is demonstrated that conventional OLS can be a better estimator in this case.

1. Introduction

The link between education and cognition has been a significant issue in academia. For one thing, cognitive ability, as valuable human capital, is a crucial determinant of functioning and well-being in daily life, especially for old adults (Banks, o'Dea, and Oldfield, 2010; Bijwaard, van Kippersluis, and Veenman, 2015; Wilson et al., 2013). For another, education, as a kind of investment, has been one of the most important paths to human capital accumulation (Cunha and Heckman, 2007; Farkas, 2003). Despite of a well-established positive association between education and cognition (e.g. Evens et al., 1993; Stern et al., 1994), the question if cognitive abilities can be fostered through education still haunts researchers of various fields, and less is known about the causal direction.

The main problem in exploring the association is the endogeneity of education, which stems from reverse causation (i.e. higher cognitive ability leads to more years of schooling) and unobserved innate ability (e.g. IQ). To address this problem, prior studies heavily rely on exogenous shocks that cause either prolonged or shortened years of schooling (Glymour et al., 2008; Banks and Mazzonna, 2012; Huang and Zhou, 2013). Even though their studies used different methods, consistent conclusions had been reached that education has a significantly positive effect on cognitive abilities.

Using China Health and Retirement Longitudinal Survey (CHARLS), this paper aims to advance the understanding of the effect of education on cognitive abilities and its variation across gender, by taking advantage of the decisive role of Chinese Communist party membership during the Cultural Revolution in China. Its contribution

is three-fold. First, it enriches the understanding of the effect of education on cognitive abilities in diverse social-historical backgrounds. China is still a developing country in transition. A deeper understanding of the investment in human capital is very crucial to economic development and social welfare. Second, it discusses the methodological issue of the endogeneity of education in OLS estimates of cognitive abilities, advancing research design in a sense. Lastly, it broadens our understanding of the long-term effect of the unique historical event-Cultural Revolution and its consequences except education interruption.

2. Literature Review

2.1 Education and Cognitive Abilities

To disentangle the association between education and cognitive abilities, in the first place, it is imperative to realized that the formation of cognitive abilities is closely related to fluid intelligence and crystallized intelligence (Blair, 2006; Cattle, 1963). The former refers to the capacity of solving novel problems, independent of any prior obtained knowledge, while the latter pertains to the ability of using skills, knowledge and experience. This decomposition explains conflicting results from past research (Horn and Cattell, 1963). On one hand, in the controversial book *The Bell Curve*, Herrnstein and Murray (1994) claimed that education does not affect cognitive abilities, because IQ is fixed at early stage of life. Their interpretation aligns with the idea that higher cognitive abilities beget better education. On the other hand, Singh-Manoux, Richards and Marmot (2005) concluded that education affects cognitive abilities through socioeconomic positions. Their interpretation implies reversal causation and

indirect effect of education on cognitive abilities.

Since fluid intelligence is relatively fixed and crystallized intelligence can be fostered, the investment in education is meaningful. Cunha and Heckman (2007) made a strong argument that abilities are created rather than simply inherited. They developed economic models to show that there are critical and sensitive periods in skill formation and investment during life-course. Moreover, they differentiated non-cognitive abilities (e.g. self-control, motivation, preference for leisure etc.) from cognitive abilities and argued that there is a reciprocal relationship between them. Mirowsky and Ross (1998) also stressed the importance of non-cognitive ability (i.e. personal control) and connected it with education. They suggested that education develops not only useful skill (e.g. reading, writing etc.) but also personal traits (e.g. perseverance, confidence etc.). Those personal traits lead to confidence in self-control and make people tend to adopt healthy lifestyle.

Apart from those unobserved non-cognitive abilities, there are several other mechanisms through which education may affect cognitive abilities, and those mechanisms can be generally classified into two paradigms. The first one builds on fundamental cause theory proposed by Link and Phelan (1995). They argued that it is socioeconomic status (SES) that limits access to valuable resources, cause health inequalities and maintains the pattern. Singh-Manoux et al. (2005) proved that education affects cognitive ability through socioeconomic status. People exposed to economic hardship are more likely to suffer from poor cognition (Lynch, Kaplan, and Shema, 1997). The other paradigm revolves around “use-it-or-lose-it” hypothesis. It

centers on the contribution of cognition-demanding occupation/activities to cognitive vitality, including but not limited to retirement (Mazzonna and Peracchi, 2010; Rohwedder and Willis, 2010) and various intellectual and social activities (Hertzog et al., 2008; Paris et al., 2012)

2.2 Heterogeneous Effect of Education

Notwithstanding a large body of research exploring the effect of education on cognition, less is known about the heterogenous effects of education on cognitive abilities across gender. DiPrete and Buchmann (2006) found that the returns to education in the form of earning is higher and rising faster for women than men. Weber et al. (2014) demonstrated that more gender-equal opportunities for education increases gender difference favoring women in some cognitive functions.

2.3 The Culture Revolution

The Cultural Revolution, launched by Mao Zedong in 1966, is a radical political movement that aims to preserve true communist ideology by purging remnants of capitalist and traditional elements, such as Confucianism, from society. A great mass of people were mobilized to protest against cadres deemed to have betrayed China's Communist ideology. During this tumultuous period, the Chinese educational system was greatly disrupted. All schools were closed from 1966-1969 so that students could join in the campaign; all levels of education, especially college level, did not resume until 1971-1972 (Shirk, 1982); millions of urban residents were sent down to rural area to get "re-educated"; consequently the mere chance of enrollment in school heavily relied on political background (Unger,1982).

3. Data and Methods

3.1 Data

The datasets used in this study come from Chines Health and Retirement Longitudinal Survey (CHARLS). CHARLS is a nationally representative longitudinal survey of those aged 45 or older, covering social-demographic, socioeconomic and health information of the respondents and their spouse. Two waves, CHARLS 2011 and CHARLS 2014, are employed and merged together to capture variables concerned. CHARLS 2011 is the baseline survey, while CHARLS 2014 is designed to collect life-history information by asking retrospective questions.

3.2 Analytical Strategy

The identification of the effect of education on cognitive abilities heavily relies on natural experiment (e.g. Glymour et al., 2008; Banks and Mazzonna, 2012; Huang and Zhou, 2013). This study is no exception. It tries to solve the endogenous problem in causality, by taking advantage of the decisive role of Chinese Communist Party membership in school enrollment during the Cultural Revolution. Compared with prior research, this design has three advantages. First, the Cultural Revolution caused massive interruption of education, and millions of school-age children/youth got prevent from receiving different stages of education. Hence, the conclusions, regarding the effect of education on cognitive abilities, drawn from the event has much more generalizability, as opposed to the changes in compulsory schooling law and corresponding fuzzy regression discontinuity design (Bank and Mazzonna, 2012). Second, the Chinese society under Mao was economically equal and highly

homogenous. This historical context avoids the violation of the assumption of exclusion restriction of instrumental variable, as opposed to various state characteristics in the United States (Glymour et al., 2008). Third, using cohort to instrument education can be problematic (Huang and Zhou, 2013), especially in the case of China, because those who experienced education interruption also suffered from the Great Famine (1959-1961). Therefore, the instrumental variable is correlated with unobserved term (e.g. damage to cognition caused by early malnutrition.

Following the Meng and Gregory's (2002) definition of impacted cohort of the Cultural Revolution, the sample is restricted to those who was born between 1947 to 1961. Table 1 presents the average years of schooling for those cohorts.

To estimate the effect of education on education on cognitive abilities, I will regress cognitive abilities on education and controls separately with OLS and 2SLS first. Then, based on the relative statistics from 2SLS, I will decide on how to estimate the heterogenous effect of education. The OLS and 2SLS models are as follows

$$Cognition = \pi_0 + \pi_1 Eduyear + \pi_2 Controls + \varepsilon \quad (1)$$

$Cognition = \beta_0 + \beta_1 \widehat{Eduyear} + \beta_2 Controls + \eta$, where

$$\widehat{Eduyear} = \alpha_0 + \alpha_1 CCP + \alpha_2 Controls \quad (2)$$

3.3 Measurements

Dependent Variable cognitive abilities are measured in three ways, episodic memory, mental status and the combined (Lei et al., 2012). The measurement of episodic memory takes the form of word recall. Respondents are asked to memorize as many words listed by the interviewer as they can within limited time. Mental status

questions include specific times questions about month, day, year, season and the exact day of week, doing subtraction from 100 five times, and the ability to draw a line. An overall cognition combines the two. Episodic memory score ranges from 0 to 10, mental status from 0 to 11, overall cognition 0-21.

Endogenous & Instrumental Variables Education is originally categorical variable in CHARLS and recoded into a continuous variable by two steps to facilitate model estimation. First, highest level of education is coded into corresponding years of schooling based on the education system in China. Second, additional years of schooling after highest education level and incomplete primary school education are taken into account to adjust for a more precise years of schooling.[1] CCP membership is used to instrument education (1=either side of biological/adoptive/step parents is CCP member, 0=otherwise)

Controls include age, age square, sex (0=male, 1=female), birthplace (0=rural, 1=urban), marital status (0=married with spouse present/married but not living together temporarily, 1=separated/divorced/widowed/never married), health status (1=5),[2]and social activities (0=otherwise, 1=at lease participating one social activity)[3]. Table 2 shows the descriptive statistics, in which Column 1 report full sample, while column 2 and column 3 reports male and female subsample respectively.

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[1] According to the education system in China, elementary school is equal to 6 years of schooling, middle schooling 9, vocational school and high school 12, two-/three-year college/associate degree 15, four-year college/bachelor's degree 16, master's degree 19, doctoral degree 23 (master and doctoral degree do not show up in the sample)

[2] There are three almost identical questions asking self-rated health. The scaling is slightly different, but with same range. I combined them tighter to avoid missing values on the variable.

[3] Social activities include interacted with friends; played majong, chess, cards, or went to community club; provided help to family, friends, or neighbors who do not live with you and who did not pay you for the help; went to a sport, social, or other kind of club; took part in community-related organization; done voluntary or charity work; cared fo a sick or disabled adult who does not live with ou and who did not pay you for the help; attended an educational or training course; stock investment; used the internet; other.

4. Results

Panel A in Table 3 presents the estimates from OLS estimator. The coefficients indicate that education is significantly positive correlated with episodic memory, mental status and overall cognition. Panel B in Table 3 presents the estimates from 2SLS. The coefficients in the second and third column are only slightly smaller from those in Panel A, but with bigger standard error. This is the same as expected, because unobserved innated ability is filtered out by instrumental variable. However, it is unclear why the coefficient in the first column substantially greater than its counterpart in Panel A. Cragg-Donald statistic in each column is much bigger than Stock-Yogo critical value (16.38), rejecting the null hypothesis that CCP membership is weak instrument. Unexpectedly, Durbin-Wu-Hausman test does not reject that null hypothesis that education is exogenous. It implies that OLS estimator is a more efficient estimator than 2SLS estimator.

Considering the advantage of OLS estimator, I add an interaction between education and sex to equation 1 and re-estimate it with OLS estimator. All coefficients of the interaction are significantly positive, suggesting that the return to education favors women more than men (See Panel C in the Table 3)

5. Robustness Checks

5.1 Alternative pathways

There are two potential channels through which CCP membership can be correlated with error term in equation 1. First, if the fathers with CCP membership had higher education (i.e. higher innate ability), it would be likely that they pass down the innate

abilities to their children by genes. Yet this possibility can be ruled out by the fact that CCP membership is determined by political factors rather than education credentials (Bian, Shu, and Logan, 2001). Second, if the father with CCP membership took advantage of the market transition in China after open-up policy to exchange their power for higher socioeconomic status (Bian and Logan, 1996), they would pass down their resources to their children whereby the children can increase their cognitive abilities. However, a cross table of CCP membership shows only a small proportion of CCP members are cadres. Ordinary CCP members hardly can exchange their power for other resources. Therefore, the two potential channels may not work.

Furthermore, assuming that the cognitive abilities function is consistently estimated by OLS (i.e. no correlation between education and the error term), then the CCP membership dummy should be insignificant in a cognitive abilities function that also include education. I test this proposition by adding CCP membership to the equation 1. As expected, the variable is insignificant (See Panel D in the Table 4)

5.2 Cohort effect

As mentioned in section 2, the sequential relationship between the Great Famine (1959-1961) and the Cultural Revolution (1966-1976) can bias the results because of the unobserved early adverse experience. Therefore, we re-estimate the equation 1 with an urban subsample, and education is still positively correlated with cognitive abilities (See Panel E in the Table 4)

6. Conclusion and Discussion

The Cultural Revolution (1966-1976) creates a natural experiment that can be used

to estimate the potential causal effect of education on cognitive abilities and its variation across gender. Because during the turmoil period, parents' CCP membership was a determinant of school enrollment and uncorrelated with unobserved cofounders. With CCP membership as instrumental variable, this study finds that education does have a causal effect on episodic memory, mental status and overall cognitive abilities. Moreover, women benefit more from additional years of schooling. Even though it is still unclear the reason behind it, one conjecture can be that women may start from a more disadvantaged level.

Other than the exploration of the causal relationship between education and cognitive abilities, this paper also has some intellectual contribution to research design. For a long time, instrumental variable has been regarded as a magic tool to solve endogenous problem in identifying the effect of education. This paper, nonetheless, casts doubt on the necessity of correcting for the omitted bias when estimating the return to education, at least in the case of estimating its effect on cognitive abilities. In this sense, my study resonates with Angrist and Krueger (1991). Unobserved innate abilities are by no means trivial factors. Yet it is questionable to use more sophisticated model instead of simple OLS.

Deng and Treiman's (1997) believed that the Cultural Revolution temporarily provided relatively equal access to education. but eventually China would return back to the secular trend. Currently, as education is becoming more and more dependent on family investment, it is challenging to identify the independent effect of education on health outcomes. On one hand, we need to emphasize the significance of human capital

investment. One the other hand, more research is needed to explore the relationship between education inequality and health disparities in different social and historical contexts.

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Table 1: Birth cohort and years of schooling

Birth Year	Year of Schooling	Age in 2011	Age in 1966	Age in 1976
1947	4.52	64	19	29
1948	4.79	63	18	28
1949	4.19	62	17	27
1950	4.39	61	16	26
1951	4.07	60	15	25
1952	4.13	59	14	24
1953	4.38	58	13	23
1954	4.90	57	12	22
1955	5.29	56	11	21
1956	5.58	55	10	20
1957	5.84	54	9	19
1958	6.03	53	8	18
1959	6.35	52	7	17
1960	7.53	51	6	16
1961	6.95	50	5	15

Source: Author's calculation based on CHARLS

Table 2: Descriptive statistic

	Full Sample	Male Sample	Female Sample
Episodic Memory (0-10)	3.73 (1.48)	3.79 (1.44)	3.68 (1.51)
Mental Status (0-11)	8.86 (2.12)	9.04 (2.03)	8.59 (2.20)
Overall Cognition (0-21)	10.60 (4.03)	11.58 (3.62)	9.71 (4.18)
Eduyear	5.14 (4.21)	6.65 (3.82)	5.14 (4.21)
Age	57.31 (4.00)	57.42 (4.00)	57.21 (3.99)
Female (Yes=1)	0.51		
Urban (Yes=1)	0.08	0.08	0.08
Married (Yes=1)	0.08	0.07	0.09
Social Activity (Yes=1)	0.47	0.47	0.48
Health Status (1-5)	3.5 (1.00)	3.40 (1.02)	3.59 (0.99)

Note: Standard deviation in parentheses.

Source: CHARLS

Tabel 3: OLS and 2SLS estimates of the return to education

	Episodic Memory (0-10)	Mental Status (0-11)	Cognition (0-21)
Panel A: OLS			
Eduyear	0.100***(0.005)	0.161***(0.009)	0.470***(0.011)
Observation	5891	3970	6580
R-squared	0.109	0.112	0.313
Panel B: 2SLS			
Eduyear	0.147***(0.039)	0.148***(0.072)	0.410***(0.093)
Observation	5860	3955	6548
Cragg-Donald	100.409	63.032	98.487
Durbin-Wu-Hausman	1.531	0.033	0.417
Panel C: OLS			
Eduyear	0.090***（0.007）	0.144***（0.012）	0.384***(0.016)
Female	0.100 (0.064)	-0.368**（0.017）	-1.220***(0.144)
Eduyear*Female	0.018*（0.009）	0.035*（0.017）	0.155***(0.021)
Observation	5891	3970	6580
R-squared	0.101	0.113	0.318

Note: Standard errors in parentheses. ***p<0.001,**p<0.01,*p<0.05. Controls include age, age squared, birthplace, marital status, health status, social activities

Tabel 4: Robustness Check: OLS estimates of the return to education

	Episodic Memory (0-10)	Mental Status (0-11)	Cognition (0-21)
Panel D: OLS			
Eduyear	0.0***(0.005)	0.162*** (0.009)	0.470***(0.011)
CCP	0.066 (0.053)	-0.016 (0.089)	-0.078 (0.120)
Observation	5860	3955	6548
R-squared	0.109	0.113	0.313
Panel E: Urban			
Eduyear	0.124***(0.017)	0.111***(0.023)	0.340***(0.034)
Observation	528	466	551
R-squared	0.124	0.044	0.179

Note: Standard errors in parentheses. ***p<0.001. Controls include age, age squared, birthplace, marital status, health status, social activities