The rise of education in China through the 20th century

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Introduction
The important role of education or human capital, in economic development has long been discussed. The literature on long-term human capital stock estimates for developed countries is comprehensive. Meanwhile within Asia, studies on estimation of educational stock for Japan, Korea and Taiwan are vast too, which partly contribute to the debate that the rapid rise of Asia lies in its impressively rich endowment of education. Unfortunately, however, empirical studies on human capital formation for China before 1978 is so limited so far that economists and historians are still uncertain about even basic questions. What is the level and pattern of educational growth for China in 20th century? To what extent did education rise? Under different political regimes, how changes in educational attainment were affected by Chinese educational system and political uncertainty? Comparing to other Asian counterparts, did China share the similar characteristics of its relatively high progress in education? In order to answer all those questions, more empirical evidences need to be presented, and as a starting point, we offer a long-term assessment on human capital stock in this paper. Even though the quality of data in hand is not satisfied, based on different technical approaches, we will try to generate a annual series of human capital stock for 20th century China.

I. Education transformation in 20th century
The 20th century for China is far from a peace and stable era. After exposure to western challenges from late 19th century, the long-lasting ancient Empire collapsed in 1911 and followed by political fragmentation, the World War II, civil war, political radicalism during Mao era and then finally economic reform period. In the face of these economic, political and culture changes, education transformation took place. Before proceeding to a quantitative estimation of educational stock in China, it would be useful to provide a summary and introduction of huge changes in Chinese education system in the 20th century. There were at least two structure breaks we
observe in Chinese education system; the first happened at the turn of the 20th century, and the second occurred after the Communist Party came to power in 1949.

1. First structure break: transformation from traditional to modern education (Is tradition a virtue or burden?)
At the turn of the 20th century, the long-lasing traditional education system was gradually replaced by western and modern education system. The Chinese traditional education system worked admirably for more than one thousand years. There is much literature argues that China always had relatively high level of human capital before modern education diffused, because basic education, mainly in informal and traditional format, was already fairly widely diffused among mass population in China during 19th to 20th century. However, more and more exposure to western imperial powers and calling for industrialization in the late 19th century pushed China to carry out a large number of western-influenced reforms, and reformers saw western education a method to modernize China's economy and society. In 1904, the Imperial Civil Service Exam was abolished, as a symbol of the end of traditional education system; afterwards reformers began to urge a thorough-going change in the educational system, and they planed for a modern mass educational system which was professionally staffed and publicly financed.

The traditional education system was centred around the civil service examination, which had existed for about 1300 years. This exam served the function of selecting senior positions in the State’s bureaucracy; therefore, a high reward to high achievement on this exam generated considerable demand for education in Imperial China, and provided people a channel of upward social mobility. However, under this system, the aim for people to receive education was quite narrow-- pursing success in the Imperial Civil Service Exam to become a member of bureaucrat class.

There is no denying that the traditional education system generated fairly high education demand and high social mobility, however, the weakness of the traditional education is critical. The major weakness of the traditional education system lies in its striking narrow focus content: mastery of the Confucian classics and the ability to write the eight-legged essays. This directly caused the curriculum to focus excessively on social science education, and overlook the importance of natural science and other
subjects. Additionally, in traditional China, instead of governments, local lineages and social elites played an extremely active role in providing schooling to children. The absence of public funding for education meant that schooling was still quite limited to middle class and rich families. Furthermore, the schooling system had no rigorous formal regulation, namely clear classification of grades and formal training for teachers. The informal home schooling was the most common education format witnessed in traditional China, and teachers were principally private tutors, directly engaged by the elders. The final shortcoming of traditional education was that it failed to educate females. The rationale behind women being excluded from schools is easy to understand. The function of schooling was to select bureaucrats through exams; as women were not allowed to be a part of bureaucrat class, they were therefore not included in the formal educational system.

Table 1.3: The difference between traditional and modern education

<table>
<thead>
<tr>
<th></th>
<th>Traditional Education</th>
<th>Modern Education</th>
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<tbody>
<tr>
<td>Aim</td>
<td>Preparation for civil service examinations, path to bureaucrat class</td>
<td>Function: disseminates knowledge and cognitive skills</td>
</tr>
<tr>
<td></td>
<td>Content: Confucian classic works, writing skills</td>
<td>Vocational instruction</td>
</tr>
<tr>
<td></td>
<td>Characteristics:</td>
<td>publicises modern ideology (nationalism and democracy)</td>
</tr>
<tr>
<td></td>
<td>1. civil service examination oriented</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. private provision of schools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. Informal schooling system without clear classification of grades</td>
<td></td>
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<td></td>
<td>4. female have no educational opportunities</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Content: Western subjects: mathematics, Chinese, Physics, English, etc</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Characteristics:</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1. mostly public financed and public provision of schools</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2. formal schooling system with clear classification of grades</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3. gender neutrality</td>
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At the beginning of the 20th century, educational system underwent a thorough reform. The three major progresses in this educational transformation lie in: the great
improvement in education content, equal educational opportunity towards both sex and the shifting from informal schooling to formal educational. Firstly, the greatest improvement was curriculum change. The changes made to the school curriculum were significantly western-influenced and they were along three general lines: the elimination of Chinese Confucian classics as a subject in itself; the introduction of new western subjects; and manual work and military drill were emphasised.\(^1\) Additionally, the modern system offered equal educational opportunities for both sexes. In 1908, the Ministry of Education issued 36 regulations for normal schools for girls and 26 ones for primary girl-only schools. Since then educational opportunities began to open to females, and this was the beginning of formal education for women in China.\(^2\) The third transformation of the educational system is that private informal education institutions (\textit{Sishu}) began to be replaced by public formal schools. From 1904, the Ministry of Education called on village, county, and provincial officials to achieve compulsory primary schooling in format of modern institutions, therefore modern educational institutions became more prevalent.\(^3\)

Before late 19th century, under the traditional education system, children commonly attended \textit{Sishu} (China’s old-style school) to receive basic education. \textit{Sishu} had been the main educational institution before the modern school system was established. Usually Sishu is privately funded, informal and in a small-scale.\(^4\) Originally, students in \textit{Sishu} were mainly ungraded, but it was roughly subdivided into junior \textit{Sishu} and Senior \textit{Sishu}. Children went to junior \textit{Sishu} to achieve basic literacy and numeracy level when they were very young (4~7); and after around 4 years of basic studies, students could enrol in senior \textit{Sishu} to learn confusion classics which is preparation

\(^1\) P. W. Kuo, Reorganization of education under the Republic


\(^3\) Yan Se, 2010, Big BRICs, Weak Foundations: The beginning of public elementary education in Brazil, Russia, India, and China, 1880-1920

\(^4\) Not only in China, the shift from informal school to modern formal school commonly was witnessed in other nations. In many ways, \textit{Sishu} was very similar to \textit{Terakoya},\(^4\) the traditional informal format school which was widely seen in Japan in 19th century, and ‘Common School’ in the US, which meant it was usually a one-room schoolhouse, with ungraded pupils in rural areas through the 19th to 20th century.
for civil service examination. After 1905, abolition of civil service examination, senior Sishu lost its function and gradually phased out, but the junior Sishu which mainly aim to teach children basic reading and writing skills still existed, especially in villages and small towns, even after modern graded primary schools increased in number. A large number of regional evidences show that, Sishu, if not expanded, persistently existed until 1950s, suggesting that the transformation from informal schooling to formal education was not accomplished within a short time, and during most of the time in the first half of the 20th century these two educational track: modern schools and traditional Sishu, coexisted. Even though Sishu spread all over the nation and played a big role in promoting basic education in China before 1950s, due to the limitation of national level records, information on Sishu, such as total number of schools and students, remained un-known.

In short, the first structure break for education system occurred at the turn of the 20th century, which was fully western and Japan influenced, urged a transformation from traditional education system to a modern one. The abolishment of the civil service exam system in 1905 marked a sharp change in the incentives to provide education, the finance structure of education, and educational content. However, this transformation didn’t mean that the disappearance of traditional education, in contrast, we observe that Sishu survived in China until 1950s, suggesting that the first half of the 20th century is characterized by the feature -- coexistence of two educational-tracks at the same time.

2. Education system under Communist era

In 1949, after the Communist Party came to power, the education system underwent major changes again. The education began mostly public provided, and since the system operated in a highly centralized way, the traditional education was forbidden and then phased out. All schools used the same textbooks and arrange their courses according to teaching plans issued by the national Department of Education. At the same time, educational opportunity started to tie with family class origin and the student’s own political conformity in Mao era. During Great Leap Forward and the

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6 Great Leap Forward: 1959 to 1962
Great Culture Revolution, the development of education was seriously disrupted, especially during the Culture Revolution; tertiary education was forced to close for 10 years.

After 1978, when economic reform took place, the education system began to return to normal and tend to follow US model. Chinese government put economic growth as its priority, therefore more and more attention began to be paid to pursue education development. A significant improvement happened in 1986, 9-years compulsory education compulsory education was introduced; however the local authorities have never managed to support sufficient number of primary schools so that all children could attend. After many modifications through trial and error, the new educational system was gradually consolidated.

II. Methodology and data

Various indexes may be selected to measure the levels of education across nations and over time. The most popular and most commonly used measure of human capital stock in the literature is educational attainment. Unfortunately, in terms of estimation on human capital of China, both long-term assessment and cross-countries studies are extremely rare. Only few economic historians present some informative or indirect evidences to support the statement that China always had relatively high level of human capital. In her landmark book on education in the Qing dynasty, Rawski (1979) argues that basic education, mainly in informal and traditional format, diffused not only in elites and middle class, but also deeply spread to low income class and even rural areas in China during 19th to 20th century. Her study shows that the basic literacy level of Chinese males lay at 30 to 45% and females at 2 to 10% in 19th century. Similarly, John Buck, in his book “Land Utilization in China”, states that 45% of all males over 7 years of age had received some schooling, while 30% were literate in the 1930s. Furthermore, Buck presents regional level evidences pointing out that as early as the first half of the 19th century, the literacy rate in rural Canton already stood at

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7 Great Culture Revolution: 1967 to 1977  
8 The effect of Culture Revolution and Great Leap forward to education has not been in a consensus yet.  
40-50%, while the figure for urban Canton\textsuperscript{10} even achieved 80-90%. \textsuperscript{11} Recently, Yan Se (2011) is the first to use national enrolment ratios investigating the period between 1880 and 1890. His study is only focus on modern primary schooling, and presents the results that 4% of school-age in 1900 enrolled in formal schools in China, however, because he the only indicator he based on is primary enrolment ratios, leaving a lot of unsolved puzzles to us.

In short, there is no study on estimating human capital stock for China before 1978, and studies on period after 1978 are also fairly rare. This paucity of the empirical analyses mainly can be attributed to the lack of detailed dataset including education data, but also because economic history still remained as a marginal discipline in academic world inside China, not enough academic attention have been paid on this topic. In this paper, we will use different approach to complement the imperfect data quality, and try to generate a long-term series of human capital stock for 20\textsuperscript{th} century China.

Methodology
In order to estimate educational attainment, three approaches are most common in relevant literature. Wössmann (2003) distinguishes these three fundamental techniques. The first one, (Lau \textit{et al.}, 1991; Nehru \textit{et al.}, 1995, Godo 2001) is Perpetual Inventory Method (PIM): with sufficiently long series of enrolment data available, we can calculate the total years of formal education received by population. The second method pioneered by Barro and Lee (1993; 1996; 2001), relied on attainment figures taken directly from censuses (Psacharopoulos and Arriagada 1986), which requires good quality census at best for every 10th year. The third approach is the projection approach applied by Kyriacou (1991): he estimates the ‘average years of schooling’ from censuses for a few benchmark years on lagged enrolment ratios. Depending on the relationship between years of schooling and lagged enrollment ratios, we could project backward the series of educational attainment.

\textsuperscript{10} Canton was one of the most developed provinces in China, so it was likely that its residences’ literacy level was higher than the average national level.

\textsuperscript{11} Buck, John Lossing, 1937, Land utilization in China, Nanking: University of Nanking.
Because the census data in China only exists after 1980s, the ‘Barro and Lee’ approach cannot be applied to this paper. In terms of national level of annual enrollment series, the quality is poor before 1978, but it exists for most of years since 1907, providing us the chance to construct human capital stock series by perpetual-inventory approach. Therefore, due to the paucity of educational data in 20th century China, we will use both perpetual-inventory approach and projection method to construct a long-term series for Chinese education stock, and lastly use the first census which includes education information as supplementary evidence.

1. perpetual-inventory approach

The perpetual inventory method (superscript PIM) derives the relevant stock measures from available flow data. Average years of schooling is calculated by accumulating the ‘total school enrollment’ at corresponding years and ages after adjusting for changes in mortality, immigration, repeaters, and drop-outs. It can be used to accumulate the total number of years of schooling $S$ embodied in the labor force at time $T$ by

$$S_{PIM} = \sum_{t=T}^{T-A_h+D_0} \sum_{g} E_{g,t+g-1} (1 - r_g - d) p_{g,t+g-1}$$

where $E_{g,t}$ is total (gross) enrollment at grade level $g$ at time $t$ as in equation (2), $Ah$ is the highest possible age of a person in the labor force, $Al$ is the lowest possible age of a person in the labor force, $D0$ is the age at which children enter school (typically six), $r_g$ is the ratio of repeaters to enrollments in grade $g$ (assumed to be constant across time), $d$ is the drop-out rate (assumed to be constant across time and grades), and $p_{g,t}$ is the probability of an enrollee at grade $g$ at time $t$ to survive until the year $T.5$ By assuming $Al = 15$ and $Ah = 64$, the studies count all persons between age 15 and 64 inclusive as constituting the labor force. In this paper for the sake of simplicity and unavailability of relevant data, we neglect changes in mortality, repeaters and drop-outs. Additionally, there is no enrollment at grade level before 1990s, therefore, enrolment at schooling level (primary schooling, secondary schooling, and tertiary schooling) are used.
This approach has been used widely in the construction of series on educational attainment in the labour force, but it requires sufficiently long data series on enrolment ratios. According to our definition, the oldest working labour in any given year is 65, and the earliest age he/she could begin education is 6, therefore estimating average years of schooling for a given years requires enrolment records going back about 60 years prior. Since this research tries to cover the whole 20th century, if our estimation of educational attainments starts at 1900, enrolment data must go back to 1840, when modern education did not exist at all under Qing government. Unfortunately, the earliest records on modern schooling enrolments in China only start at around 1900,12 thus based on PIM, the earliest average years of schooling we can stem from enrolment data is the year of 1958.

2. Projection approach

Because the series of average years of schooling based on PIM only begins from 1958, we still have no information on the first half of the 20th century. In order to roll back our estimates to periods prior to 1958, the second best choice of approaches—projection method—will be used. We will regress educational attainment obtained based on PIM on Lagged enrolment to derive an equation with which to estimate average years of schooling for missing years. This method has been used in some studies due to lack of historical data, and Kyriacou (1991) finds that this relationship between lagged enrolment ratios and average years of schooling is rather strong across the 42 countries in his study.13

\[ s_{T}^{PRO} = \alpha_0 + \alpha_1 e_{pri,T-15} + \alpha_2 e_{sec,T-5} + \alpha_3 e_{hig,T-5} \]

3. Individual survey

The third approach involves utilizing direct observations of levels of educational attainment from surveys or census at given year at best every 10 years. For most historical cases, however, such census and survey material is simply not available or

12 In literature, the extrapolation could be used to project back the enrolment series. However, western sense of modern school system was only introduced in China at the end of 19th century; because of this clear structure break in Chinese educational history around the turn of 20th century, using extrapolation to estimate enrolments before 1900 was not valid.

13 Ludger Wobmann, 2000, specifying human capital: a review, some extensions, and development effects
only exist in random year. But what we could do is to divide the population by birth
cohorts, and project the years of schooling for each birth cohorts respectively to get a
general trend of changes in human capital formation.

Data
In order to estimate stock of human capital in China through 20th century, three sets of
annual quantitative information are required: size of total population, sizes of different
age groups of the population, and annual student enrolment numbers at primary, secondary and tertiary levels.

1. Population
For period before 1949, there was no valid estimation of annual population except
Angus Maddison’s work. After 1949, national yearbook which is published by the
Chinese national bureau of statistic provides the most widely-used and reliable data
on Chinese population. Thus, in this paper, the population series is derived from
Maddison for period before 1949, and the figures come from population census for
periods afterwards.

2. Age structure
In terms of population age structure, for the first half of the 20th century, there are
only four population censuses published by nationalist government14 in which
information on age structure are provided. They were published in 1912, 1928, 1947,
and 1953, respectively. In these population censuses, age cohorts cover 5-year age
intervals, and I interpolate the cohort shares between census years to cover those
missing years we don't have information on. Then I apply the same proportion as in
the first census (1912) to every year prior to 1912. For period after 1952, we can get
annual age-structure data from Chinese population statistic yearbook, because nearly
every year has very detail population information published by the bureau of statistics
after then.

3. School enrolment

14 Nationalist government refers to the government under nationalist party, which was
in power before 1949.
As discussed before, there is no complete enrollment series for different level of schooling for the whole 20th century. According to the quality of the enrollment data, to process the enrolment data, three big problems must be coped with. Firstly how to trace back the enrolments figures for periods before 1907, since school level enrolment records only exist for period after 1907? Secondly, how to make amends for enrollment data for missing years? There is no data during the warlord era (1919 - 1922), civil war (1945 – 1948), and the first few years after the Communist China was founded (1951 – 1954). Lastly, but not the least, how to deal with the invalid enrollment records during Great Leap Forward? The data for the Great Leap Forward (1958 – 1961) had not been published during that time, even though the bureau of statistics added some figures in to complete the series several years after 1961, unfortunately, the figures are not reliable and lie at unrealistic high level, suggesting that government manipulated the process of data collecting to over-report the enrollments during that period, which is is consistent with the infamous fact that during Great Leap Forward governments at all level tended to exaggerate their success.

Firstly, in order to project our enrolment series backwards, we extrapolated the series back to 1900 drawing on the rate of change from 1912 to 1922. Similarly, liner interpolation was used to obtain annual values for those missing years: 1919 to 1921 and 1951 to 1954. Furthermore, the most trick part is how to cope with the unreliability of the data during the Great Leap Forward. Drawing on the rate of changes from 1967-1977(culture revolution), I interpolate the 3-years during Great Leap Forward; and the data we estimate here will be used in estimation rather than the unrealistic high level figures in official records.

4. Individual Survey—CHIP 1988
Due to the unsatisfactory quality of the enrolment series, we turn to Individual Survey as commentary evidence to support our results. The Chinese Household Income Project 1988, which is a sub-sample of the annual income and expenditure surveys of the Chinese State Statistical Bureau, is the first census data including information on years of schooling. Based on CHIP 1988, we could roughly compute the outline of the years of schooling by different birth cohorts, and more importantly it provides us
some information on rural-urban divide and gender disparity in terms of educational attainment, which are not available from official enrolment records.

The main problem of this data lies in that the number of people born between 1890 and 1900, who can be tracked in 1988, is very small. The CHIP 1988 incorporates 56438 individual observations; however, the sample size for the 1890s birth cohorts consists of only 110, while for the 1900s birth group, the number is 489. At the same time, given education is highly likely positive associated with the length of life span, educational attainment for those early birth cohorts who still lived in 1988 may be higher than the average level for their generation.

In conclusion, because of the limit on data’s availability and quality, this paper needs to use three approaches and two tracks of data to estimate the human capital stock in China. Firstly, based on enrolment series, average educational attainment from 1958 to 2000 will be estimated based on Perpetual Inventory Method. Then, the series of educational attainment before 1958 will be estimated by the Projection Approach on lagged enrolments records. At last, we could re-exam those previous results by comparing to the average schooling by birth cohorts in CHIP data in 1988.

III. Potential problems

This paper tries to construct a continuous time series of human capital stock of the workforce in China, unfortunately, there is a potential problem by using annual national enrolment data provided by education yearbook, that the series of enrolments only includes students enrolled in modern formal schools, and other forms of education, for instance the enrolments in traditional schools--Sishu are excluded.

As discussed in the previous section, the Chinese educational system in the first half of the 20th century is characterized by the feature that two educational tracks, traditional and modern one, existed at the same time. Some narrative studies within China demonstrate that before the modern schooling system was established, the Sishu were already widespread in China; more importantly, even after the emergence of modern schools, Sishu never went out of fashion in rural China until the 1950’s.
In other words, the shifting from traditional education to the modern one didn’t happen very fast, in contrast it was a story of two tracks rising together. Thus, when constructing educational stock series, only including one educational track—modern schools and excluding students in *Sishu* would seriously underestimate the enrolment rates, therefore educational attainment in China before 1950s.

Therefore, in order to estimate the rise of education in China through 20th century, assessment of the contribution of traditional schooling to human capital stock is essential. To solve this problem, ideally, we would obtain total enrolments by adding the modern and traditional parts together. Unfortunately, the enrolments for *Sishu* are very difficult to pin down, because there are simply no national level records about *Sishu*. The best we can do here is interpreting our results in this paper as the stock of modern education accumulation in Chinese labour force in 20th century first, and in next chapter, we will try to do some ‘guess work’ to minimize the bias caused by excluding enrolments of *Sishu*.

### IV. China’s catch-up in educational attainment

In previous section we summarize those big transformations in education in China, at this point; we present an overall outline of human capital stock of successive birth cohorts of Chinese in 20th century. In doing so we are observing changes in educational attainment during the 20th century for those affected by the Chinese educational system.

Even though average years of schooling for workforce, which is defined as people aged between 15 and 65, is the most common indicator for educational attainment in literature now, we want to look at some more defined age cohorts first, because it would allow us to roll back the approach to earlier period, and also provides us insights on changes of educational attainment within and across age cohorts. Therefore, in this section, we use perpetual-inventory approach and only focus on the average years of schooling of each birth cohort measured at age 35, when almost all have completed their schooling and entered job market. In next section, series of human capital stock of working-age population will be presented.
For birth cohort from late 19th century to 1980s, the increase in average years of schooling at age 35 years has been substantial, as illustrated in Figure 1. But clearly the increase in educational attainment accelerated for people born after 1928. For cohorts born between 1894 and 1928, the increase was continuous and unbroken that a straight line would nicely fit the data. But the improvement seems not satisfied enough, the average schooling only increased 1.2366 years, or 0.3634 per decade. If add the facts we discussed before that, the results based on perpetual-inventory approach based on modern enrolment series would under-estimate educational attainment for people received education before 1950 because of neglecting traditional education received by people; the growth rate for birth cohorts before 1927 would be even more disappointing.

Figure 1: Years of schooling at age 35 years by birth cohorts

![Graph showing years of schooling at age 35 by birth cohort]

After the 1927 birth cohort, however, a great speedup occurred, and educational attainment increased from 1.3 years to 9.07 years, implying that the growth was 1.935 per decade, which is an extremely substantial increasing speed, even comparing to USA during its education expansion period. One thing worth

For US birth cohort between 1876 and 1951, when education expanded most rapidly, the average schooling increased 0.82 years per year.

mentioning, there are three breaks, which exactly reflect the disruptions of warfare, the Great Leap Forward and the Cultural Revolution to the improvement in educational attainment. For birth cohorts between 1925 and 1932, the educational attainment kept stagnant, if we assume that normal people received education from age 6 to 18, they are supposed to receive education between 1931 and 1950, which is consistent with the fact that China went through major warfare starting from 1937 to 1949. Furthermore, for people born between 1947 and 1950, the average years of schooling barely changed, this group would receive education roughly between 1953 and 1968, which covers the period of Great Leap Forward. An even bigger drop took place for birth groups between 1965 and 1970, who would receive education during the Great Culture Revolution. As we know, during Great Culture Revolution, 1966 to 1977, although majority of primary schools continued to operate, most of secondary schools were shut down completely from 1966–68 and almost all tertiary level institutions remained closed for 10 years.\footnote{Zhong Deng and Donald J. Treiman, 1997, The Impact of the Cultural Revolution on Trends in Educational Attainment in the People's Republic of China}

The national level enrolment data has no continues separate information for male and female, so in order to have more detailed understanding on difference of human capital stock according to gender and region, individual survey—CHIP1988—is used in this section. Figure 2 illustrates that women and men both shared in the increase in educational attainment through the 20\textsuperscript{th} century, but female gained more than male, especially for people born in the late 19\textsuperscript{th} century and after the 1930s.

The higher growth speed of educational attainment for female stems from the extremely low initial level of female education at the beginning of the 20\textsuperscript{th} century. This gender inequality in education can be partly explained by Confucian ideology which confines women to a subordinate role in education. Due to the similar culture, we observe huge gender inequality in education in all other Asian countries. While the very low initial education level for female also can be explained by a common feature to all early stages of industrialization. Even though, the large gap in education between males and females rapidly closed in China over a few decades of modern education expansion, the advantage men had in education never disappear through the
history in 20th century. For people born in the 1920s, males tended to have 3 years more schooling than females, while the gap reduced to 2, then 1.5 and then 0.97 years for people born in the 1940s, 1950s and 1960s respectively.

Figure 2: Years of schooling by birth cohort and gender

Source: Chinese Household Income Project 1988

In sum, rapid educational improvement characterized for cohorts born from the beginning of the 20th century to 1960s, and that was especially true for people born after 1930s, and for female who had been newly included in education system.

V. Human Capital stock of workforce

As discussed, average years of schooling for working-age population is now the most standardized indicator for human capital stock, which not only reflects the true human capital stock embodied in working force, but also could be used in growth accounting to estimate the impact of education on growth.\textsuperscript{18} In this section we offer an annual series of the educational attainment for workforce in China between 1920 and 2000

\textsuperscript{17}Detailed information about the CHIP is available at the website http://www.icpsr.umich.edu/ICPSR/access/index.html. (The Study No. for CHIP 1998 is 9836, and the Study No. for CHIP 1995 is 3012)

\textsuperscript{18}Unfortunately, growth accounting cannot be applied to China before 1960, simply because there is no valid GDP series and capital stock series exist.
estimated by perpetual-inventory methodology and slightly modified version of Projection method.

As mentioned in the Methodology section, because the annul enrolment series we have starts at 1900 and normally we define people aged between 15 and 65 as labour force, we are only able to carry out series of the human capital stock of the workforce for the year after 1958 based on perpetual-inventory approach. In order to roll this series more backward to cover longer period, we employ the method of projection approach and use on prior enrollment rates to estimate the education stock. We estimate educational attainment data on P20, S10 and H5, (20-years lagged primary enrolment ratios, 10-years lagged secondary enrolment ratios, and 5-years lagged tertiary enrolment ratios), therefore, we manage to roll back our series of educational attainment data as early as 1920. 

The process of human capital formation in 20th century China is summarized in Table 2. Firstly, the rapid population growth contributes to the accumulation of human capital in China during the 20th century. From 1900 to 2000, population grew 2.2 times at the average rate of 1.251 per cent per year. This relative high increase in the population occurred mainly in the Communist era due to government’s encouragement (1950 – 1980), which is the second booming period in Chinese demographic history. Even though after 1980, China adopted one-child policy to

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</tr>
<tr>
<td>R²</td>
<td>0.9652</td>
<td>F=166.74</td>
<td></td>
</tr>
</tbody>
</table>

According to regression results, we could generate the equation bellow:

\[ AYS = 0.0558515 \cdot P_{T-20} + 0.0358239 \cdot S_{t-10} + 0.7538049 \cdot S_{t-5} + 0.4970103 \cdot Cons \]

19 Even though the common used lagged enrolment are Pt-15, S t-5, and Ht-5, we try other different combinations of lagged enrolments, and the results is best when using Pt-20, St-10, Ht-5.

slow down population growth, the base of population is too large; therefore the growth rate didn’t decline substantially.

Table 2. Human capital accumulation in China (1920 -2000)

<table>
<thead>
<tr>
<th>year</th>
<th>population total</th>
<th>Workforce (15 - 64)</th>
<th>Workforce share (%)</th>
<th>average schooling for labour force</th>
<th>enrolment ratios for people age 6-20 years</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>472.00</td>
<td>330.40</td>
<td>70.00</td>
<td>0.55</td>
<td>4.81</td>
</tr>
<tr>
<td>1930</td>
<td>489.00</td>
<td>342.39</td>
<td>70.02</td>
<td>0.69</td>
<td>8.33</td>
</tr>
<tr>
<td>1940</td>
<td>518.77</td>
<td>352.70</td>
<td>67.99</td>
<td>1.07</td>
<td>10.81</td>
</tr>
<tr>
<td>1950</td>
<td>551.96</td>
<td>346.90</td>
<td>62.85</td>
<td>1.46</td>
<td>18.30</td>
</tr>
<tr>
<td>1960</td>
<td>662.07</td>
<td>379.27</td>
<td>57.29</td>
<td>1.77</td>
<td>33.05</td>
</tr>
<tr>
<td>1970</td>
<td>829.92</td>
<td>481.50</td>
<td>58.02</td>
<td>3.06</td>
<td>43.22</td>
</tr>
<tr>
<td>1980</td>
<td>987.05</td>
<td>604.59</td>
<td>61.25</td>
<td>5.00</td>
<td>55.30</td>
</tr>
<tr>
<td>1990</td>
<td>1143.33</td>
<td>742.83</td>
<td>64.97</td>
<td>6.53</td>
<td>56.76</td>
</tr>
<tr>
<td>2000</td>
<td>1276.27</td>
<td>894.67</td>
<td>70.15</td>
<td>8.25</td>
<td>69.48</td>
</tr>
</tbody>
</table>

Growth rate (% per year)

<table>
<thead>
<tr>
<th>Whole period</th>
<th>1.25</th>
<th>1.25</th>
<th>0.00</th>
<th>3.40</th>
<th>3.39</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before 1949</td>
<td>0.52</td>
<td>0.16</td>
<td>-0.36</td>
<td>3.00</td>
<td>4.55</td>
</tr>
<tr>
<td>communist era</td>
<td>1.69</td>
<td>1.91</td>
<td>-0.53</td>
<td>3.44</td>
<td>4.73</td>
</tr>
<tr>
<td>1950-1960</td>
<td>1.84</td>
<td>0.90</td>
<td>-0.92</td>
<td>1.93</td>
<td>6.09</td>
</tr>
<tr>
<td>1960-1970</td>
<td>2.29</td>
<td>2.42</td>
<td>0.13</td>
<td>5.64</td>
<td>2.72</td>
</tr>
<tr>
<td>1970-1980</td>
<td>1.75</td>
<td>2.30</td>
<td>0.54</td>
<td>5.04</td>
<td>2.50</td>
</tr>
<tr>
<td>1980-1990</td>
<td>1.48</td>
<td>2.08</td>
<td>0.59</td>
<td>2.70</td>
<td>0.26</td>
</tr>
<tr>
<td>1990-2000</td>
<td>1.11</td>
<td>1.88</td>
<td>0.77</td>
<td>1.96</td>
<td>2.04</td>
</tr>
</tbody>
</table>

Meanwhile, the level of education stock embodied in population, the more important aspect of human capital, increased even more rapid, measured by average years of schooling. From 1920s to 2000, we observe that average amount of education that each member of working age population has received before entering the job market
increased rapidly as illustrated in table 2. The figure started at very low lever, 0.55\textsuperscript{21}, and it rose to 7.92 in 2000. Average years of schooling for working age population grew at the average rate of 3.4% per year.

In general, the increase trend has been quite smooth during the whole 20\textsuperscript{th} century, and there is only one structure breaking point at around 1960. The average schooling increased slowly at the first half of the 20\textsuperscript{th} century, from 0.55 in 1920 to 1.265 in 1948. The first decade after the Communist Party came to power didn’t bring much improvement in education either. The average years of schooling lay at 1.28 at 1949, and it only increased to 1.5357 at the end of that decade. The figure skyrocketed from 1.5373 in 1960 to 5 in 1980, and from 190 onward, the growth decelerated, and the number reached 8.25 in 2000. In sum, a full century of human capital formation can be divided to two sub-periods: before 1960 and afterwards.

**Before 1960**

As discussed, for period before 1950, the series of educational attainment stemming from modern schooling enrolment data has downward bias because of lacking the enrolment series from traditional educational institutions. Table 2 displays that there was very slow educational growth from 1920 to 1960, and if we add Sishu enrolments data into this picture, the original level of educational attainment would be higher than 0.55 years in 1920, but the average years of schooling in 1960 may change very little, therefore the growth rate for this period would be even less satisfactory. Unfortunately, the series before 1958 is not estimated by PIM, therefore we have no more information on the changes of the average years of schooling by education level, leaving some unsolved puzzles.

**After 1960**

For period after 1958, the stock data on human capital is calculated by PIM, thereby, we not only carry out the series of educational attainment for labour force in this period, but also the average years of schooling by different levels of education for working age population. Educational attainment by schooling levels provides us more

\textsuperscript{21} The extremely low level of years of schooling is because we exclude the traditional education from our measurement.
detailed information on changes of the composition of human capital stock in China through time, and how different level of education contribute to the education stock respectively.

Table 3, average schooling i in different levels of education in China, 1950 – 2000

<table>
<thead>
<tr>
<th>Year</th>
<th>Average schooling in different levels of education</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Primary</td>
</tr>
<tr>
<td>1920</td>
<td>0.55</td>
<td></td>
</tr>
<tr>
<td>1930</td>
<td>0.69</td>
<td></td>
</tr>
<tr>
<td>1940</td>
<td>1.07</td>
<td></td>
</tr>
<tr>
<td>1950</td>
<td>1.46</td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>1.77</td>
<td>1.4</td>
</tr>
<tr>
<td>1970</td>
<td>3.06</td>
<td>2.25</td>
</tr>
<tr>
<td>1980</td>
<td>4.99</td>
<td>3.11</td>
</tr>
<tr>
<td>1990</td>
<td>6.53</td>
<td>3.81</td>
</tr>
<tr>
<td>2000</td>
<td>8.25</td>
<td>4.53</td>
</tr>
</tbody>
</table>

Whole Period 3.40

1920-2000

communist era

<table>
<thead>
<tr>
<th>Period</th>
<th>Average schooling</th>
<th>Percentage (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Total</td>
<td>Primary</td>
</tr>
<tr>
<td>1950-2000</td>
<td>3.44</td>
<td></td>
</tr>
<tr>
<td>1950-1960</td>
<td>1.93</td>
<td></td>
</tr>
<tr>
<td>1960-1970</td>
<td>5.64</td>
<td>4.85</td>
</tr>
<tr>
<td>1980-1990</td>
<td>2.7</td>
<td>2.06</td>
</tr>
<tr>
<td>1990-2000</td>
<td>1.96</td>
<td>1.45</td>
</tr>
</tbody>
</table>

* Average schooling after 1958 comes from perpetual inventory method, but the figure before 1958 is projected back based on lagged enrolment ratios
i. Average schooling refers to the average years of schooling for working-age population.
ii. Primary schooling provided for persons of age 6 -12 years
iii. Secondary schooling provided for persons of age 12 -18 years
iv. Tertiary schooling provided for persons of age 18-24 years
Primary schooling expansion:
From Table 3, at the beginning of the Communist era, for Chinese people, nearly 80% of educational attainment came from primary education, but the number dropped to 55.5% in 2000, which is still a very high level comparing to developed nations. Even though the average years of primary schooling received by labour force increased in the second half of the 20th century, the growth rate declined through time, suggesting that the expansion of primary education decelerated in last 4 decades. The average years of primary education people received is 4.4 years in 2000, which is far behind the length of primary schooling -- 6 years and only equivalent to the level Japan achieved as early as in 1940, implying that the rise of primary schooling had only limited achievement in China. Given the strong association between the availability of primary schools and subsequent literacy, the under provision of primary schools kept literacy low.

Secondary schooling:
Similarly, there is considerable increase in the years of second schooling as well. In 1960, people received less than 0.5 years of secondary education and after promoting mass education for several decades, the figure increased to 3.25 in 2000. Not only the absolute years of secondary schooling increased, the contribution of secondary education to total educational stock persistently rose between 1960 and 2000. In 1960 only 16.74% of educational attainment received by labour force coming from secondary schooling; while this share increased to 40.99% in 2000. The growth rate for average years if secondary schooling received by population stayed at relatively high level, around 9%, from 1960 and 1980; even though the number declined since then, it still remained at a level higher than 2% per year, suggesting that the rise of secondary schooling has been substantially rapid in the second half of the 20th century. According to Godo, 3.25 years of secondary schooling is equivalent to the level for Japan in 1960, showing that consider Japan as a comparison counterpart, secondary education catch-up is more successful in China than primary education.

Tertiary education
For tertiary education, at the beginning of the Communist era, the level of year of tertiary education lay at very low level, 0.02 years. Through the golden growth age for primary and secondary schooling—1960 to 1970, higher education didn’t experience
growth but a small drop, reflecting the 10-years disruption to higher education in culture revolution. After 1978, universities began to open to mass population again, and from then the growth of tertiary education accelerated. Apparently, the catch-up of higher education is much latter than primary schooling and secondary schooling, only after 1990, the growth accelerated, and the growth rate achieved a very high level—8.09%. But just like most of developing nations, the average years of tertiary schooling a working age Chinese received still remained at very low level, in 2000, the number was only 0.37 year, which is far behind the level in developed countries. Comparing to Japan again, 0.37 is equivalent the level Japan reached in 1969, suggesting that China is still 30 years lagged behind Japan in terms of higher education promotion.

VI. International comparison
The global view holds that there were huge differences in education outcomes—enrolment rates, quality of schooling, educational attainment—across nations. In the late 19th century and early 20th century, some nations, led by the US and Germany, already achieved success in promoting mass primary schooling, and were enjoying their high school movement, while other nations, such as China, were still struggling with developing formal schooling. In the previous section, we construct the series of education stock in China through 20th century, which allows for basic international comparison of human capital stock. It helps us to know from international prospective, where should we place China on the ‘international education map’. 22 In Table 4, we present comparative data on average years of schooling in the working-age population for several countries through 20th century. We include high-income country—US, the leading economy in Asia—Japan, and several Asian counterparts—Korea and Taiwan.

Yamauchi and Godo (2003) are the first to assess long-term human capital stock series for several Asian countries and regions: Japan, Korea and Taiwan, but in their research they didn’t include China. Drawing the data from Godo, according to Figure 6, we can observe that the huge gap between USA and the whole Asia. Asian nations

22 Peter Lindert did a large amount of work on the international comparison on education attainment across countries. But his influential book has no data on China for period before 1978.
began to catch up after the World War II, but a few-years disparity remained still. Inside Asia, Japan already was the apparent front runner in terms of educational stock at the beginning of the 20th century and remained its superiority through the 20th century, while the other Asian countries gradually converged to Japan; however this convergence for Korea and Taiwan happened much earlier and faster than China did.

Table 4: human capital stock of labor force in USA, Japan, Korea, Taiwan and China

<table>
<thead>
<tr>
<th>year</th>
<th>USA</th>
<th>Japan</th>
<th>Korea</th>
<th>Taiwan</th>
<th>China</th>
</tr>
</thead>
<tbody>
<tr>
<td>1920</td>
<td>8.30</td>
<td>4.30</td>
<td>0.60</td>
<td>0.60</td>
<td>0.55</td>
</tr>
<tr>
<td>1930</td>
<td>9.10</td>
<td>5.60</td>
<td>0.80</td>
<td>1.00</td>
<td>0.69</td>
</tr>
<tr>
<td>1940</td>
<td>9.80</td>
<td>6.50</td>
<td>1.10</td>
<td>1.60</td>
<td>1.07</td>
</tr>
<tr>
<td>1950</td>
<td>10.50</td>
<td>7.60</td>
<td>n.a.</td>
<td>2.50</td>
<td>1.46</td>
</tr>
<tr>
<td>1960</td>
<td>11.30</td>
<td>8.70</td>
<td>3.30</td>
<td>3.60</td>
<td>1.77</td>
</tr>
<tr>
<td>1970</td>
<td>12.00</td>
<td>9.80</td>
<td>4.80</td>
<td>5.10</td>
<td>3.06</td>
</tr>
<tr>
<td>1980</td>
<td>12.80</td>
<td>10.70</td>
<td>6.90</td>
<td>7.30</td>
<td>5.00</td>
</tr>
<tr>
<td>1990</td>
<td>13.50</td>
<td>11.50</td>
<td>9.00</td>
<td>9.10</td>
<td>6.53</td>
</tr>
<tr>
<td>2000</td>
<td>14.00</td>
<td>12.3</td>
<td>10.5</td>
<td>10.9</td>
<td>8.25</td>
</tr>
</tbody>
</table>

*Data for USA, Japan, Korea and Taiwan come from Yoshihisa Godo.

According to table 4, China had similar educational level comparing to Taiwan and Korea in 1920, even neglecting the contribution of traditional education, however China lagged behind afterwards, the within Asian divergence occurred after 1920. Taiwan under Japanese imperialism experienced very rapid educational stock increase, and Korea perhaps had the similar scenario; in contrast, we witness very limited achievement in terms of human capital accumulation in China. Therefore the gap of educational attainment between China and other Asian counterparts widened during 1920 to 1960. The 4 decades between 1920 and 1960, average years of schooling of workforce rise in a very disappointing speed. This stagnation may be partly because of extensive warfare’s during that period; additionally, it is partly caused by political radicalism during Mao period. In next chapter we would investigate more on the
reason why China had such limited achievement on promoting basic education during 1930 to 1960.

Figure 4: International comparison in educational attainment from 1920 to 2000

The real catch-up only happened after 1960, the within Asian divergence began to narrow. We observe a substantial increase in educational attainment in China, and its growth rate reaches the similar level Korea and Taiwan have. Even though the convergence between Japan and China is obvious after 1960, among Korea, Taiwan, and China, there are no signs showing that the education gap would narrow in near future.

If we use Japan as a benchmark, it would help us understand the mechanism of how education rise in China through 20th century. As illustrated in Figure 5, the educational attainment in 1920 in China was only 10% of that in Japan, the ratio rose to 0.603 in 2000. The Japan/China gap by levels of education displays one interesting feature about China’s educational catching-up. China’s experience is against what most literature suggests that primary expansion should happen first, following with high school movement. In China, the catching-up of primary and secondary education happened at the same time, and surprisingly, the speed of the catching-up of secondary education accelerated rapidly after 1970. This sequence looks very
unnatural comparing to other late developing countries, suggesting that China has low and misguided spending by favoring secondary schools over primary schools. Given that a large amount of literature emphases that primary schooling has the largest positive effect on promoting industrialization in developing countries, also rates of return in late industrial nations are generally believed to be higher for primary education than for secondary education, this favouring secondary schooling catch-up suggests a misallocation of resources, 23

Figure 5: China/Japan ratio in educational attainment by level of education (primary, secondary and tertiary)

Furthermore, the movement of the Japan/China ratio in tertiary education displays that the catch-up of higher education only have limited achievement through 20th century. Firstly, this ratio experienced huge fluctuations during Mao Period, and then it stagnated afterwards, we barely observe any improvement in higher education. The ratio finally increased after 0.2 in 1990 to 0.3 in 1995, showing a sign of catching up in future.

In short, by putting China in the international education map, we observe that there was a within Asian divergence in terms of educational stock between 1920 and 1960. During those 4 decades, China lagged behind Korea and Taiwan. The education catch-up for China only happened after 1960, which was most contributed by the rise of secondary schooling. Given the fact that Chinese economic growth accelerated after 1978, it is consistent with what literature suggests that educational catching-up usually preceded economic catching-up in East Asian countries.

**Conclusion:**
Generally speaking, China’s population bears the marks of educational expansion since the 20th century. The education system itself is more outward looking and more diverse in structure, finance, and content than in the past. In this paper, as a starting point for further research, we try to outline the development of education in China through 20th century. Because of the quality of data, we use different methods to carry out the annual series of average years of formal education from 1920 to 2000. It was found that the growth of *average schooling* in China has a natural break during the 20th century, and in terms of educational inequalities, gender disparities appear to have narrowed substantially through 20th century. Before 1960, the growth of educational attainment was slow, resulting divergence between China and other Asian counterparts. For period 1960 onward, the growth was much faster; as a result, the major gap in the level of school education existing between Japan and China was largely closed by 2000

Unfortunately, the goal of educating the masses has not been achieved even today in China, unlike the ‘common school movement’ in the US, or the education rise in late Tokugawa and Meiji Japan, which generally promoted mass basic education among the population. The central explanation for the failure in elevating mass schooling was the insufficient provision of primary schooling.

*Guess work for next chapter: how to assess the contribution of traditional education to human capital stock?*
As discussed, the previous results have one potential problem that they exclude the contribution of traditional schooling. Does *Sishu* play a significant role in human capital formation in 20th century? If the size of traditional education is small enough,
we could just neglect it for the sake of simplicity. However, by comparing the educational attainment by birth cohort stemming from two data tracks: modern enrolment series and individual survey, we find that the gap is significant, implying that Sishu is an important element contributing to educational stock at the first of the 20th century. Thus excluding Sishu enrolments from estimating stock of human capital would cause serious downward bias for the first half of the 20th century.

In order to assess the role of Sishu in human capital formation, there are two problems we need to cope with. Firstly, in the absence of the national level data, the only resource we can turn to as a benchmark to construct Sishu enrolment series? Is it valid to project regional Sishu enrolment ratios to national level? Secondly, since Sishu is assumed as an informal kind of primary education, how do we make adjustments for the difference in quality of schooling between Sishu and modern schools?

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