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Education and Non-cognitive Skills

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Abstract

In this paper we estimate the causal relationship between schooling and non- cognitive skills in later life. We exploit two exogenous changes in education policy in China and Indonesia and estimate the effect of schooling on non-cognitive skills as measured by the Locus of Control and five-factor model. We employ Regression Probability Jump and Kink Design (RPJK) for identification. Our results indicate that schooling leads to a less Internal Locus of Control, and makes individuals more conscientious, open and extroverted. The effect of schooling on non-cognitive skills can explain significant variation in returns to schooling on the labor market.

Keyword: Education; Noncognitive Skills; Compulsory Education Law; Regression Discontinuity; Jump and Kink

JEL Classification: J24, I26, I28

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1 Introduction

Men are different in their physical characteristics as well as mental capacity. Psychologists have long been noticed that individuals possess different levels of intelligence and cognitive abilities[1], personality and consciousness.[2] In economics, we define personality traits and beliefs as non-cognitive skills, or “soft skills”.

It is well known that cognitive skills are linked to the long-term economic well-beings, as such skills are strong predictors for wages (Heckman et al., 2006; Bowles et al., 2001). Recent studies suggest that non-cognitive skills also matter in the labor market. Individuals with better soft skills earn higher wages and are more likely to be employed (Heckman et al., 2006; Glewwe et al., 2016; Lindqvist and Vestman, 2011; Cubel et al., 2016; Shurer, 2017). In some cases, non-cognitive skills are better predictors for labor market outcomes than cognitive skills (Lindqvist and Vestman, 2011; Gove et al., 2011).

How are non-cognitive skills formed? In this paper we attempt to understand the relationship between years of schooling and non-cognitive skills later in life. While the determinants of cognitive skills have been extensively studied in the economic literature[3], the process of how non-cognitive skills are formed is much less understood. Little is known, empirically, about the determinants of non-cognitive skills and their relative importance at different stages of human capital development. Existing evidence suggests that parental income, quality of child care in early childhood and length of schooling are related to formations of non-cognitive skills during childhood and adolescent (Fletcher and Wolfe, 2016; Gupta and Simonsen, 2015; Dahmann and Anger, 2014).

There are two aspects of schooling that make it unique in the process of non-cognitive

[1] In psychology, cognitive skills refer to the capacity to perform high-level mental process such as perception, thinking, memory and judgment. They correspond to the processes run by a computer.

[2] Consciousness is defined as the subjective awareness of ourselves and our environment. The content of consciousness is known as self-concept, which includes beliefs about ourselves, such as abilities, values, goals and physical characteristics.

[3] Empirical studies suggest that length and quality of schooling as well as family background are causally linked to the development of cognitive skills (Dahl and Lochner, 2012; Carlsson et al., 2015). A survey of the literature is provided by Heckman and Rubinstein (2001) and Attanasio (2015)

skills formation. First, it is believed that both nature and nurture play an important role in the development of non-cognitive skills. The skill formation theories proposed by Cunha et al. (2010) suggest that both cognitive and non-cognitive skills can be produced at different stages of childhood into adulthood, taking parental environment and other investment as inputs. Early investment affects the production technology of these skills in later stages. In addition, stocks of cognitive skills can promote the production of non-cognitive skills and vice versa. The complementarity between cognitive and non-cognitive skills suggests that schooling could affect non-cognitive skills both directly and indirectly. Second, scholarly studies on personality development in the psychology literature have noted that although personality traits are consistent over long periods of time[4], there are noticeable mean changes at different points in life. These phases of change usually happen in early childhood, early adolescence and early adulthood (Roberts and Wood, 2005; Skirbekk et al., 2015; McAdams and Adler, 2005; Soto and Tackett, 2015)[5]. In the modern education system, schooling usually takes place from childhood to early adulthood, during which the critical period of non-cognitive skills formation is likely to remain open.

In this paper, we focus on two of the most commonly used measures for non-cognitive skills in the economics literature: the five-factor model and the Locus of Control measures. These two measures have been used in many studies that attempt to build an understanding of non-cognitive skills formation (Borghans et al., 2008, 2011; Almlund et al., 2011; Heckman and Kautz, 2013). The five-factor model, the most dominant model of personality structure in contemporary personality psychology, reduces complex personality descriptions to five big factors. The model was developed by psychologists in an attempt to define the boundaries of personality traits, simplify the trait universe and discover the latent structure of personality. In addition to the five-factor model, other theories have also been proposed to explain the

[4]There are two types of consistency defined in the literature. Individual consistency means that the personality traits of an individual remain the same over time. The population definition of consistency means that groups of individuals' traits do not change overtime, or that the relative placement of an individual in the group does not change overtime (Roberts and DelVecchio 2000).

[5]Personality traits are dimensions of personalities derived from a universe of descriptions. See appendix A for more detailed discussion.

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variations in personality. Among these is the Locus of Control (LOC) measure proposed by Julian B. Rotter in 1966 (Rotter, 1966). The LOC measure refers to a person's belief that the outcome of behaviors are typically either under their control (internal) or the control of the environment (external).

We exploit the exogenous variation in two education policies in China and Indonesia to identify a causal relationship between years of schoolings and non-cognitive skills. We first investigate the effect of compulsory schooling laws in China in 1986 that for the first time imposed nine years of compulsory schooling for all Chinese citizens. We then study an education policy change in Indonesia in 1978 that extended the school year for all students enrolled in the 1978 academic year by an extra 120 days. We chose China and Indonesia because both countries underwent an education policy change in the 1970s and 1980s. The Chinese data have measures of Locus of Control while the Indonesian data cover the five-factor model. Including both countries in our analysis provides a more comprehensive analysis of the relationship between schooling and non-cognitive skills.

We employ a Regression Probability Jump and Kink (RPJK) design to identify the effects of schooling on non-cognitive skills. While standard regression discontinuity design relies on a discontinuity (or a jump) of the probability of being treated to identify a local average treatment effect, RPJK relies on changes in both the jump and the slope of treatment probability. This method provides identification when a jump is small or absent (Card et al. 2015 and Dong 2016). The data for our analyses come from the China Family Panel Studies (CFPS) and the Indonesia Family Life Survey (IFLS). Using the RPJK design, we show that schooling is an important determinant for non-cognitive skills later in life. We find that individuals completed middle school appear to have less Internal Locus of Control. We also find that individuals experienced longer school years turn out to be more conscientious, open to experience and extroverted.

Our paper contributes to the literature in several ways. First, we are one of the very first

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papers that provide a causal link between schooling and non-cognitive skills [6]. Most of the existing empirical evidence that links schooling to non-cognitive outcomes are interventions carried out in early childhood[7]. Dahmann and Anger (2014) is the only study we are aware of that demonstrates an empirical relationship between years of schooling and non-cognitive skills in a compulsory schooling setting[8]. Our paper uses data from China and Indonesia to show the long run impact of schooling on non-cognitive skills. We show that an increase in years of schooling changes individuals' Locus of Control and their personality traits as measured by the five-factor model in mid-life. Our results indicate that the effect of schooling on non-cognitive skills can be long lasting and persistent throughout one's course of life. Our results also provide another channel through which schooling may affect lifetime economic well-being. Using a decomposition method similar to Heckman and Kautz (2013), we find that schooling's influence on non-cognitive skills can explain a significant portion of variation in the overall returns to schooling on the labor market. This helps establish the economic significance of our estimates.

Our paper also adds to the literature on the non-pecuniary returns to education. The labor market returns to education have been well documented by many empirical studies [9]. Recent studies have also found that schooling has significant non-pecuniary returns (Oreopoulos and Salvanes, 2011). Our results indicate that schooling makes individuals more conscientious, open to experience and extroverted. These characteristics are shown to be positively associated with life-time subjective well-being (Hayes and Joseph, 2003; Penley and Tomaka, 2002). Although it is difficult to place a normative judgment on personality traits, our results show that schooling can lead to changes in non-cognitive skills that are favorable in terms of overall enjoyment of one's life.

[6] Many empirical studies demonstrate that schooling is highly correlated with cognitive skills (Knudsen et al., 2006; Falch and Massih, 2011). Attempts have also been made to show a causal relationship running from schooling to cognitive skills (Carlsson et al., 2015; Dahmann, 2015)

[7] See (Heckman and Kautz, 2013) for a review.

[8] The authors find that a reduction in length of schooling led to a significant increase in extroversion and a decrease in emotional stability, measured by the five-factor model, among German high school students. No significant effects on the Locus of Control measures was detected.

[9] See Schultz 1988 for a comprehensive review

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The paper is structured as follows. Section 2 provides the basic background information about the two education policy changes in China and Indonesia. Data and variables are detailed in Section 3, and the identification strategy is discussed in 4. Section 5 presents the empirical results, including the main findings, robustness checks, heterogeneous effects, and roles of non-cognitive skills in the labor market. Section 6 concludes.

2 Education Policy Changes in China and Indonesia

We use two policy experiments in China and Indonesia to show the effect of schooling on later non-cognitive outcomes. As mentioned in section 1, we do not intend to compare the outcomes of the two countries. But rather, results complement each other as two different outcome measures of non-cognitive skills are used in our analyses.

2.1 The Education System and 1986 Compulsory Education Law in China

The modern educational system in China dates back to the early 20th century. As a component of the Self-strengthening Movement, the Qing imperial government followed the Japanese educational model by abolishing the imperial examination system and establishing new public schools. The curriculum also started to include subjects such as European languages, mathematics, astronomy and chemistry. After the founding of the People's Republic of China in 1949, the Communist Party gradually took over all missionary and private schools across China and transformed them into public schools. However, this industrialization-oriented educational system was almost shut down during the Cultural Revolution (1966-1976). During the first two years of the Cultural Revolution, all primary schools in urban China were closed for 2-3 years, and secondary- and tertiary-level institutions were closed for much of the revolution period.

After the Cultural Revolution, ideological struggles in China gradually diminished and

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modernization has become the government's priority. The education policy continued to evolve. China began a process of education reform that aimed to gradually align the educational system with the newly emerging marketization of the economy (Hawkins 2000). The reforms intended to systematically implement a nine-year compulsory education program, to decentralize the financing and management of education, to increase vocational and technical education, and to increase the number and quality of teachers. In 1985, the Central Committee of the Chinese Communist Party issued the "Decision on the Reform of the Educational System", which assigned basic education responsibility to the local levels of governments both in terms of management and finances (Hawkins 2000).

To provide legislative support for this reform, the Compulsory Education Law of the People's Republic of China was passed on April 12, 1986 and officially went into effect on July 1, 1986. The compulsory education law stipulates that a nine-year compulsory education should be implemented in all urban and rural areas of China and across all ethnicity groups (Nanzhao and Muju 2007). This law had several important features. Firstly, nine years of education became compulsory, and all children who have reached the age of six (seven in some exceptional regions) are required to enroll in schools. Secondly, compulsory education is divided into two stages: six-year primary education and three-year junior middle school education. After primary school, graduates can be directly admitted into junior middle schools without selection tests. Thirdly, the compulsory education is tuition-free, but miscellaneous fees (e.g., books and other expenses such as transportation, food, and heating) were exempted until 2008. Fourthly, it became illegal for any organization or individual to employ children or adolescents at the ages of compulsory education. Fifthly, provinces were allowed to decide their steps, methods, and deadlines for implementing the compulsory education in accordance with the economic and cultural development in their own localities, (see Hawkins 2000). Hence the timing of the actual implementation of the nine-year compulsory education varies significantly across provinces, depending on local economic and development conditions.

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In contrast with U.S. and U.K. compulsory schooling laws which specify the minimum age at which children can leave school, China's 1986 Compulsory Education Law stipulates the number of years of compulsory education (nine years). Individuals enrolled in school when the new compulsory system was implemented were mandated to stay in school until they finish the required nine years of education. Another component of the education law is the decentralization of financing and implementation. Table 1 shows the exact year, month and day when the compulsory education system was implemented in each province. A significant difference exists in the timing of implementation. Some provinces implemented the compulsory education system soon after the law's passage (e.g., Ningxia, Shanghai, Zhejiang), while a few provinces did not implement the new system until the early or mid-1990s (e.g., Gansu, Guangxi, Hainan, Hunan, Tibet).

Before the 1986 Compulsory Education Law, China has followed the former Soviet Union in having six years of primary school education and beginning school in September. Children in most part of China began school at age seven according to the "Decision on Education System Reform" issued by the Government Administration Council in 1951 [10]. Based on the above information, we are able to define the first affected cohort in each province (as shown in column 2 Table 1) and use it as the threshold or cutoff point in the standard regression discontinuity design. We use respondents' residential location at the provincial level at age 12 as a proxy for the residential location where compulsory education is provided. One concern is that people could have moved from one province to another during the period of compulsory education, and thus makes it difficult to determine the exact restraint of compulsory education law they were faced with. However, this is unlikely given that in the 1980s, China has very restrictive internal migration, and hukou status was difficult to be manipulated (Worden et al., 1987).

[10] In 1951, The Government Administration Council issued the "Decision on the Education System Reform" which sets the age at which children start primary school to be seven (see `http://xuewen.cnki.net/R2006090880000764.html`).

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[Insert Table 1. Cutoff Points]

2.2 The Longer School Year Change in Indonesia's Education Policy in 1978

The education system in Indonesia was largely inherited from the Dutch colonial system. Formal education in Indonesia came to a halt between 1942-1945, during the Japanese occupation. After Independence in 1945, Act 31 of the national constitution makes explicit that basic education is compulsory for all citizens and requires the state to fund it. In 1950, the first Basic Education Act specified six years of compulsory education. However, Indonesia has only recently achieved the goal of providing primary school education to all children. After President Sukarno's rule ended in 1966, the focus of education shifted to support national development. With the discovery of oil and a dramatic improvement in education, Indonesia's education system underwent an ambitious expansion program. The guideline for the First Long Term Development Plan (1969 - 1994) prioritized the provision of universal primary education (six years), which effectively aimed to increase access to elementary education to all Indonesian citizens has been prioritized. The oil boom in the 1970s also provided financial support for the government to implement programs such as INPRES school construction, the inclusion of the Islamic education sector into the national education system under the Ministry for Religious Affairs, and in 1975, a new curriculum that aimed to support economic development in 1975 (Baunto 2015). Children usually start school at age seven and they can choose to attend government-operated public schools (supervised and financed by Department of National Education) or private religious schools (supervised and financed by Department of Religious Affairs).

Before 1978, the Indonesian school year began in January and ended in December. In 1978, the then Education Minister proposed to synchronize the school year with the fiscal calendar year, beginning in September and ending in June. In order to do so, all students

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enrolled in school in 1978 were required to stay in school and repeat an extra half a year (until June 1979) before moving onto the next level in September. Given that on average a child spends approximately 240 days at school, the change in academic calendar added about 120 school days to the 1978 calendar for students that were enrolled. Students born on or after Jan 1st 1972 were not old enough to enroll in primary schools in 1978 when the government implemented the longer school year policy, hence, would undergo the normal length of schooling. Students born in 1971 or earlier were subject to the 1978 policy change and would experience longer school years. Based on the above information, we use the timing of birth of the youngest affected cohort as the cutoff point, as shown in the last row of Table 1. Due to a lack of preparation and a shortage of teachers, however, most students repeated the second half of their grade without learning any new material; children mainly spent the extra time repeating what they had already learned [11]. Therefore we consider the effect of this policy as a pure impact of lengthening the time a child has to stay in school, without any changes on the quality of education received.

3 Data and Variables

Data and Samples Our analysis uses data from the China Family Panel Studies (CFPS) and the Indonesia Family Life Survey (IFLS). The CFPS-2010 is a nationally representative sample of Chinese communities, families, and individuals, covering 25 of 31 provinces/regions and 95% of the total population of China.[12] The final sample includes 14,960 households and 33,600 adult respondents in 2010. The CFPS 2010 consisted of 4 questionnaires (Community, Family, Adolescent, and Adult). It contains rich information on demographic and socioeconomic characteristics, including gender, date of birth (month and year), ethnicity, marital status, educational attainment, family background, registered residency (or *hukou* in Chinese), type of residency (rural or urban) at different ages, employment details and

[11] For more details on the reform and the impact of the reform on various outcomes please see Samarakoon and Parinduri (2015) and Parinduri (2014).

[12] the six omitted provinces are Hainan, Inner Mongolia, Ninxia, Qinghai, Tibet and Xinjiang

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health details, etc.

The Indonesia Family Life Survey (IFLS) is a nationally representative longitudinal survey that covers 13 out of the 27 Indonesian provinces.[13] The survey collects data on individual respondents, households and communities on a wide range of social economic variables. The first wave was administered in 1993, and subsequent waves were conducted in 1998, 2000, 2007-2008, and 2014-2015 on the same 1993 households and their split-offs. A personality module and measures for the five-factor model were added in the latest wave conducted in 2014-2015. We use the latest wave (IFLS-5) for our analysis, in which 16,204 households and 50,148 individuals from the original 1993 households and their split-offs were interviewed. We match individuals' year of birth to the education policy change in 1978.

Non-cognitive Outcomes. The CFPS-2010 asks ten self-rated personality traits questions that allow us to construct Locus of Control measures for each respondent. As discussed in section 1, Locus of Control is a personality measure which refers to a person's belief that the outcomes of behavior are typically either under their control (internal) or the control of the environment (external). This psychological concept captures a generalised attitude, belief or expectancy regarding the nature of the causal relationship between one's own behaviour and its consequences (Rotter 1966). The Locus of Control measure has been used in many existing studies of non-cognitive skills and labor outcomes (Acemoglu and Johnson, 2009; Heckman et al., 2006; Heckman and Kautz, 2013). In the CFPS-2010, for each of the personality trait questions, respondents were asked to indicate their agreement, using a 1 (strongly disagree) to 5 (strongly agree) scale, whether they thought a certain factor was the most important for future success. Five out of the ten factors relate to the respondents' level of External Locus of Control (luck, family's connections, social status, wealth, and connections), while the other five determine the Internal Locus of Control (hard work, effort, education, talent, and intelligence). For ease of comparison, we standardize the answer to each question by

[13] It is representative of 83% of the total population

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computing a z-score[14]. Following Kling et al. (2007), we also create a Locus of Control Index (LOC index). In particular, we rescale the answers to each question so that a smaller number indicates more External Locus of Control and larger number indicates more Internal Locus of Control. We then construct a LOC index by averaging the z-scores. The higher the LOC index, the more Internal Locus of Control a person has. By aggregating the LOC measures to a summary index we improves statistical power to detect effects that move in the same direction (Kling et al., 2007)

[Insert Table 2A here]

The IFLS-5's personality module covers fifteen questions related to the five-factor model. The five-factor model is a well-accepted taxonomy of non-cognitive skills that has been widely used in the recent psychology and economics literature. Some describe the five-factor model as the "longitude and latitude" of non-cognitive skills, by which all more narrowly defined skills may be categorized" (Heckman and Kautz 2013; Costa and McCrae 1992). The "five factor" in the model are: *Openness to Experience, Conscientiousness, extroversion, agreeableness, and emotional stability.* Table 2B defines these factors and their corresponding survey questions in the IFLS-5. For each factor, IFLS-5 asks three questions on a five-point likert-type scale, with 1 being strongly disagree and 5 strongly agree. Similar to the Locus of Control measures, we rescale each answer and compute an averaged z-score for each of the five factors [15].

[Insert Table 2B here]

Measures of Schooling The CFPS-2010 contains information on respondent's highest educational level as well as total years of schooling. Our analysis uses both a binary variable indicating whether the respondent completed middle school (finishing the nine-year compul-

[14]We use all valid observations in the CFPS-2010 as reference

[15]The higher the summary index, the more open, conscientious, extroverted and agreeable a person is.

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sory education) and the respondent's total years of schooling. The IFLS-5 records information on the age at which the respondent first attended and left each school level, the highest education level completed well as the highest grade completed. Based on this information and the education system in Indonesia, we are able to compute the total years of schooling and a binary variable indicating whether the individual was affected by the longer school year policy in 1978. We call this variable *longer school year*. We define the variable to be one if an individual entered primary school in 1978 or earlier, and did not drop out of school before 1978.

Other variables. To test for the validity of our RDJK setting and explore potential heterogeneous effects, we also use information on respondent's demographic and socio-economic variables like age, gender, ethnicity, and other relevant individual and parental characteristics. The summary statistics of the outcome variables and other covariates are shown in the appendix Table A1 and Table A2, respectively.

4 Estimation Strategy using RPJK

4.1 Graphical Evidence

To motivate our estimation strategy, we first examine graphically the relationship between years of schooling and the two education policy reforms, respectively. Figure 1A and 1B demonstrate the effect of compulsory schooling law by showing the probability of completing middle school and total years of schooling as a function of the year-quarter of birth using the CFPS-2010 sample. Each dot in the figure presents unconditional mean in each year-quarter of birth bin. We recenter the running variable to 0 according to the specific cut-off of the compulsory schooling reform in a given province [16]. The solid lines are the fitted lines from the local linear estimation with the bandwidths calculated using Imbens and Kalyanaraman

[16] As shown in Table 1 the compulsory schooling reform rolled out gradually across China in from 1986 to 1994

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(2012)'s approach. As shown in Figure 1A and 1B, there are noticeable kinks with a small or possibly nonexistent jump at the cutoff point 0. This pattern is likely due to the gradual roll-out of the compulsory education system in China. Individuals further away from the threshold are more likely to be treated hence the noticeable kink around the cutoff point.

[Insert Figures 1A and 1B here]

Next, we look at the impact of the longer school year change in Indonesia. Figure 2A plots the relationship between the proportion of people who experienced the longer school year and year-quarter of birth using the IFLS-5, with the running variable re-centered at the cut-off. The figure clearly shows that the share of people experiencing the longer school year declines dramatically just to the right of the cutoff, and there is a sizable jump and slope change. When total years of schooling is used as the outcome variable, as shown in Figure 2B, there appears to be a less noticeable discontinuity at the cutoff yet still a visible decrease in slope after the cutoff point. The observed kink around cutoff is likely due to the nature of the policy. Individuals need to be enrolled in school in 1978 to be affected by the policy. Earlier cohorts are more likely to drop out of school by 1978 hence there's a steep positive slope before the cutoff.

[Insert Figures 2A and 2B here]

The jumps and kinks caused by the policy experiments in Indonesia and China provide us with possible randomness to identify the effect of schooling non-cognitive outcomes in later life. Specifically, we use the RPJK framework (Dong 2016). In the China case, the jump and kink we exploit arise from the effective dates of the compulsory education law in each province: (1) children born after the cutoff dates were subject to nine years of compulsory education; (2) the later a child was born, the more extensively compulsory education had been implemented in her/his residential province and the more likely she/he

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had been treated; and (3) children born before the cut-off dates were not subject to nine years of compulsory education. In the Indonesia case, the jump and kink arise from the effective date of the longer school year policy: (1) children born before the cut-off date were enrolled in school during the policy hence were subject to the extra school days in 1978; and (2) children born after the cut-off date were not.

4.2 Framework

In this section, we illustrate the identification strategy using the RPJK framework. For simplicity, we will only focus on the China case as an example.

Consider the following Rubin causal model: let Y_{i1} be the outcome (i.e., measures of non-cognitive skills; see Section 3 for details) of individual i completing junior middle school; let Y_{i0} be the noncognitive outcome without completion; and denote D_i as the educational attainment for individual i, i.e., 1 if individual i has completed middle school and 0 otherwise. The effect of education is identified as

$$\gamma = E\left[Y_{i1} - Y_{i0}\right]. \tag{1}$$

However, as we cannot observe for individual i both his/her Y_{i1} and Y_{i0}, the comparison of outcomes between middle school graduates ($D_i = 1$) and non-middle school graduates ($D_i = 0$) could be biased due to the selection issue, i.e., $E\left[Y_{i0}|D_i = 1\right] \neq E\left[Y_{i0}|D_i = 0\right]$.

To solve this identification issue, we explore two education policies in China and Indonesia which created exogenous jumps and kinks in schooling. These jumps and kinks allow us to apply an RPJK framework.

For any function $H(c)$, define one-sided limits $H^{+} = \lim_{\epsilon\to 0} H(c_0 + \epsilon)$ and $H^{-} = \lim_{\epsilon\to 0} H(c_0 - \epsilon)$ when they exist. Also define one-sided derivatives when they exist $H^{+'} = \lim_{\epsilon\to 0} \frac{H(c_0+\epsilon)-H^{+}}{\epsilon}$ and $H^{-'} = \lim_{\epsilon\to 0} \frac{H^{-}-H(c_0-\epsilon)}{\epsilon}$for some small ϵ. The nine-year compulsory education law implies that: (1) the probability of finishing middle school is discontinuous

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at a cutoff point c_0 of the timing of birth (c_i, measured in quarters relative to c_0), i.e., $D_i^+ | (c_i = c) \neq D_i^- | (c_i = c)$; (2) the probability of finishing middle school increases with the timing of birth, so the slope changes discretely at the cut-off point c_0. Assuming $E[Y_{i0}|c_i = c]$ is continuous in c at c_0, Hahn et al. (2001) show that the treatment effect at the cut-off point c_0 can be identified as

$$\gamma^{RD} = \frac{Y_i^+ - Y_i^-}{D_i^+ - D_i^-}, \tag{2}$$

which is numerically equivalent to the IV estimator using E_i as instruments for treatment status D_i, where E_i is a dummy variable indicating whether an individual i belongs to a law-affected cohort, i.e., taking a value of 1 if $c_i \geq c_0$ and 0 otherwise.

When there is no jump but is instead a kink or a slope change in the treatment probability, assuming $E[Y_{i0}|c_i = c]$ is continuously differentiable in c at c_0, Card et al. (2012) show that the treatment effect at the cut-off point c_0 can be identified as

$$\gamma^{RK} = \frac{Y_i^{+'} - Y_i^{-'}}{D_i^{+'} - D_i^{-'}}, \tag{3}$$

which can be identified using $(c_i - c_0) E_i$ as the IV for D_i.

When considering a general model with both a jump and kink at c_0, Dong (2016) shows that the treatment effect at the cut-off point c_0 can be identified as

$$\gamma^{RPJK} = \frac{Y_i^+ - Y_i^- + w_n \left(Y_i^{+'} - Y_i^{-'}\right)}{D_i^+ - D_i^- + w_n \left(D_i^{+'} - D_i^{-'}\right)}, \tag{4}$$

where w_n is any sequence of nonzero weights such that $\lim_{n\to\infty} w_n = 0$. γ^{RPJK} can be estimated by a 2SLS estimation using E_i and $(c_i - c_0) E_i$ as IVs for D_i, and the weights (the relative strength of the two IVs) in the local 2SLS estimation have the required property. Dong (2016) shows that this RPJK estimator is preferred when either a jump or a kink is plausible, especially when there is a relatively large kink along with a small jump, and when

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the kink can also be justified on institutional grounds (as in this paper's two settings).

We adopt a non-parametric approach (i.e., local linear regression) as suggested by Hahn et al. (2001) and Dong (2016) to estimate the jump and kink parameters in (4). Specifically, the effect of the compulsory education law on educational attainment or the "first stage" relationship is estimated from

$$\min_{\alpha_1,\beta_1,\tau_1,\delta_1} \sum_{i=1}^{N} K\left(\frac{c_i - c_0}{h_1}\right)\left[D_i - \delta_1 - \beta_1 (c_i - c_0) - \alpha_1 E_i - \tau_1 E_i (c_i - c_0)\right]^2, \tag{5}$$

Similarly, the reduced-form equation is

$$\min_{\alpha_2,\beta_2,\tau_2,\delta_2} \sum_{i=1}^{N} K\left(\frac{c_i - c_0}{h_2}\right)\left[Y_i - \delta_2 - \beta_2 (c_i - c_0) - \alpha_2 E_i - \tau_2 E_i (c_i - c_0)\right]^2. \tag{6}$$

where h_1 and h_2 are the optimal bandwidths chosen by Imbens and Kalyanaraman (2012)'s approach; and $K(.)$ is a kernel function.

Once we separately estimate equations (5) and (6), γ^{RD} can be calculated as $\frac{\hat{\alpha}_2}{\hat{\alpha}_1}$, while γ^{RK} can be calculated as $\frac{\hat{\tau}_2}{\hat{\tau}_1}$. Using both E_i and $E_i(c_i - c_0)$ as IVs for D_i, we can identify γ^{RPJK}. Standard errors are clustered at the year-quarter of birth level (i.e., the level of the running variable) as suggested by Card and Lee (2008), and then calculated by the delta method.

A potential concern about the above 2SLS estimator is that it may also capture the cohort effect—that is, people born in different quarters are inherently different (e.g., Angrist and Krueger 1992; Buckles and Hungerman 2013, etc.). To address this concern, we add quarter-of-birth dummies to control for seasonality; specifically, $Q1$ (corresponding to birth in September–November), $Q2$ (corresponding to birth in December–February), $Q3$ (corresponding to birth in March–May), and $Q4$ (corresponding to birth in June–August). We also use the month-of-birth dummies (i.e., dummies for January, February, and so on) to control for seasonality, and the results are quite similar.

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4.3 Potential Manipulation

The key identifying assumption of the standard RD estimation is that $E\left[Y_{i0}|c_i = c\right]$ is continuous in c at c_0, while the RPJK estimation further assumes the continuous differentiability. These continuity assumptions require that people cannot precisely manipulate the assignment variable, i.e., the timing of birth (as discussed in Lee (2008) and Card et al. 2012).

Two threads of anecdotal evidence suggest that our identifying assumption is satisfied. First, these two policies can be considered as random policy shocks as a large majority of the population did not have prior knowledge that it would happen. For the Chinese compulsory schooling reform, the cohorts on the margin are people born in the late 1960s to the early 1970s, the Cultural Revolution period, which was full of uncertainty. No one at that time could predict that 16 years later, Deng Xiaoping would enact a compulsory education law reform. Second, cesarean sections were not widely available across China in the 1960s and 1970s, making it difficult to manipulate the timing of childbirth. Similarly in Indonesia, children born at the margin in the early 1970s could not have anticipated an educational policy reform in 1978 and were unlikely to manipulate their timing of birth so as to take advantage of it.

To lend further support to our identifying assumption, we provide two sets of quantitative analyses suggested by Lee and Lemieux (2010) and Dong (2016): testing the smoothness of the density of the running variable (i.e., no jumps or kinks in) and the conditional means of predetermined characteristics. For the density test, we follow McCrary (2008) in plotting the probability density function of the assignment variable. In Figure 3, the upper and lower panel show the number of observations in each birth-year-quarter bin using the CFPS-2010 and IFLS-5 data, respectively. We re-center the running variable to 0 according to the relevant policy cut-off dates. There is some fluctuations, but we do not find any statistically and economically significant discontinuity in the density of our running variable at the cut-off point. To confirm this graphical diagnosis, we also extend the McCrary test to examine the continuity of both the p.d.f. and the derivative of the p.d.f., as seen in Card et al. (2012),

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Landais (2015) and Dong (2016). In particular, we include both E_i and $E_i\,(c_i - c_0)$ in the local linear regression of the empirical density (of the number of observations in each birth-year-quarter bin) and test the significance of both coefficients. The coefficient of E_i (testing for a jump in the p.d.f) and of $E_i\,(c_i - c_0)$ (testing for a change in the slope of the p.d.f) reported in the footnotes of Figure 3 are both insignificant, which supports the assumption of our RPJK design.

[Insert Figure 3 here]

We also check the validity of our research setup by directly examining whether individuals' predetermined socioeconomic characteristics are smooth (no jumps or kinks) at the cutoff points. If there were full manipulation caused by the manipulation of birth timing, we would find discontinuities in these predetermined characteristics at the cut-off points. Specifically, we examine the predicted probability of completing middleschool and the probability of experiencing a longer school year, calculated as the fitted values from an OLS regression of middle school indicator (or longer school indicator) on all predetermined covariates.[17] To this end, we go through a set of predetermined variables that are available in the two datasets. For CFPS-2010, we investigate individual's gender, birth weight, family background during the cultural revolution period, parent's educational attainment, parents' occupation status, and parent's party membership when child was 14, and whether either parent was absent before age 12. For IFLS-5, we check the sample balance for gender, place of birth, ethnicity, whether the respondent has attended kindergarten, parent's ethnicity and whether parent had attended school. Appendix Figures 1A and 1B plot the predicted probabilities against birth cohorts, showing no particular jump or drop around the cut-off points. Table 3 reports the estimated jump and kink of the predicted probabilities. The coefficients are all close to

[17] Estimated jumps and kinks using these covariates as as dependent variables are presented in Appendix Table A3. For all these predetermined characteristics, we do not find any statistically and economically significant jumps at the cutoff points. Among the 19 covariates, only two indicators shows a weakly significant kink coefficients.

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zero and statistically insignificant, which further supports the validity of the RPJK design.

[Insert Table 3 here]

In summary, our exercises in this subsection suggest that it is unlikely that there's manipulation in timing of birth related to the compulsory education law in China and the longer school year policy in Indonesia, which implies that our estimation strategy is valid.

5 Empirical Findings

5.1 The Impacts of Education Policy on Schooling Outcomes

The jump and kink in education outcomes generated by the policy changes allow us to estimate the effect of schooling on non-cognitive skills in later life. We first present estimates from the first-stage regressions in Table 4. Panel A shows the effect of being born after the cut-off on the probability of completing middle school and the total years of schooling using the CFPS-2010 sample. Panel B shows the effect of being born before the cut-off on the probability of experiencing a longer school year and the total years of schooling using the IFLS-5 sample. All coefficients are estimated using local linear regressions and uniform kernel functions[18]. The CFPS-2010 regressions control for quarter-of-birth dummies and province of residence at age 12. The IFLS-5 regressions control for quarter-of-birth dummies. Row 1 in each panel reports the estimated jumps at the cut-off cohort and row 2 reports the estimated kinks (changes in slope) at the cut-off. At the bottom of the table, we also report the control mean for each outcome variable and the optimal bandwidth used in each regression.

[Insert Table 4 here]

As shown in Table 4 Panel A, Using the CFPS-2010 sample, we find the probability of

[18]Using triangular kernel functions generates very similar results.

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finishing middle school has a significant kink at the cut-off but no significant jump (column 1). There is both a significant jump and kink at the cut-off for total years of schooling, the jump is significant at 10% level and the kink is significant at 1% level, as shown in columns 4. This is consistent with the pattern shown in Figure 1. More specifically, we find that the compulsory education law increases the probability of completing middle school and the total years of schooling. The estimated jump for completing middle school is around 3.1% and the estimated jump for total years of schooling is 0.28 years. Compared with the control means, the law increased the probability of completing middle school by roughly 6% of the mean; in terms of the total years of schooling, the effect of the compulsory education law is about 4% of the mean. Despite the relatively small magnitudes of the jumps, the estimated kinks at the cut-off are around 0.6% for completing middle school and nearly 6% for total years of schooling, which are quite substantial changes in slope (as can be seen in Figure 1).

Estimates in the Panel B of Table 4 show that for the Indonesian policy change, the probability of experiencing a longer school year has both a significant jump and kink at the cut-off. The significance are both at 1% level. The estimated jump for experiencing a longer school year is around 52.6%, or 4 times the control mean, and the estimated jump for total years of schooling is 0.56 years, or 5.9% of the control mean. The estimated kinks at the cut-off are about 2.5% for experiencing a longer school year and almost 4% for total years of schooling.

In summary, our results show that there are both a jump and a kink for cohorts on the margin for the IFLS sample. Using the CFPS sample, the jump induced by the compulsory education law is relatively small and not significant in the probability of finishing middle school.

5.2 The Impacts of Schooling on Noncognitive Outcomes

In this subsection, we discuss the effect of schooling on the non-cognitive outcomes in later life, measured by the Locus of Control and the five-factor model. Note that from this

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section onward we focus on the two binary measures of schooling: whether an individual has completed middle school (CFPS-2010 sample) and whether an individual has experienced longer school year (IFLS-5 sample).

Table 5 reports the second stage results of schooling on both non-cognitive outcome measures. Column 1 reports the estimated effect of schooling on the locus of control index, and columns 2 to 6 report the estimated effects using the five-factor model. Estimates for each component of the Locus of Control index are presented in Appendix Table A4. We include the same set of control variables as in the first stage, whose coefficients are omitted to save space.

[Insert Table 5 here]

The estimate in column 1 indicates that completing middle school decreases the Internal Locus of Control Index by 0.359 standard deviation. Or in other words, individuals that have completed middle school are more likely to feel that success depends on external factors rather than internal factors. Figure 4 displays the relation between birth quarter and the Locus of Control index, without controlling for quarterly dummies and place of residence at age 12. Consistent with the regression results, the figure clearly shows that the Locus of Control index has a dramatic decline (a slope change) just to the right of the cutoff, and a visible discontinuity (level drop) at the cutoff.

In addition to the summary index, we also present figures for each component of the index separately in Appendix Figures 2 (hard work, effort, education, talent and intellect for Internal Locus of Control; luck, family's connections, social status, wealth, and connections for External Locus of Control). Regression results are presented in Appendix Table A4. Both figures and regression results suggest that there are noticeable slope changes for each component of the Locus of Control Index as well.

[Insert Figure 4 here]

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We next investigate whether schooling leads to changes in the measure of the five-factor model. The estimates in columns 2 to 6 of Table 5 suggest that schooling significantly increases individuals' conscientiousness, openness, and extroversion, while the estimates on agreeableness and emotional stability are positive, although not significant. The effects are substantial; that is, conscientiousness increases by 6.8% of the standard deviation, individuals' openness to experience increases by 10.5% of a standard deviation, and extroversion increases by 10.3% of a standard deviation.

Figures 5A to 5E present similar plots as those in Figure 4, but display the relation between birth cohort (our running variable) and the five-factor personality traits. We find that individuals' conscientiousness, openness and extroversion show dramatic increases in slope just to the left of the cut-off point. In contrast, agreeableness and emotional stability show only a slight slope change at the cutoff.

[Insert Figures 5A-5E here]

Taken together, these findings suggest that schooling affects different facets of an individual's personality traits, rendering individuals less likely to believe in an Internal Locus of Control, and to increase conscientiousness, openness to experience and extroversion.

5.3 Robustness Checks

Including predetermined socioeconomic characteristics. Our RPJK estimators require that cohorts on the margin (i.e., cohorts born right before v.s. right after the cutoff point) be balanced along all dimensions except for facing the compulsory education law or longer school year. If this identifying assumption is satisfied, inclusion of socioeconomic controls should have little effect on our estimators for both statistical significance and estimated magnitude. As shown in Appendix Table A5, we find that the inclusion of predetermined characteristics barely changes our findings.

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Alternative Bandwidth. To check whether our findings are sensitive to the optimal bandwidth that we choose using the Imbens and Kalyanaraman (2012)'s method, we experiment with alternative bandwidth from $h^* - 4$ to $h^* + 4$. Figures 6A and 6B plots the estimates for non-cognitive outcomes (i.e., the LOC and the five-factor model, respectively) when using alternative bandwidths. The x-axis plots the bandwidth used in each regression, the points show the RPJK estimates, and the dashed lines mark the 95 percent confidence intervals. We find stable estimates among all the outcomes, suggesting that our results are not driven by a particular bandwidth.

[Insert Figures 6A and 6B here]

5.4 Heterogeneous Effects

In this subsection we examine the heterogeneous policy effect by gender and parental background.

Table 6 presents the effects of schooling on the LOC index and five-factor model by gender. For both males and females, schooling leads to a less Internal Locus of Control. Regarding the five-factor model, there are significant increases in four out of the five dimensions for males, but only two factors are significantly affected by schooling for females. Overall, the results are consistent with the pooled results, and the effects are more profound for males than for females, although most of these differences in the estimates for males and females are not statistically significant (except for Conscientiousness).

[Insert Table 6 here]

Tables 7 presents the effect of schooling by father's education. Specifically, we compare the effect of schooling on individuals who have literate fathers with individuals whose fathers are illiterates. We do not find any heterogeneous impact of schooling on the Locus of Control

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by father's education. For respondents whose father is literate, more schoolings leads to increases in openness as well as emotional stability. However, schooling does not have any significant impact on the personality traits measured by the five-factor model for respondents whose father is illiterate, maybe due to the small sample size. The differential effects across mother's education are reported in Table 8. We find similar schooling effects on non-cognitive outcomes across literate and illiterate mothers.

[Insert Table 7 here]

[Insert Table 8 here]

5.5 The Role of Non-cognitive Skills in Labor Market Outcomes

Lastly, we examine the economic significance of the effects of schooling by anchoring the non-cognitive measurements in objective labor market outcomes.[19] Specifically, given our documented effects of schoolings on non-cognitive outcomes (i.e., LOC and Big Five), we would like to identify, for example, whether these effects translate into economically meaningful differences in labor market outcomes, including being employed, being in the labor force, being self-employed, working with pension benefits, number of weekly working hours, and monthly wage income.

To this end, we use a decomposition method similar in spirit to Heckman and Kautz (2013). Specifically, the analysis is conducted in three steps. First, we estimate the effects of schooling on individuals' labor market outcomes using the same RPJK framework as in our baseline estimation. From these regressions we obtain the full schooling effect β^{full}. Second, we include non-cognitive measures (i.e., LOC index or five-factor model) in the regressions

[19] The economic significance of non-cognitive skills has been well documented (Groves, 2005; Heckman et al., 2006; Heckman and Kautz, 2013; Heckman et al., 2006) show that self-esteem and Locus of Control affect labor-market outcomes and social performance in adulthood, and the effects appear to be as strong as for cognitive skills.

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in the first step, from which we retain the partial schooling effect $\beta^{partial}$ – that is, the full schooling effect net of schooling-induced changes in the outcomes via non-cognitive skills. Lastly, we calculate the relative contribution of non-cognitive skills by taking $\frac{\beta^{full}-\beta^{partial}}{\beta^{full}}$ and normalize to 100%. Appendix Table A6 reports the estimates of β^{full} and $\beta^{partial}$, using CFPS-2010 in the upper panel and IFLS-5 in the lower panel, respectively.

Figures 7A and 7B show the relative contribution of non-cognitive skills and other factors (i.e., the residuals associated with unmeasured skills) to the total effect. We find that non-cognitive skills play an important role in labor market outcomes. For example, schooling's influence on non-cognitive skills can explain more than 4% of schooling's impact on being in the labor force using the Chinese dataset and 16% using the Indonesian dataset. Similarly, it can explain 1.3% of being self-employed, 6% of pension benefits, around 9% of weekly working hours and 10% of monthly wage income using the Chinese dataset. The numbers are 55.6%, 7.4% 14% and 29% using the Indonesian dataset. For comparison, Heckman and Kautz (2013) find that for males the impact of the Perry Preschool Program on externalizing behavior accounts for around 19% of the total treatment effect on income and probability of employment; and Nilsson (2014) finds that the effects of prenatal exposure to a policy that increases alcohol availability on children's non-cognitive ability can explain about 13% of the policy's impact on labor market outcomes. Overall, the decompositions pinpoint the economic significance of our main findings, and also confirm the role of non-cognitive skills in explaining long-run labor market outcomes.

[Insert Figures 7A and 7B here]

6 Conclusion

In this paper we estimate the effect of schooling on non-cognitive outcomes using data from China and Indonesia. Our empirical evidence suggests that schooling does affect later

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life non-cognitive outcomes and the magnitude is significant. In China, the completion of middle school decreases Locus of Control measures by 0.359 standard deviation. In Indonesia, staying in school for an additional 120 days increases individuals' conscientiousness, openness and extroversion by 0.068, 0.105 and 0.103 standard deviations, respectively. This number is comparable to the effect of schooling on cognitive scores measured by Carlsson et al. (2015), which indicates that staying in school for an additional 180 days raises crystallized intelligence test scores by one fifth of a standard deviation.

Our results fill in an important gap in the literature by providing a causal link between schooling and non-cognitive skills. We show that the effect of schooling is significant and long lasting. It persists throughout one's course of life way beyond adolescence. We overcome the external validity issue by exploiting two different education policy changes in China and Indonesia. The estimated effect of schooling on non-cognitive outcomes using the compulsory schooling reform in China is a local average treatment effect. The Indonesian policy almost universally affected every student that were enrolled in school hence closer to an average treatment effect. There are also important limitations in our study. Due to data limitations, the mechanisms through which schooling affect these non-cognitive outcomes are not yet clear. A longer series of panel data is needed to answer these important questions.

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References

Acemoglu, Daron and Simon Johnson, "Disease and Development: The Effect of Life Expectancy on Economic Growth," *Health and growth*, 2009, p. 77.

Almlund, Mathilde, Angela Lee Duckworth, and James J. HJames J. Heckman. Kautz, "Personality psychology and economics," *NBER working paper 16822*, Feb 2011.

Angrist, Joshua D and Alan B Krueger, "The effect of age at school entry on educational attainment: an application of instrumental variables with moments from two samples," *Journal of the American Statistical Association*, 1992, *87* (418), 328–336.

Attanasio, Orazio P., "The determinants of human capital formation during the early years of life: theory, measurement and policies," *Journal of the European Economic Association*, 2015, *13* (6), 949–997.

Baunto, Assad L., *Education in South-east Asia*, London: Bloomsbury Academic, 2015.

Borghans, Lex, Angela Lee Kuckworth, James J. Heckman, and Bas ter Weel, "The economics and pscyhology of personality traits," *IZA Discussion Paper No 3333*, Feb 2008.

_ **, Bart H.H. Golsteyn, James J. Heckman, and John Eric Humphries**, "Identification problems in personality psychology," *NBER working paper 16917*, May 2011.

Bowles, S, H. Gintis, and M. Osborne, "The determinants of earnings: a behavioral approach," *Journal of Economic Literature*, 2001.

Buckles, Kasey S and Daniel M Hungerman, "Season of birth and later outcomes: Old questions, new answers," *Review of Economics and Statistics*, 2013, *95* (3), 711–724.

Card, David, David Lee, Zhuan Pei, and Andrea Weber, "Nonlinear policy rules and the identification and estimation of causal effects in a generalized regression kink design," *Working Paper*, 2012.

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Tel: (65) 6516 6134 Fax: (65) 6778 1020
Website: www.lkyspp.nus.edu.sg

_ , **David S. Lee, Zhuan Pei, and Andrea Weber**, "Inference on causal effects in a generalized regression kink design," *Econometrica*, November 2015, *83* (6), 2453–2483.

Carlsson, Magnus, Gordon B. Dahl, Bjorn Ockert, and Dan-Olof Rooth, "The effect of schooling on cognitive skills," *The Review of Economics and Statistics*, 2015, *XCVII* (3), 533–547.

Costa, Paul T and Robert R McCrae, "Four Ways Five Factors are Basic," *Personality and Individual Differences*, 1992, *13* (6), 653–665.

Cubel, Maria, A Nuevo-Chiquero, S Sanchez-Pages, and M Vidal-Fernandex, "Do personality traits affect productivity? Evidence from the laboratory," *Economic Journal*, 2016.

Cunha, Flavio, James J. Heckman, and Susanne M. Schennach, "Estimating the technology of cognitive and noncognitive skill formation," *Econometrica*, 2010, *78* (3), 883–931.

Dahl, Gordon B. and Lance J Lochner, "The impact of family income on child achivement: evidence from the earned income tax credit," *American Economic Review*, 2012, *102* (5), 1927–1956.

Dahmann, Sarah, "How does education improve cognitive skills? instructional time versus timing of instruction," *SOEP papers on Multidisciplinary Panel 796*, June 2015.

_ **and Silke Anger**, "The impact of education on personality: evidence from a German high school reform," *IZA Discussion Paper No 8139*, April 2014.

Dong, Yingying, "Jump or Kink? Regression Probability Jump and Kink Design for Treatment Effect Evaluation," 2016.

Falch, Torberg and Sofia Sandgren Massih, "The effect of education on cognitive ability," *Economic Inquiry*, July 2011, *49* (3), 838–856.

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Website: www.lkyspp.nus.edu.sg

Fletcher, Jason and Barbara L. Wolfe, "The importance of family income in the formation and evolution of non-cognitive skills in childhood," *NBER working paper 22168*, April 2016.

Glewwe, Paul, Qiuqiong Huang, and Albert Park, "Cognitive skills, noncognitive skills and school-to-work transitions in rural China," *Journal of Economic Behavior and Organization*, 2016.

Gough, H.G. and A.B. Heilbrun, *The Adjective Check List Manual*, Consulting Psychologists Press, 1983.

Gove, WA, A Hussey, and M Jetter, "The gender pay gap beyond human capital heterogeneity in non-cognitive skills and in labor market tastes," *Journal of Human Resources*, 2011.

Groves, Melissa Osborne, "How Important is Your Personality? Labor Market Returns to Personality for Women in the US and UK," *Journal of Economic Psychology*, 2005, *26* (6), 827–841.

Gupta, Nabanita Datta and Marianne Simonsen, "Academic performance and type of early childhood care," *IZA Discussion Paper No 9045*, May 2015.

Hahn, Jinyong, Petra Todd, and Wilbert Van der Klaauw, "Identification and Estimation of Treatment Effects with a Regression-Discontinuity Design," *Econometrica*, 2001, *69* (1), 201–209.

Hawkins, John N, "Centralization, decentralization, recentralization-Educational reform in China," *Journal of Educational Administration*, 2000, *38* (5), 442–455.

Hayes, N. and S. Joseph, "Big 5 correlates of three measures of subjective wellbeing," *Personality and Individual Differences*, 2003, *34*, 723–727.

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Website: www.lkyspp.nus.edu.sg

Heckman, James J. and Tim Kautz, "Fostering and measuring skills: interventions that improve character and cognition," *IZA Discussion Paper No 7750*, Nov 2013.

_ **and Yona Rubinstein**, "The importance of nocognitive sskill: lessons from the GED testest program," *The American Economic Review*, 2001, *91* (2), 145–149.

Heckman, James J, Lance J Lochner, and Petra E Todd, "Earnings functions, rates of return and treatment effects: The Mincer equation and beyond," *Handbook of the Economics of Education*, 2006, *1*, 307–458.

Hogan, Robert and Joyce Hogan, *Hogan Personality Inventory Manual*, Hogan Assessment Systems, 2007.

Imbens, Guido and Karthik Kalyanaraman, "Optimal Bandwidth Choice for the Regression Discontinuity Estimator," *The Review of Economic Studies*, 2012, *79* (3), 933–959.

Kling, Jeffrey, Jeffrey Liebman, and Lawrence Katz, "Experimental Analysis of Neighborhood Effects," *Econometrica*, 2007, *75* (1), 83–119.

Knudsen, Eric I., James J. Heckman, Judy L. Cameron, and Jack P. Shonkoff, "Economic, neurobiological and behavioral perspectives on building America's future workforce," *NBER working paper 12298*, 2006.

Landais, Camille, "Assessing the welfare effects of unemployment benefits using the rregression kink design," *American Economic Journal: Economic Policy*, 2015.

Lee, David and Thomas Lemieux, "Regression Discontinuity Designs in Economics," *Journal of Economic Literature*, 2010, *48* (2), 281–355.

Lee, David S, "Randomized experiments from non-random selection in US House elections," *Journal of Econometrics*, 2008, *142* (2), 675–697.

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Website: www.lkyspp.nus.edu.sg

Lindqvist, Erik and Roine Vestman, "The labor market returns to cognitive and noncognitive ability: evidence from the Swedish enlistment," *American Economic Journal: Applied Economics*, 2011, *3* (1), 101–128.

McAdams, Dan P. and Jonathan M. Adler, *Handbook of personality development*, Lawrence Erlbaum Associates, Inc.,

McCrary, Justin, "Manipulation of the running variable in the regression discontinuity design: A density test," *Journal of Econometrics*, 2008, *142* (2), 698–714.

Nanzhao, Zhou and Zhu Muju, "Educational reform and curriculum change in China: a comparative case study," *International Bureau of education*, 2007.

Nilsson, J.P., "Alcohol availability, prenatal conditions, and long-term economic outcomes," *Institute for International economic studies*, 2014.

Oreopoulos, Philip and Kjell G Salvanes, "Priceless: The nonpecuniary benefits of schooling," *The journal of economic perspectives*, 2011, pp. 159–184.

Parinduri, R.A., "Do children spend too much time in schools? evidence from a longer school year in Indonesia," *Economics of Education Review*, 2014.

Penley, J.A. and J. Tomaka, "Associations among the big five, emotional responses, and coping with acute stress," *Personality and Individual Differences*, 2002.

Roberts, Brent W. and Dustin Wood, *Handbook of personality development*, Lawrence Erlbaum Associates, Inc.,

_ **and Wendy F. DelVecchio**, "The rank-order consistency of personality traits from childhood to old age: a quantitative review of longitudinal studies," *Psychological Bulletin*, 2000.

Rotter, J.B., *Generalized expectancies for internal versus external control of reinforcement*, Washington: American Psychological Association, 1966.

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Samarakoon, S. and R.A. Parinduri, "Does education empower women? evidence from Indonesia," *World Development*, 2015.

Shurer, A, "Bouncing back from health shocks: Locus of control and labor supply," *Journal of Economic Behavior and Organization*, 2017.

Skirbekk, V., M. Blekesaune, and U.M. Staudinger, "Personality development in the second half of life and critical life events," *Gerontologist*, 2015.

Soto, Christopher J. and Jennifer L. Tackett, "Personality traits in childhood and adolescence: structure, development and outcomes," *Psychological Science*, 2015.

Worden, Robert L, Andrea M Savada, and Ronald E Dolan, "China A country study," Technical Report, DTIC Document 1987.

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Table 1: Cutoff Points

Places	Effective Date	Affected Cohort Born
Compulsory Education Laws in China		
Beijing	1986/8/6	From 1970/9/1
Tianjin	1986/11/12	From 1970/9/1
Hebei	1986/7/1	From 1970/9/1
Shanxi	1986/7/1	From 1970/9/1
Inner Mongolia	1988/9/15	From 1972/9/1
Liaoning	1986/7/1	From 1970/9/1
Jilin	1987/2/20	From 1970/9/1
Helongjiang	1986/7/1	From 1970/9/1
Shanghai	1985/1/9	From 1969/9/1
Jiangsu	1986/9/9	From 1970/9/1
Zhejiang	1985/9/1	From 1969/9/1
Anhui	1987/9/1	From 1971/9/1
Fujian	1988/8/1	From 1972/9/1
Jiangxi	1986/2/1	From 1969/9/1
Shandong	1986/9/12	From 1970/9/1
Henan	1986/10/1	From 1970/9/1
Hubei	1987/3/1	From 1970/9/1
Hunan	1991/9/1	From 1975/9/1
Guangdong	1986/10/7	From 1970/9/1
Guangxi	1991/9/1	From 1975/9/1
Hainan	1991/12/16	From 1975/9/1
Chongqing	1986/7/1	From 1970/9/1
Sichuan	1986/1/14	From 1970/9/1
Guizhou	1988/1/1	From 1971/9/1
Yunnan	1986/10/29	From 1970/9/1
Tibet	1994/7/1	From 1978/9/1
Shaanxi	1987/9/1	From 1971/9/1
Gansu	1990/9/3	From 1974/9/1
Qinghai	1988/10/1	From 1972/9/1
Ningxia	1986/7/1	From 1970/9/1
Xinjiang	1988/5/28	From 1971/9/1
Longer School Year in Indonesia		
Indonesia	1978/6/1	Before 1972/1/1

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Table 2A. Outcome Variables and Corresponding Details

Variable	Survey Questions
	CFPS-2010
	How much do you agree with the following statement: 1 (strongly disagree) - 5(strongly agree)
Luck	The most important factor affecting one's future success is his/her luck.
Family's Connections	The most important factor affecting one's future success is whether his/her family has 'connections'.
Family's Social Status	The higher a family's social status is , the greater the child's future achievement will be; the lower a family’s social status is, the smaller the child’s future achievement will be.
Family's Wealth	A child from a rich family has a better chance of succeeding in the future; a child from a poor family has a worse chance of succeeding in the future.
Connections	In today's society, having social connections is more important than having individual capability.
Hard Work	In today's society, hard work is rewarded.
Effort	The most important factor affecting one's future success is his/her effort.
Education	The higher level of education one receives, the higher the probability of his/her future success.
Talent	The most important factor affecting one's future success is his/her talent.
Intellect	In today's society, intellect is rewarded.
LOC Index	Scale for each statement is re-scored and z-standardized in the internal direction and then averaged to creat the internal-external locus of control score as the noncognitive skill index: the higher the score, the more internal the individual.

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Table 2B. The Big Five domains and their facets

Personality Factor	***Definition of Factor***	***Facets***	***ACL Marker Items for***	***IFLS-5 Survey Questions***
				How much do you agree with each statement which describe the characteristics that may apply to you: 1 (strongly disagree) - 5(strongly agree)
Conscientiousness	The degree to which a person is willing to comply with conventional rules, norms, and standards.	Competence, Order, Dutifulness, Achievement striving, Self-discipline, Deliberation	Commonplace, Narrow-interest, Simple- vs. Wide-interest, Imaginative, Intelligent	Does a thorough job. Tends to be lazy. (reversed) Does things efficiently.
Openness to Experience	The degree to which a person needs intellectual stimulation, change, and variety.	Fantasy, Aesthetics, Feelings, Actions, Ideas, Values	Careless, Disorderly, Frivolous vs. Organized, Thorough, Precise	Is original, comes up withs new ideas. Has an active imagination. Values artistic, aesthetic experiences.
Extraversion	The degree to which a person needs attention and social interaction.	Warmth, Gregariousness, Assertiveness, Activity, Excitement seeking, Positive	Quiet, Reserved, Shy vs. Talkative, Assertive, Active	Is talkative. Is reserved. (reversed) Outgoing, sociable.
Agreeableness	The degree to which a person needs pleasant and harmonious relations with others.	Trust, Straightforwardness, Altruism, Compliance, Modesty, Tender-mindedness	Fault-finding, Cold, Unfriendly vs. Sympathetic, Kind, Friendly	Has a forgiving nature. Is considerate and kind to almost everyone. Is sometimes rude to others. (reversed)
Emotional Stability	The degree to which a person experiences the world as threatening and beyong his/her control.	Anxiety, Angry hostility, Depression, Self-consciousness, Impulsiveness, Vulnerability	Tense, Anxious, Nervous vs. Stable, Calm, Contented	Worries a lot. (reversed) Gets nervous easily. (reversed) Is relaxed, handles stress well.

Source: Definition of factor, facets, and ACL maker items are from Hogan and Hogan (2007)
Note: ACL = Adjective Check List (Gough and Heibrun, 1983)

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Table 3. Smoothness of Predetermined characteristics

	VARIABLES	
	CFPS-2010	CFLS-5
	Predicted Probability of Completing Middle School	Predicted Probability of Experiencing Longer School Year
ESTIMATE	[1]	[2]
Estimated Jump	-0.006	0.000
$I(C \leqslant C_0)$	(0.027)	(0.002)
Estimated Kink	0.002	-0.000
$(C-C_0)I(C \leq C_0)$	(0.002)	(0.000)
Observations	1,079	2,113
Control Mean	0.498	0.533
Bandwidth (Quarters)	24	9

Notes: 1. Each cell presents the estimated discontinuity in the predicted education outcomes. 2. We use local linear regressions including a Imbens & Kalyanaram (2012)'s optimal bandwidths; 3. Clustered standard errors are in parentheses; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6.The predicted probability of completing middle school is calculated by OLS regression using predetermined covariates, including individual's gender, birth weight, family background during the cultural revolution period, parent's educational attainment, parent's occupational prestige scale, and parent's party membership when child was 14, and whether either parent was absent before 12; the predicted probability of experiencing longer school year is calculated by OLS using gender, born place, ethnicity, whether the respondent has attended kindergarden, parent's ethnicity and whether parent had attended school.

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Table 4. Effect of Reform on Schooling

	VARIABLE					
	Panel A. CFPS-2010					
	Finished Middle School			Total Years of Schooling		
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
	All Sample	Males	Females	All Sample	Males	Females
Estimated Jump	0.031	0.026	0.049	0.282	0.094	0.377
$I(C \leqslant C_0)$	(0.022)	(0.025)	(0.024)	(0.157)	(0.253)	(0.187)
Estimated Kink	0.006	0.006	0.008	0.058	0.021	0.084
$(C-C_0)I(C \leqslant C_0)$	(0.002)	(0.002)	(0.002)	(0.012)	(0.021)	(0.015)
Observations	8,505	4,460	5,224	8,847	4,023	5,054
Control Mean	0.498	0.578	0.432	7.048	7.774	6.333
Bandwidth (Quarters)	24	27	28	25	24	27
	Panel B. IFLS-5					
	Experienced Longer School Year			Total Years of Schooling		
ESTIMATE	[1]	[2]	[3]	[6]	[7]	[8]
	All Sample	Males	Females	All Sample	Males	Females
Estimated Jump	0.526	0.537	0.569	0.561	0.711	0.581
$I(C \leqslant C_0)$	(0.038)	(0.035)	(0.041)	(0.179)	(0.202)	(0.159)
Estimated Kink	0.025	0.017	0.022	0.039	0.034	0.038
$(C-C_0)I(C \leqslant C_0)$	(0.006)	(0.005)	(0.006)	(0.015)	(0.009)	(0.007)
Observations	2,802	1,589	1,517	8,422	6,400	6,665
Control Mean	0.129	0.103	0.127	9.490	9.771	9.531
Bandwidth (Quarters)	9	10	10	25	37	39

Notes: 1. Each cell presents the estimated jump and kink in the outcome at the cutoff point; 2. We use local linear regressions including a Imbens & Kalyanaram (2012)'s optimal bandwidths; 3. Standard errors in parentheses are clustered by cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Table 5. Impact of Schooling on Noncognitive Skills

	VARIABLES					
	CFPS-2010	IFLS-5				
	LOC	Conscientiousness	Openness to Experience	Extraversion	Agreeableness	Emotional Stability
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
Schooling	-0.359	0.068	0.105	0.103	0.025	0.127
	(0.127)	(0.029)	(0.040)	(0.041)	(0.024)	(0.100)
Observations	13,175	14,473	11,117	12,648	14,473	12,595
Control Mean	-0.00463	0.0173	0.0438	0.0152	-0.00510	-0.0909

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Table 6. Heterogeneous Effects across Gender

	VARIABLES					
	CFPS-2010	IFLS-5				
	LOC	Conscientiousness	Openness to Experience	Extraversion	Agreeableness	Emotional Stability
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
Males	-0.300	0.138	0.130	0.122	0.088	0.108
	(0.136)	(0.054)	(0.056)	(0.061)	(0.047)	(0.096)
Observations	14,682	14,591	12,574	13,074	15,767	15,040
Control Mean	0.00992	0.0347	0.125	-0.0463	0.0224	0.158
Females	-0.218	-0.015	0.084	0.092	0.006	0.134
	(0.082)	(0.036)	(0.048)	(0.052)	(0.029)	(0.120)
Observations	16,003	15,760	13,324	13,928	17,152	15,349
Control Mean	-0.0191	0.00251	-0.0259	0.0677	-0.0285	-0.316
Difference	-0.081	0.153	0.046	0.031	0.082	-0.026
	(0.166)	(0.063)	(0.061)	(0.072)	(0.055)	(0.150)

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Table 7. Heterogeneous Effects across Father's Education

	VARIABLES					
	CFPS-2010	IFLS-5				
	LOC	Conscientiousness	Openness to Experience	Extraversion	Agreeableness	Emotional Stability
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
Literate Father	-0.271	0.033	0.092	0.038	-0.030	0.257
	(0.129)	(0.034)	(0.053)	(0.053)	(0.042)	(0.115)
Observations	10,519	17,138	13,362	14,800	15,482	17,764
Control Mean	0.0121	0.0375	0.0618	0.0310	-0.00773	-0.0420
Illiterate Father	-0.241	0.014	-0.061	0.093	0.204	-0.073
	(0.134)	(0.088)	(0.120)	(0.109)	(0.128)	(0.230)
Observations	4,229	3,444	2,757	3,011	3,139	3,588
Control Mean	0.00115	0.0350	-0.0593	-0.0566	0.0520	-0.190
Difference	-0.030	0.019	0.153	-0.054	-0.234	0.330
	(0.163)	(0.097)	(0.142)	(0.127)	(0.148)	(0.236)

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Table 8. Heterogeneous Effects across Mother's Education

	VARIABLES					
	CFPS-2010	IFLS-5				
	LOC	Conscientiousness	Openness to Experience	Extraversion	Agreeableness	Emotional Stability
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
Literate Mother	-0.355	0.057	0.080	0.074	-0.057	0.169
	(0.178)	(0.039)	(0.058)	(0.052)	(0.054)	(0.109)
Observations	8,445	14,109	11,144	10,614	11,847	15,543
Control Mean	-0.0317	0.0381	0.0593	0.0393	-0.0123	-0.0491
Illiterate Mother	-0.251	0.030	0.219	0.085	0.264	0.110
	(0.122)	(0.092)	(0.194)	(0.122)	(0.188)	(0.249)
Observations	16,121	5,989	4,879	4,625	5,172	6,533
Control Mean	0.00867	0.0431	-0.0369	-0.0378	0.0282	-0.112
Difference	-0.104	0.027	-0.140	-0.011	-0.322	0.059
	(0.206)	(0.107)	(0.197)	(0.115)	(0.207)	(0.257)

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Figure 1A. The Impact of the Compulsory Education Law in China on Educational Attainment: Completing of Middle School

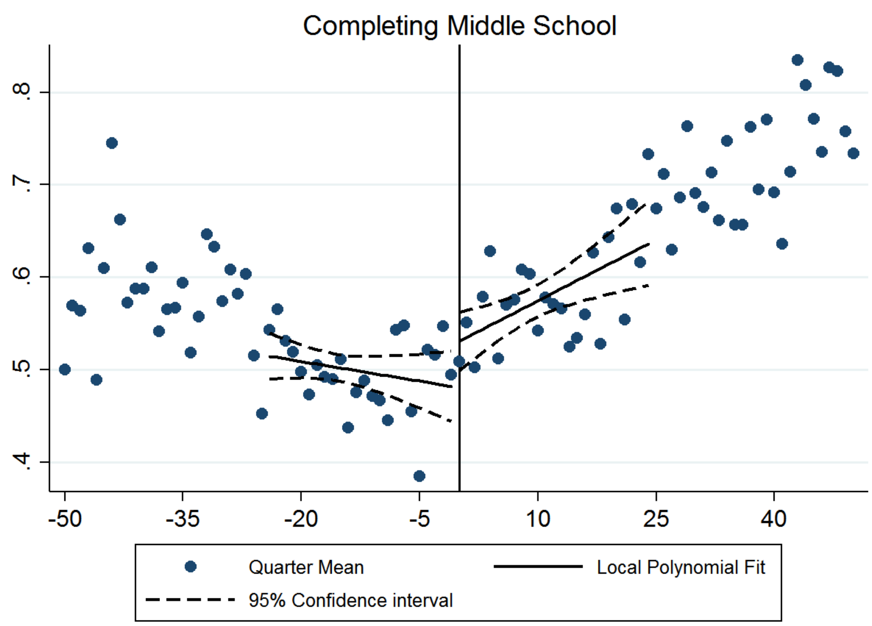
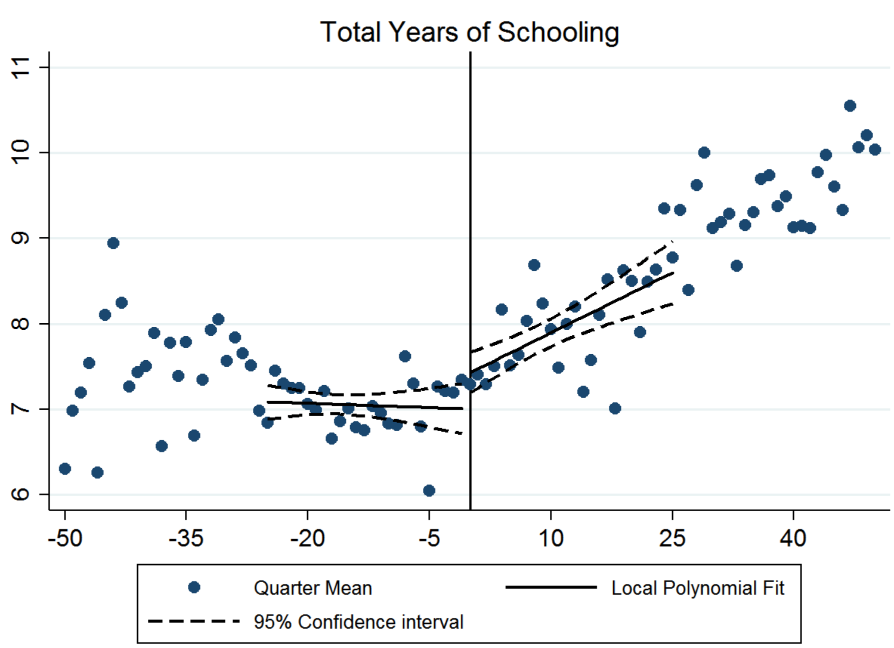


Figure 1B. The Impact of the Compulsory Education Law in China on Educational Attainment: Total Years of Schooling



Note: Figure 1A and 1B show the jumps and kinks in the probability of completing middle school and the total year of schooling at the cutoff birth cohort using CFPS-2010, respectively. The circles represent unconditional mean for each cohort, and the fitted values as well as 95 percent confidence interval from local linear regressions are plotted as lines.

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Figure 2A. The Impact of the Longer School Year in Indonesia on Educational Attainment: Experiencing Longer School Year

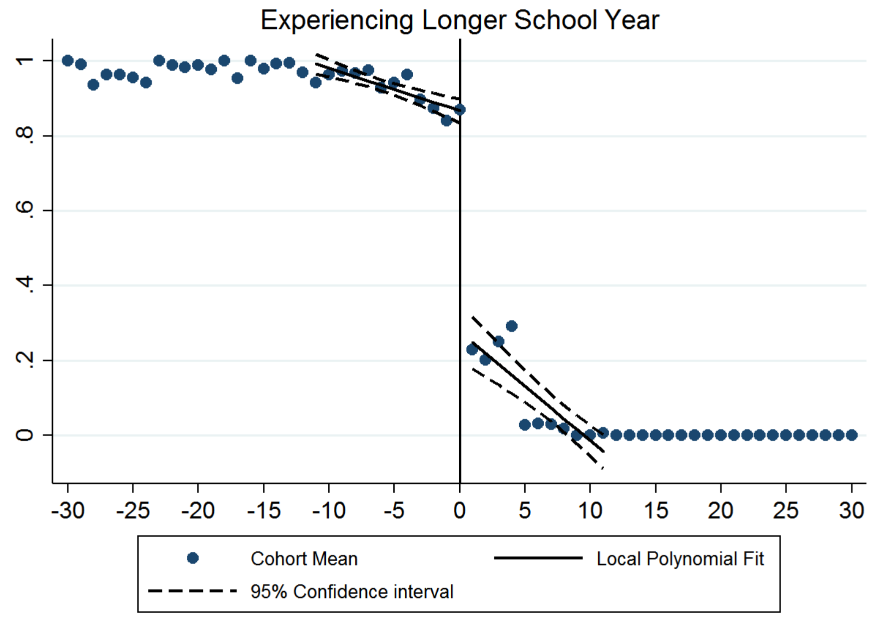
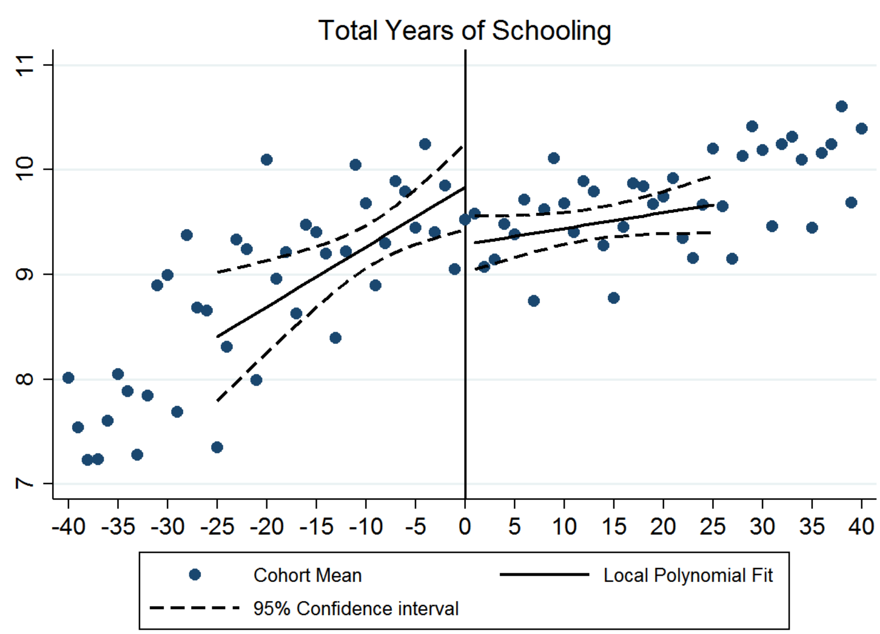


Figure 2B. The Impact of the Longer School Year in Indonesia on Educational Attainment: Total Years of Schooling



Note: Figure 2A and 2B show the jumps and kinks in the probability of experiencing longer school year and the total year of schooling at the cutoff birth cohort using IFLS-5, respectively. The circles represent unconditional mean for each cohort, and the fitted values as well as 95 percent confidence interval from local linear regressions are plotted as lines.

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Figure 3A. Density of Birth Cohort: CFPS-2010

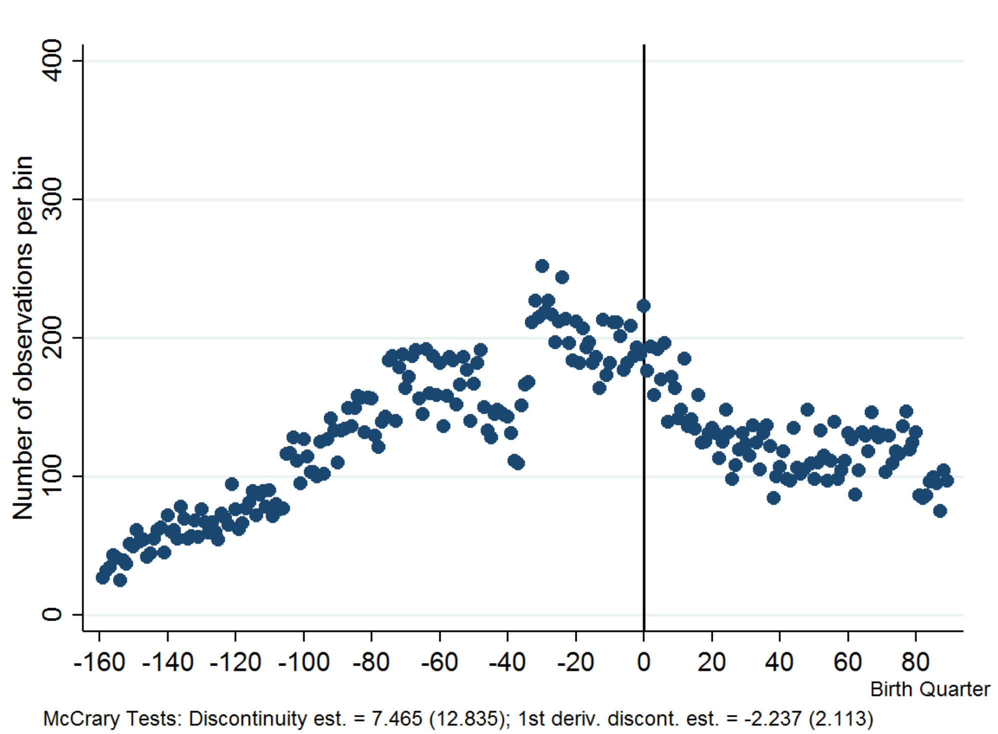

Figure 3B. Density of Birth Cohort: IFLS-5

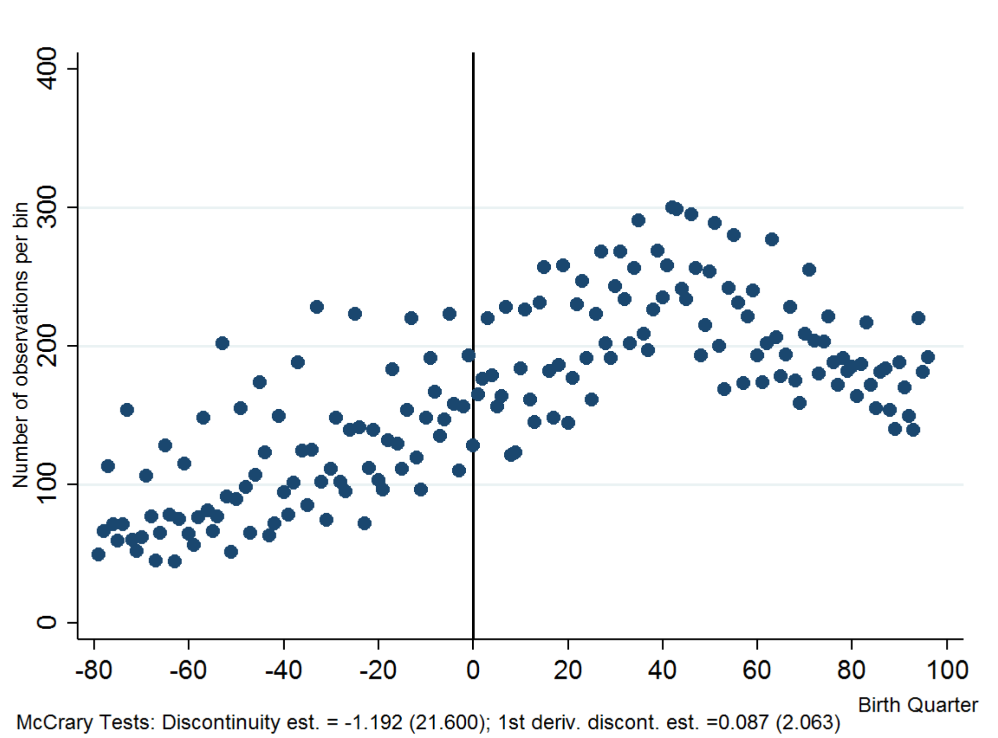

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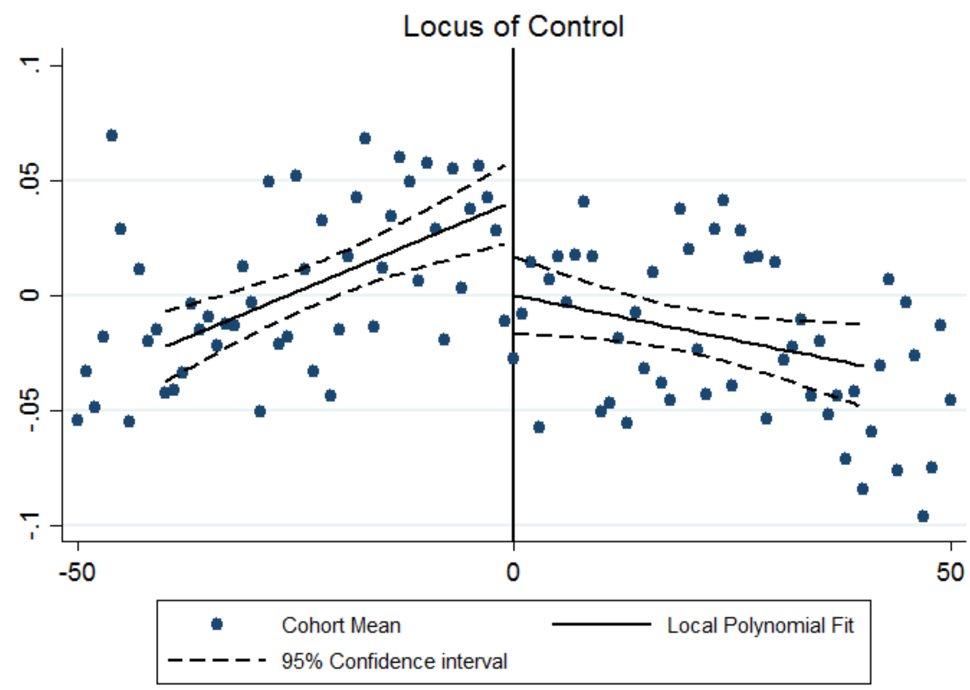
Figure 4. Estimated Discontinuities at Cohort Cutoff in Locus of Control



Note: The figure shows the estimated jumps and kinks in Locus of Control at the cutoff birth cohort. The circles represent unconditional mean for each cohort, and the fitted values as well as 95 percent confidence interval from local linear regressions are plotted as lines.

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Figure 5A. Estimated Discontinuities at Cohort Cutoff in Big Five: *Conscientiousness*

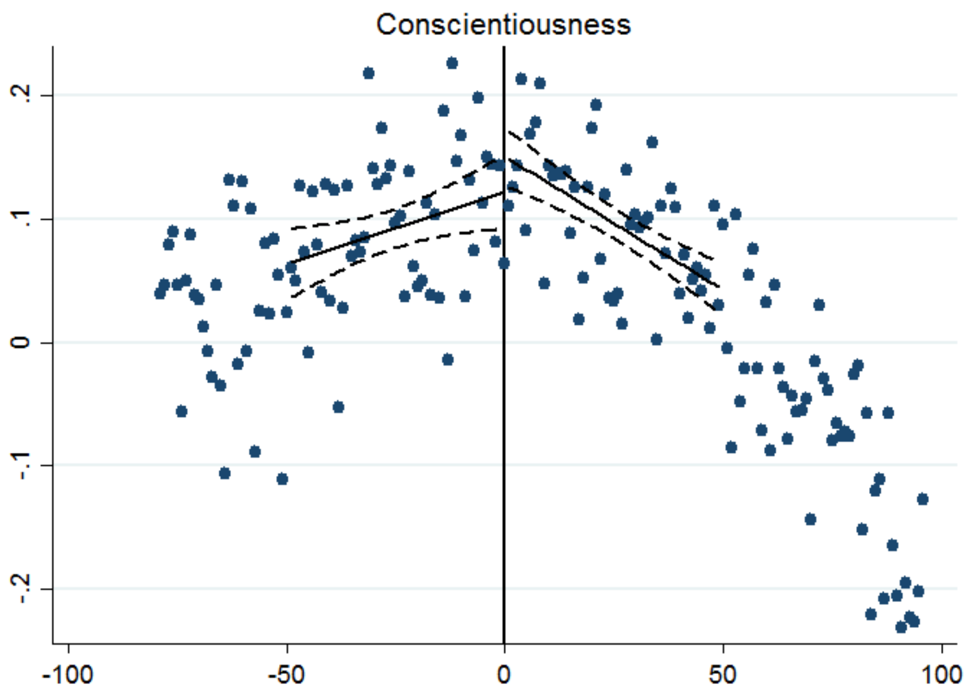

Figure 5B. Estimated Discontinuities at Cohort Cutoff in Big Five: *Openness to Experience*

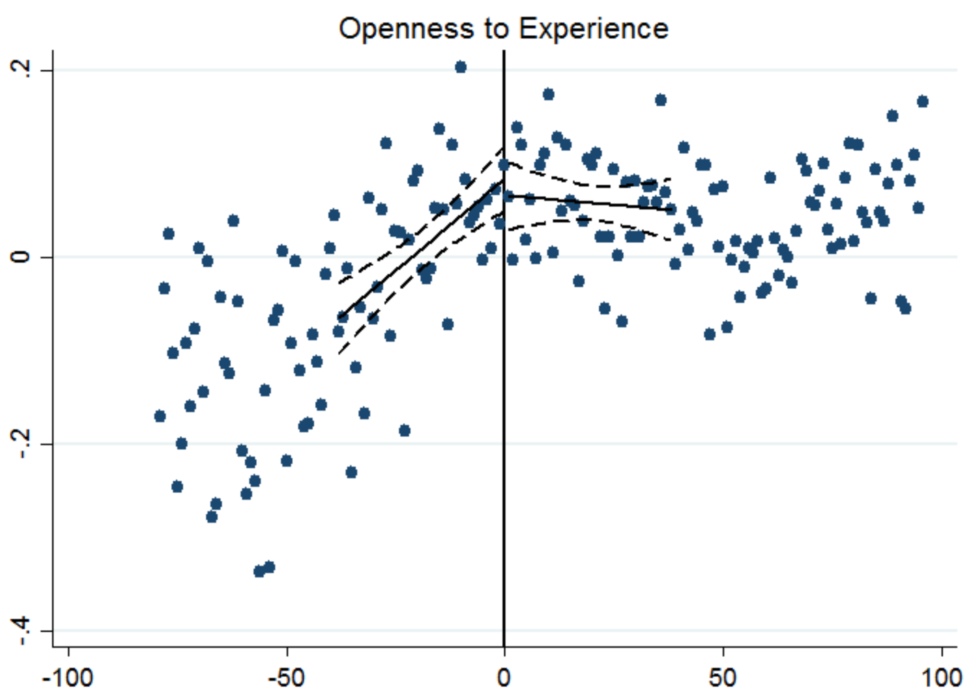

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Figure 5C. Estimated Discontinuities at Cohort Cutoff in Big Five: *Extraversion*

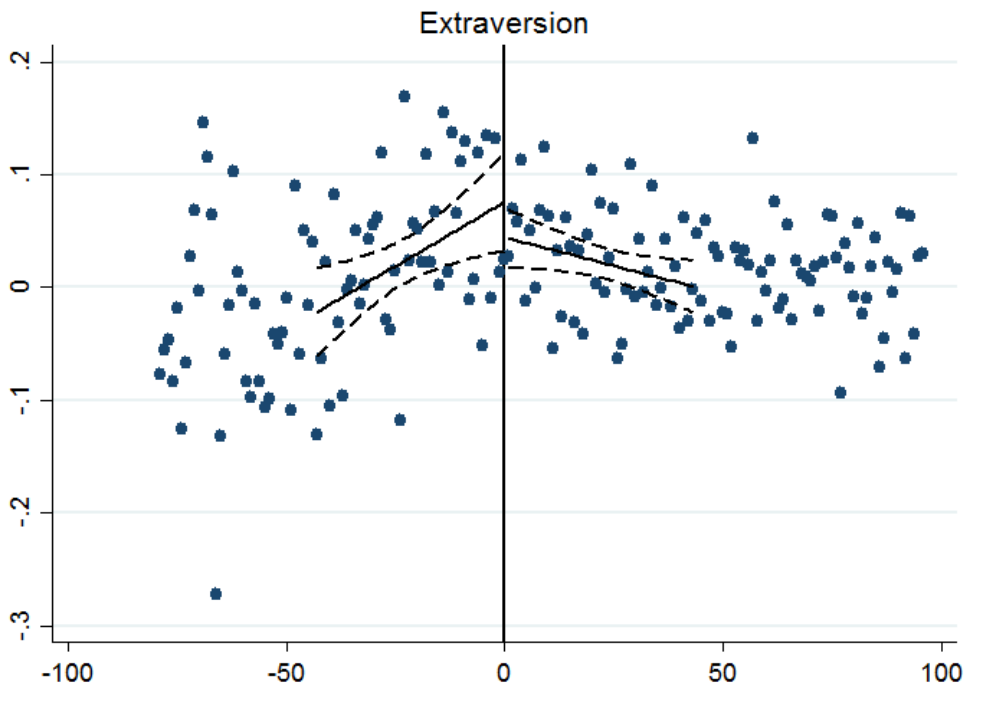

Figure 5D. Estimated Discontinuities at Cohort Cutoff in Big Five: *Agreeableness*

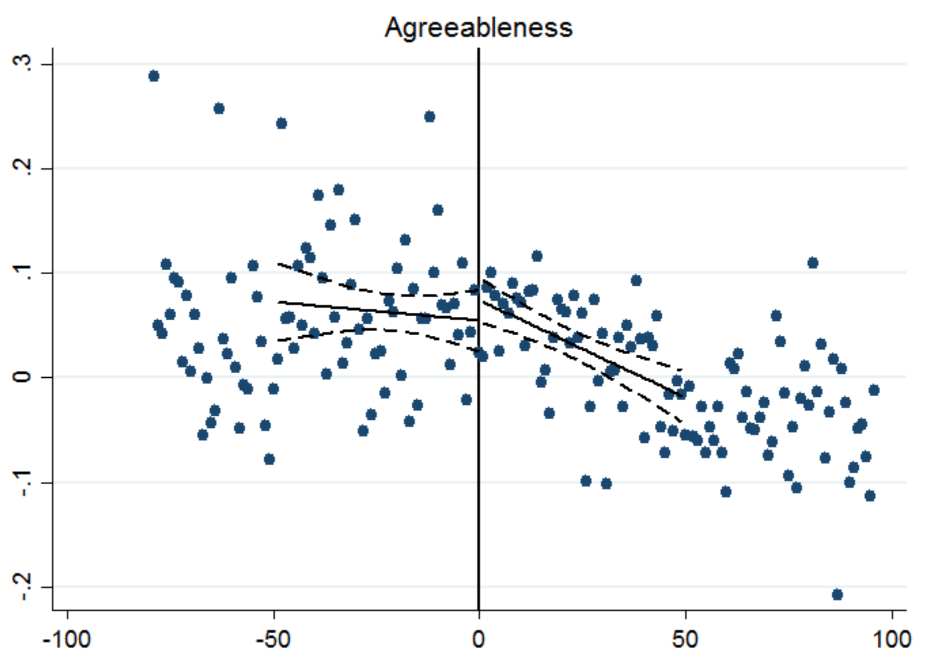

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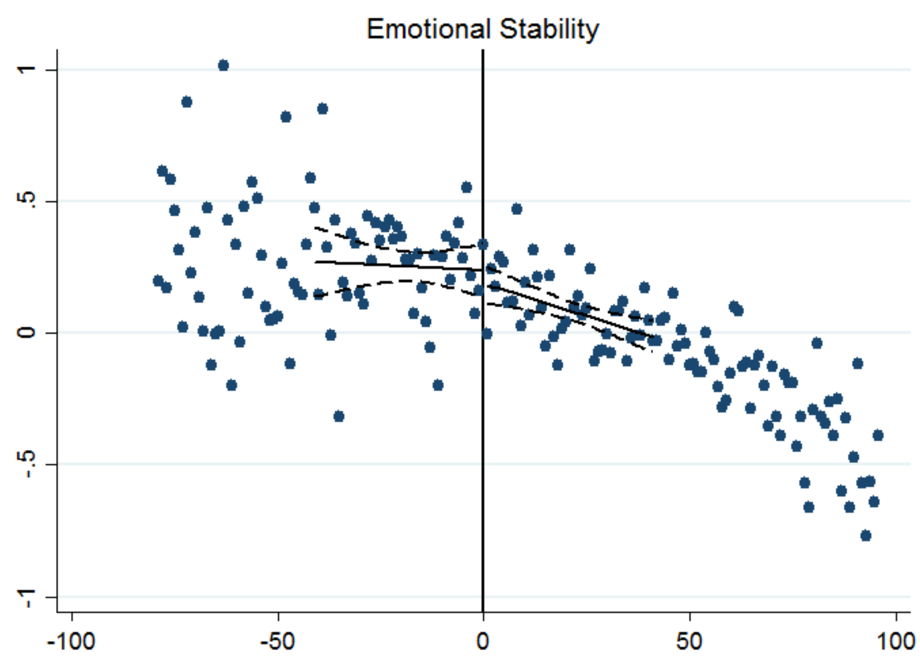
Figure 5E. Estimated Discontinuities at Cohort Cutoff in Big Five: *Emotional Stability*



Note: These figures show the estimated jumps and kinks in Big Five measures at the cutoff birth cohort. The circles represent unconditional mean for each cohort, and the fitted values as well as 95 percent confidence interval from local linear regressions are plotted as lines.

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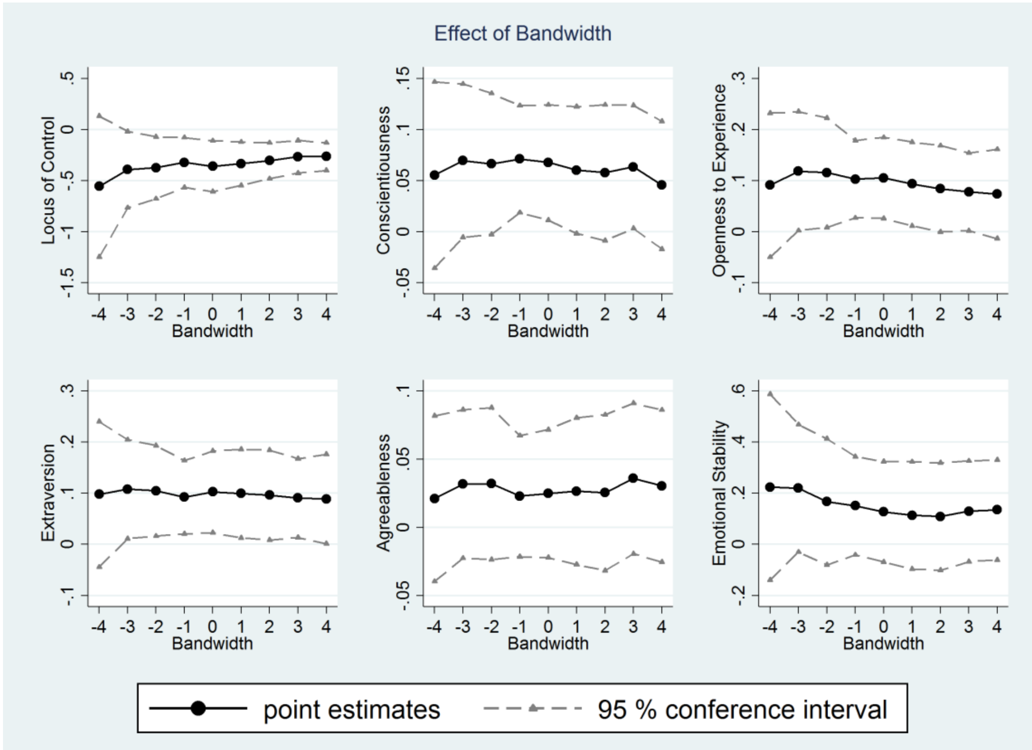
Figure 6. The Effect of Bandwidth on the Estimated Impacts on Noncognitive Skills



Notes: The lines show the point estimates of the law effects on the corresponding outcomes. The dashed lines mark the 95 percent confidence intervals. On the x-axis are different bandwidths, ranging from h*-4 to h*+4.

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Figure 7A. Decomposition of the Effect of Schooling on Labor Market Outcomes: CFPS-2010

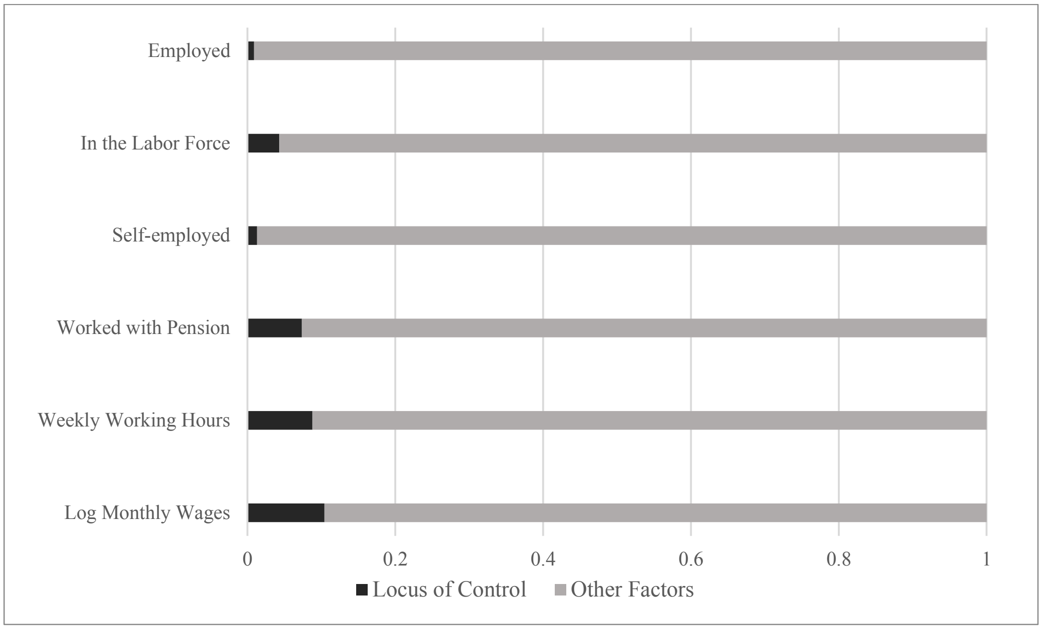
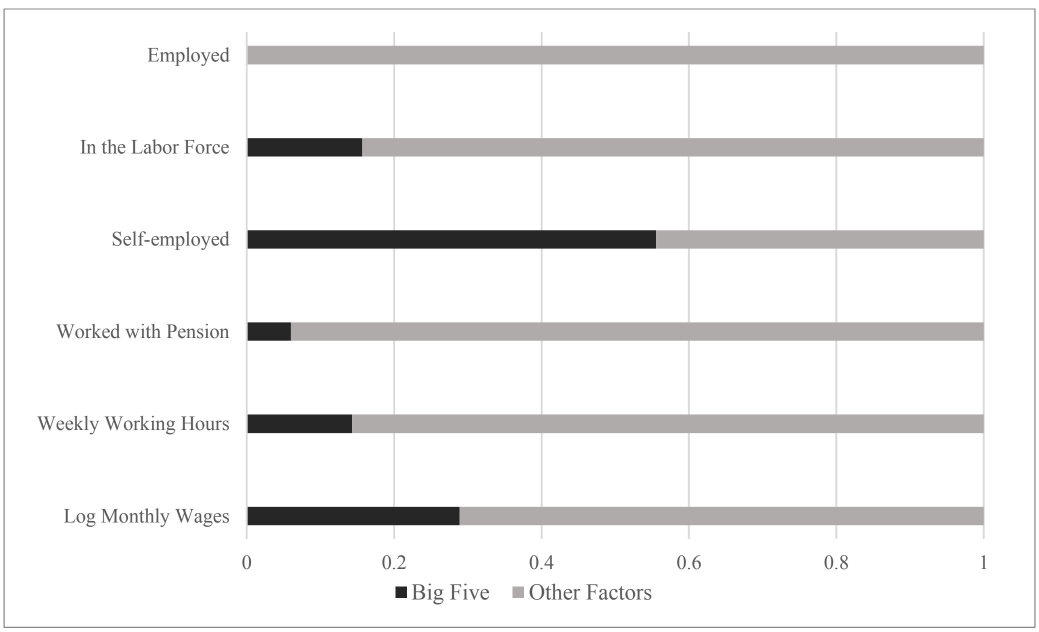


Figure 7B. Decomposition of the Effect of Schooling on Labor Market Outcomes: IFLS-5



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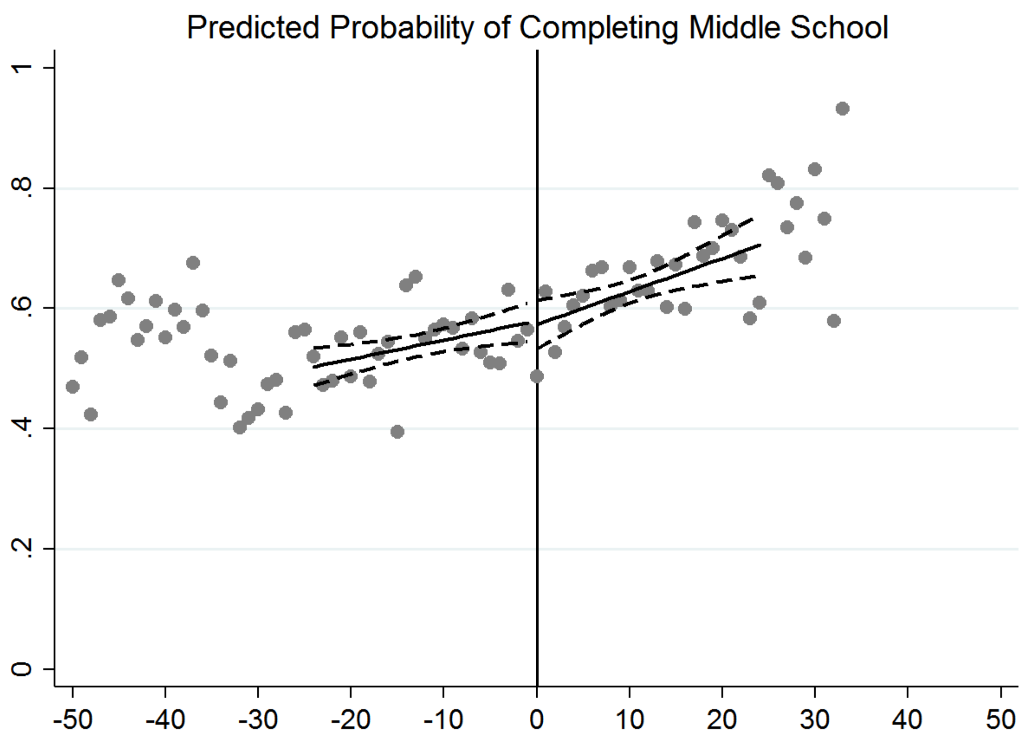
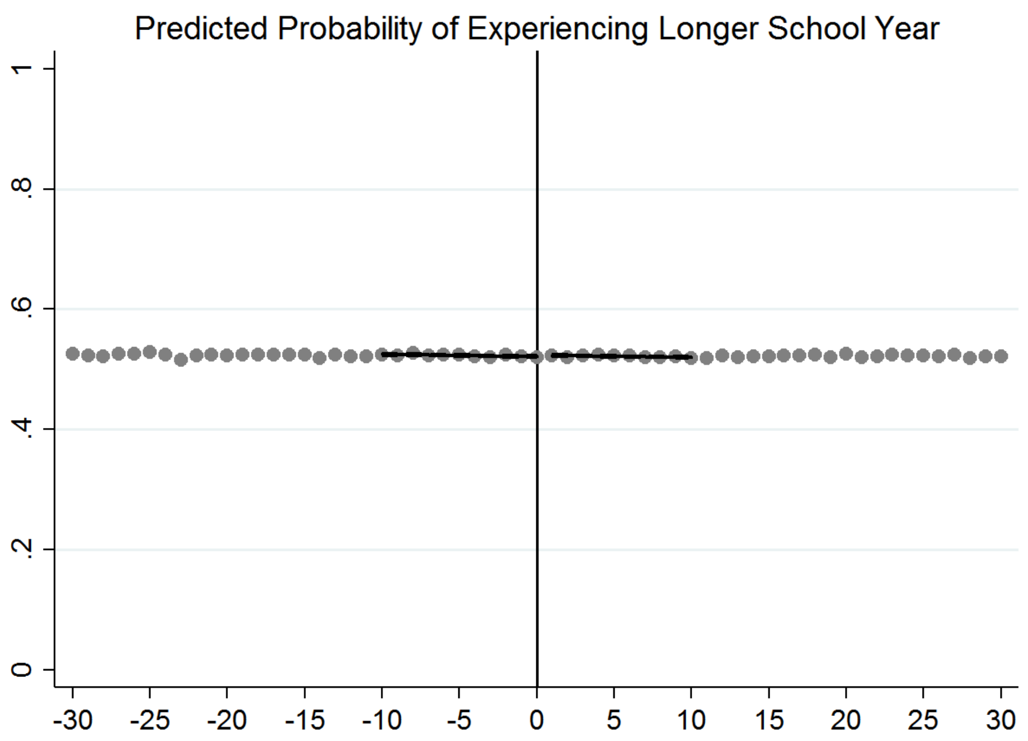
Appendix Figure 1A. Smoothness of Predicted Probability of Completing Middle School



Appendix Figure 1B. Smoothness of Predicted Probability of Experiencing Longer School Year



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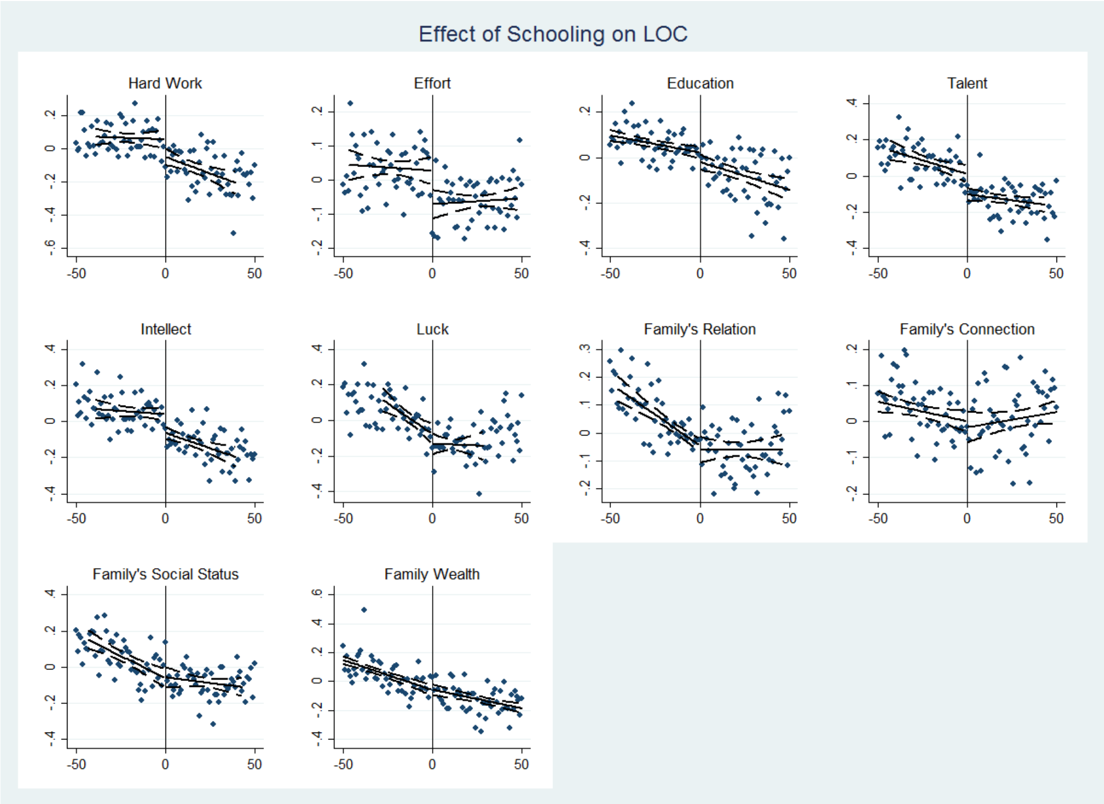
Appendix Figure 2. The Effect of Schooling on the LOC Conponents



Note: These figures show the estimated jumps and kinks in locus of control components at the cutoff birth cohort. The circles represent unconditional mean for each cohort, and the fitted values as well as 95 percent confidence interval from local linear regressions are plotted as lines.

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Appendix Table A1. Summary Statistics: CFPS

	[1]	[2]	[3]	[4]	[5]	[6]
	Treatment Cohorts			**Control Cohorts**		
Total number of observations	10,884			19,826		
Variables	**Mean**	**S.D.**	**# Obs**	**Mean**	**S.D.**	**# Obs**
Completing middle school	0.690	0.462	10,884	0.422	0.494	19,824
Total year of schooling	9.094	4.292	10,884	6.029	4.633	19,824
Locus of Control Index	-0.016	0.434	10,788	-0.005	0.392	19,202
Hard Work	-0.140	1.120	10,678	0.078	0.922	18,636
Effort	-0.043	1.057	10,637	0.014	0.960	18,259
Education	-0.118	1.089	10,643	0.077	0.930	18,393
Talent	-0.159	1.013	10,489	0.115	0.974	17,458
Intelligence	-0.144	1.099	10,643	0.099	0.917	18,415
Luck	-0.103	1.011	10,647	0.091	0.981	18,315
Family's Relations	-0.068	1.032	10,603	0.081	0.957	18,073
Family's Social Status	0.004	1.027	10,530	0.020	0.974	17,814
Family's Wealth	-0.130	1.017	10,519	0.115	0.969	17,668
Connections	-0.159	0.976	10,636	0.123	0.996	18,340
Other variables:						
Gender (male=1)	0.469	0.499	10,884	0.492	0.500	19,826
Birth weight (k.g.)	3.071	0.567	4,063	2.879	0.570	4,386
Family background during Culture Revolution	3.776	0.582	4,066	3.693	0.603	19,580
Father's education when the child was 14	6.325	4.273	7,487	2.819	4.002	14,376
Mother's education when the child was 14	4.349	4.263	7,591	1.067	2.697	15,175
Father's occupation when the child was 14	30.525	14.329	6,263	30.016	14.693	13,432
Mother's occupation when the child was 14	26.789	10.756	5,794	24.607	6.859	11,798
Father was Party member when the child was 14	0.134	0.341	8,146	0.142	0.349	15,532
Mother was Party member when the child was 14	0.021	0.142	8,185	0.020	0.139	15,793
Father was absent during ages 0-12	0.177	0.382	10,717	0.152	0.359	19,513
Mother was absent during ages 0-12	0.100	0.300	10,747	0.082	0.274	19,588

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Appendix Table A2. Summary Statistics: IFLS

	[1]	[2]	[3]	[4]	[5]	[6]
	Treatment Cohorts			**Control Cohorts**		
Total number of observations	9,077			19,733		
Variables	**Mean**	**S.D.**	**# Obs**	**Mean**	**S.D.**	**# Obs**
Longer school year	0.978	0.148	7,595	0.010	0.099	18,133
Total year of schooling	8.205	4.527	9,060	10.273	3.567	19,666
Big Five						
Conscientiousness	0.068	0.625	8066	0.017	0.635	17556
Openness to Experience	-0.060	0.723	8,066	0.040	0.660	17,556
Extraversion	-0.009	0.642	8,066	0.012	0.656	17,556
Agreeableness	0.048	0.650	8,066	-0.005	0.654	17,556
Emotional Stability	0.214	1.778	9,077	-0.083	1.781	19,733
Other variables:						
Gender (male=1)	0.490	0.500	9,077	0.483	0.500	19,729
Born in village	0.724	0.447	8,941	0.668	0.471	18,968
Ethnicity-Jawa	0.396	0.489	9,077	0.363	0.481	19,733
Has attended Kindergarden	0.108	0.310	9,035	0.293	0.455	19,663
Father's ethnicity- Jawa	0.413	0.492	9,077	0.375	0.484	19,733
Mother's ethnicity- Jawa	0.412	0.492	9,077	0.378	0.485	19,733
Father had attended school	0.733	0.442	6,917	0.869	0.337	13,754
Mother had attended school	0.542	0.498	6,863	0.787	0.410	12,912

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Appendix Table A3. Smoothness of Predetermined characteristics

	VARIABLES										
	Panel A. CFPS-2010										
	Gender-	Birth	Family	Parent's educaton at age 14		Parent's Occupation at age 14		Parent was Party member at age 14		Parental absence at ages 0-12	
	male	weight	background	Father	Mother	Father	Mother	Father	Mother	Father	Mother
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
Estimated Jump	-0.005	0.040	0.009	0.003	0.080	-0.104	0.056	0.014	-0.004	0.001	-0.001
$I(C \leqslant C_0)$	(0.016)	(0.034)	(0.018)	(0.214)	(0.152)	(0.261)	(0.168)	(0.011)	(0.005)	(0.011)	(0.008)
Estimated Kink	0.001	0.000	-0.001	-0.004	0.007	-0.022	-0.003	-0.000	0.000	0.000	0.000
$(C-C_0)I(C \leq C_0)$	(0.001)	(0.001)	(0.001)	(0.009)	(0.006)	(0.011)	(0.007)	(0.000)	(0.000)	(0.000)	(0.000)
Observations	16,279	5,101	11,997	9,148	10,839	10,473	9,304	13,277	13,182	14,924	14,480
Control Mean	0.492	2.879	3.693	2.819	1.067	41.450	39.980	0.142	0.020	0.152	0.082

	Panel B. CFLS-5							
	Gender-	Born in	Ethnicity	Attended	Ethnicity-Jawa		Had Attended School	
	Male	Villages	Jawa	Kindergarden	Father	Mother	Father	Mother
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
Estimated Jump	0.005	0.003	0.021	-0.006	0.011	0.009	0.007	0.005
$I(C \leqslant C_0)$	(0.013)	(0.015)	(0.014)	(0.012)	(0.015)	(0.016)	(0.018)	(0.014)
Estimated Kink	0.002	-0.000	-0.000	-0.001	-0.000	0.000	0.000	0.000
$(C-C_0)I(C \leq C_0)$	(0.000)	(0.001)	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Observations	16,680	17,354	19,373	13,364	17,734	18,715	8,011	12,487
Control Mean	0.483	0.668	0.363	0.293	0.375	0.378	0.869	0.787

Notes: 1. Each cell presents the estimated discontinuity in the predetermined characteristics. 2. We use local linear regressions including a Imbens & Kalyanaram (2012)'s optimal bandwidths; 3. Clustered standard errors are in parentheses; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.

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Appendix Table A4. Impact of Schooling on Locus of Control Components

	VARIABLES									
	Locus of control-Internal					Locus of control - External				
	Hard Work	Effort	Education	Talent	Intelligence	Luck	Family's Relations	Family's Social Status	Family's Wealth	Connections
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
Schooling	-0.695	0.043	-0.168	0.201	-0.528	0.738	0.576	0.239	0.635	0.295
	(0.357)	(0.196)	(0.119)	(0.258)	(0.264)	(0.512)	(0.248)	(0.138)	(0.329)	(0.148)
Observations	12,722	14,524	16,507	13,193	12,646	9,477	14,175	19,351	13,287	20,296
Control Mean	0.0779	0.0139	0.0771	0.115	0.0993	0.0909	0.0810	0.0198	0.115	0.123

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. All regressions control for quarter-of-birth dummies, dummy for residential province at age 12.

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Appendix Table A5. Add Predetermined Chacteristics

	VARIABLES					
	CFPS-2010	IFLS-5				
	LOC	Conscientiousness	Openness to Experience	Extraversion	Agreeableness	Emotional Stability
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]
Schooling	-0.518	0.075	0.126	0.095	0.036	0.139
	(0.238)	(0.030)	(0.050)	(0.045)	(0.031)	(0.109)
Observations	5,902	10,801	8,381	9,500	10,801	9,279
Control Mean	-0.00463	0.0173	0.0438	0.0152	-0.00510	-0.0909

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies; all predetermined characteristics used in the vadilidy tests are added in the regressions.

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Appendix Table A6. Impact of Schooling on Labor Market Outcomes

	CFPS-2010											
	Employed		In the Labor Force		Self-employed		Worked with Pension		Weekly Working Hours		Log Monthly Wages	
	Full	Partial	Full	Partial	Full	Partial	Full	Partial	Full	Partial	Full	Partial
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Schooling	-0.114	-0.115	-0.139	-0.133	-0.076	-0.077	0.555	0.514	-10.946	-11.908	0.528	0.583
	(0.085)	(0.087)	(0.144)	(0.139)	(0.069)	(0.069)	(0.219)	(0.203)	(6.024)	(5.981)	(0.404)	(0.424)
Observations	9,406	9,282	10,981	10,825	8,488	8,363	10,900	10,740	13,129	12,932	3,465	3,455
Control Mean	0.902	0.902	0.945	0.945	0.105	0.105	0.215	0.215	23.56	23.56	7.266	7.266

	IFLS-5											
	Employed		In the Labor Force		Self-employed		Worked with Pension		Weekly Working Hours		Log Monthly Wages	
	Full	Partial	Full	Partial	Full	Partial	Full	Partial	Full	Partial	Full	Partial
ESTIMATE	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]	[12]
Schooling	0.003	0.003	0.051	0.043	-0.009	-0.014	1.505	1.595	0.049	0.042	0.097	0.069
	(0.004)	(0.004)	(0.030)	(0.029)	(0.026)	(0.027)	(0.911)	(0.898)	(0.022)	(0.023)	(0.071)	(0.066)
Observations	7,665	7,293	10,714	10,226	8,717	8,337	13,472	12,895	13,255	12,648	9,733	9,323
Control Mean	0.975	0.975	0.653	0.653	0.307	0.307	43.06	43.06	0.545	0.545	14.62	14.62

Notes: 1. Each cell presents the estimated discontinuity at the cutoff point; 2. We use local linear regressions with optimal bandwidths calculated by the method of Imbens and Kalyanaram (2012); 3. Standard errors in parentheses are clustered at cohort levels; 4. Control mean is the mean value of the outcome variable for the prereform sample; 5. Bandwidth is the Imbens & Kalyanaram (2012)'s optimal bandwidth used in each estimation; 6. Regressions based on CFPS-2010 control for quarter-of-birth dummies and residential provinces at age 12, while regressions based on CFLS-5 control for quarter-of-birth dummies.