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**The Returns to Schooling in Rural China:  
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Education Expansion**

by

**Terry Sicular and Juan Yang**

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The Returns to Schooling in Rural China: Evidence from the Cultural Revolution  
Education Expansion

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## Abstract

During the Cultural Revolution China embarked on a remarkable, albeit temporary, expansion of post-primary education in rural areas. This education expansion affected tens of millions of children who reached secondary school age in the late 1960s and 1970s. Exploiting the education expansion and variation across birth cohorts, we estimate the returns to schooling in rural China using household survey data from the mid-1990s. Our estimated returns of 11 to 20 percent are substantially higher than most previous estimates. We calculate the impact of the education expansion on subsequent labor market outcomes of the affected cohorts and find that they enjoyed significantly higher earnings than pre- and post-expansion cohorts.

JEL Classification: I21, I28, J24, J31, O15

Key words: Education expansion, secondary education, returns to schooling, rural China, Cultural Revolution.

## 1 Introduction

Since 1970 the developing world has experienced a major expansion in post-primary education. In 1970 secondary enrolment rates in most developing countries were below 30 percent. By 2010, the secondary enrolment rate in the Middle East and North Africa was 74 percent, in East Asia and the Pacific 79 percent, and in Latin American and the Caribbean 89 percent. Even in Sub-Saharan Africa where education levels remain relatively low, secondary enrolment rates rose from 13 percent in 1970 to 40 percent in 2010.<sup>1</sup>

China participated in this worldwide wave of secondary school expansion. In China the expansion started in the late 1960s and occurred mainly in rural areas, then home to 85 percent of the population and where, unlike urban China, most children did not progress past primary school. The magnitude of the education expansion in rural China was remarkable. Between 1965 and 1977 the number of rural secondary schools, including both junior and senior levels, rose from about 9,000 to more than 180,000, and secondary school enrolments grew from 3 million to 51 million (Hannum 1999; Department of Planning, Ministry of Education 1984).

Perhaps because it occurred during the Cultural Revolution, a period associated with the disruption of education in urban China, this expansion of China's rural education system has received little attention. Studies of rural education during the Cultural Revolution are scarce and tend to emphasize problems with rural schools at the time, for example, the politicization of education, inadequate resources and low school quality. Anyway, the expansion was temporary. When China launched its market reforms in the late 1970s, the rural post-primary education expansion policy was abruptly abandoned. Many rural secondary schools closed, and levels of schooling in rural areas dropped markedly.

Despite its problems and eventual reversal, the expansion of rural secondary schooling during the Cultural Revolution persisted long enough to affect tens of millions of children. Moreover, the affected cohorts entered the labor force in the 1980s, a time of rising rural incomes associated with China's economic reforms. The impact of the Cultural Revolution rural education program on employment and incomes of the affected cohorts, let alone on China's macroeconomic growth during the reform period, has not been carefully analyzed and is not well understood.

In this paper we evaluate the impact of the Cultural Revolution rural education expansion on the education and subsequent labor market outcomes of the affected cohorts. Our analysis includes estimation of the returns to schooling. It is well known that estimation of the relationship between education and labor market outcomes is subject to endogeneity bias due to the presence of unobserved characteristics such as ability. Researchers have adopted a variety of strategies to correct for such bias and identify the causal relationship between education and labor

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<sup>1</sup> Gross secondary enrolment rates. These rates are regional averages, excluding high income countries. From World Bank Edstats database <http://datatopics.worldbank.org/education/>, downloaded September 9, 2014.

market outcomes. One approach is to make use of a policy change that altered access to education, for example, a change in compulsory schooling laws or the expansion of the school system (e.g., Devereux and Hart 2010, Devereux and Fan 2011, Harmon and Walker 1995, Oreopoulos 2006, Walker and Zhu 2008). We adopt such an approach here. The Cultural Revolution rural education expansion provides a natural experiment that we exploit to estimate the returns to education.

We estimate the returns to education in terms of household income per adult and off-farm wage earnings. We also estimate the relationship between education and participation in off-farm wage employment, which has been associated with higher earnings than farming. Using these estimates, we evaluate the impact of the Cultural Revolution education expansion on labor market outcomes of the affected cohorts. We find significant and substantial benefits for these cohorts relative to pre- and post-expansion cohorts.

For our analysis we employ rural household survey data from the 1995 round of the China Household Survey Project (CHIP). The CHIP rural survey sample spans China's major geographic regions and contains detailed information on education, income, employment, and other characteristics of households and their members. We use data from the 1995 round because at that time the cohorts affected by the Cultural Revolution education expansion were in their prime working years.

Our analysis makes several contributions. First, it adds to the economic literature on the impact of post-primary education expansion in developing countries. Our findings of a substantial impact in China are consistent with the findings of available studies for other developing countries (e.g., Duflo 2001). Second, it provides improved estimates of the returns to education in rural China. Our estimates range from 11 percent to more than 20 percent depending on the measure of earnings and specification, and are substantially higher than in most previous studies for rural China, which rarely report estimates above 6 percent (de Brauw and Rozelle 2007a, 2007b). One reason for low estimates in the literature is that few studies of the returns to schooling in China control for endogeneity. Giles, Park and Wang (2008) uses the Cultural Revolution schooling disruption in urban China as an instrument to estimate the returns to education, but only for urban residents. Fang et al. (2012) uses the 1986 Compulsory Schooling Law as an instrument and gives estimates of the returns to schooling in rural China of 20 percent, similar to ours; however, this analysis excludes the Cultural Revolution cohorts.

Third, our analysis provides new information about the long-term impact of the Cultural Revolution education expansion. We find that rural cohorts who reached secondary school age during the Cultural Revolution received significantly more years of schooling than earlier and later cohorts. Moreover, despite reports of low education quality, the subsequent income and employment benefits for the affected cohorts relative to pre- and post-expansion groups were substantial. These findings are at odds with the conventional negative view of education policies during the Cultural Revolution.

In recent years China has once again embarked on a program to increase post-primary school enrolment in rural areas. The Compulsory Education Law of

1986 called for gradual implementation of nine years of compulsory education, but in rural areas implementation of the policy was slow. Efforts to increase secondary school attendance in rural areas intensified after 2000, and in 2006 the central government announced central funding nationwide to support nine years of free, compulsory education nationwide (Knight, Sicular and Yue 2013). In the wake of these measures, rural secondary school enrolment rates have recovered to the levels achieved during the Cultural Revolution. Although the recent policy measures and economic context differ from those during the Cultural Revolution, our analysis indicates the potential for substantial long-term benefits.

In the next section we describe the Cultural Revolution rural education expansion. In section three we discuss the data, define the treatment and control groups, and give descriptive statistics on education and other characteristics of the estimation sample. Section four outlines our empirical strategy. Section five presents and discusses our empirical results. Section six explores the robustness of these results to alternative specifications. Here we investigate the sensitivity of our estimates to the possible impact of the Great Leap Forward famine on individuals conceived or born during the famine years. In section seven we calculate the magnitude of the income benefits to the affected cohorts from the Cultural Revolution education expansion and discuss some implications of our findings.

## **2 Rural Education during the Cultural Revolution**

A major target of the Cultural Revolution was the education system, which Mao regarded as perpetuating social inequalities through its hierarchical structure, “bourgeois” curriculum, and selective examination system. His May 7 Directive of 1966 called for a revolution in education, sparked political campaigns in schools and universities, and opened the way for sweeping reforms of the educational system, including measures to reduce urban-rural differences.

Much has been written about the ensuing disruption of the education system in urban China, and several empirical studies have examined the Cultural Revolution’s impact on the schooling and subsequent labor market outcomes of urban residents (Giles, Park and Wang 2008, Meng and Gregory 2002, 2007, Zhang, Liu and Wang 2007). Rural education during the Cultural Revolution has received less attention, but the main features of rural educational policy at this time are known. Starting in the late 1960s China embarked on an ambitious program to expand post-primary educational in rural areas. The goal of the expansion was to achieve universal education through junior secondary school and to increase rates of progression to senior secondary school for rural children (Pepper 1990, 95). Because less than a quarter of rural primary school graduates continued on to junior secondary school at that time, achieving universal junior secondary enrolment required substantial increases in the numbers of rural secondary students, schools and teachers. This was accomplished through decentralization of the education system and mobilization of local resources; some funding was provided by the government, but most costs were borne locally by collective farms (Pepper 1990, 76-77; Löfstedt 1980, 131).

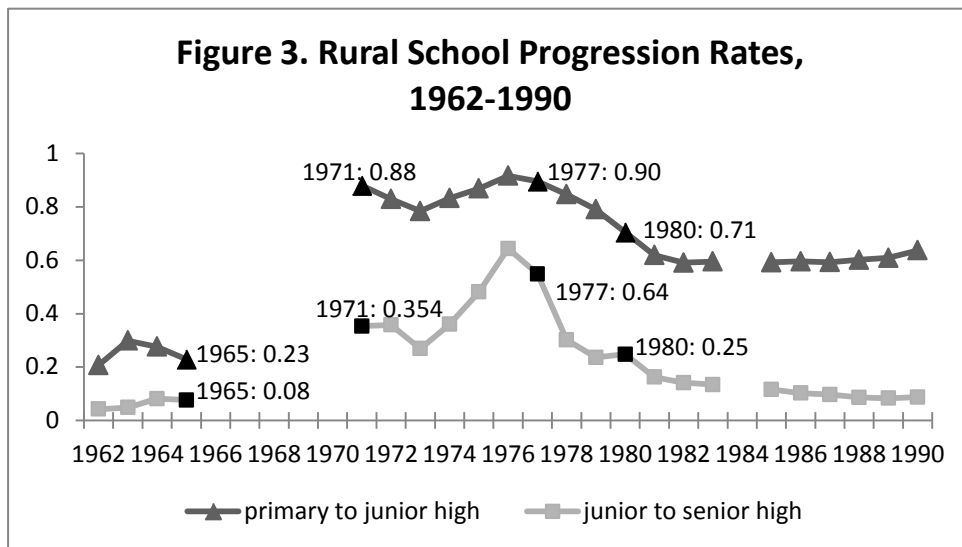
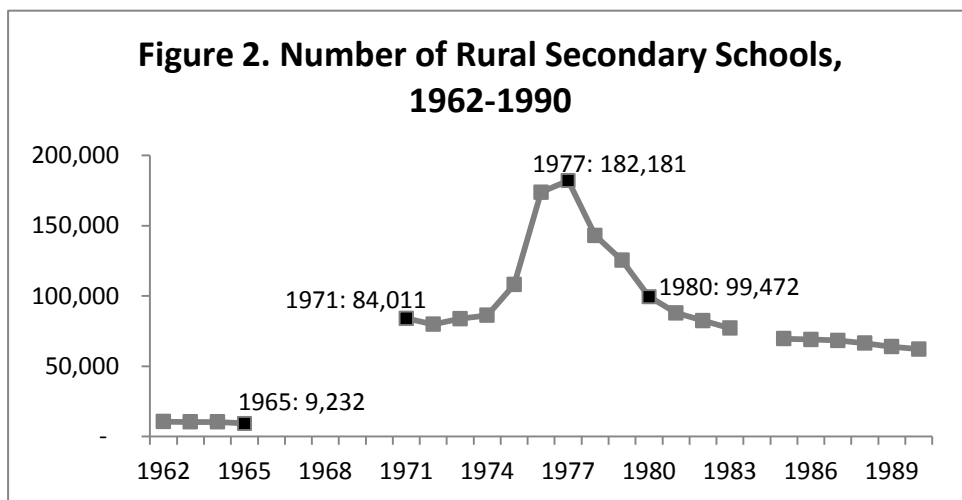
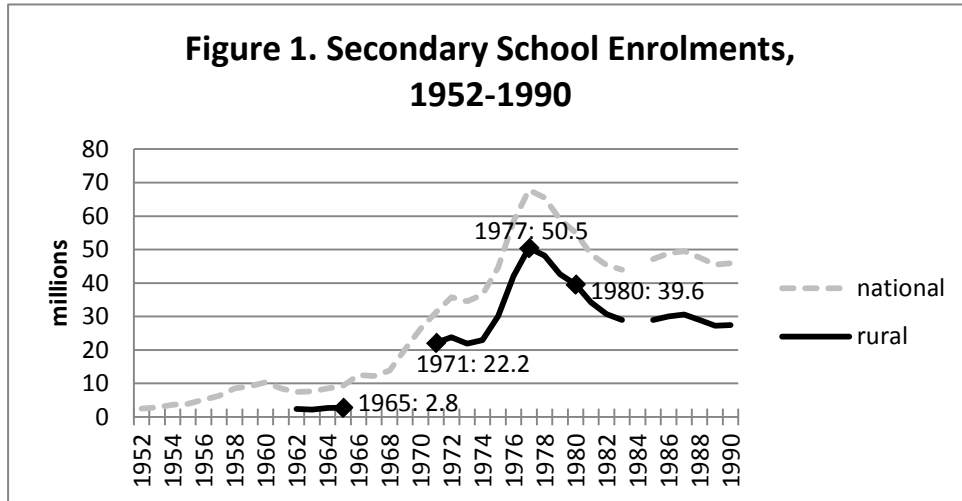
Relevant reforms also occurred in the structure and content of rural primary and secondary education. The length of schooling was shortened from twelve to nine or ten years: five years of primary, two or three of junior secondary, and two of senior secondary school (Hannum 1999, 199; Löfstedt 1980, 131; Pepper 1990, 95). Separate academic and vocational streams at the secondary level were merged into a single stream, the curriculum was revised so as to cover a combination of academic, political, and production-based content, and students were required to participate in work as well as study (Pepper 1990, 94-5). Exam-based progression from primary to junior and from junior to senior secondary school was abolished; tuition and fees were reduced or eliminated (Han 2001). School management was overhauled, with decision-making authority transferred from a school principal to school revolutionary committees made up of local peasants, students and teachers with “red” political credentials, under the supervision of the commune or production brigade’s revolutionary committee (*ibid*).

Official statistics on rural enrolments, numbers of schools and progression rates reveal the magnitude of the resulting expansion (Figures 1, 2 and 3). Data are missing for 1966-1970, but the leap in numbers between 1965 and 1971 implies substantial growth in the intervening years. For example, rural secondary school enrolments rose from 3 million to 22 million between 1965 and 1971, and then continued to rise, reaching a peak of 50 million in 1977. Progression rates from primary to junior secondary school and from junior to senior secondary school show a similar pattern, reaching a peak in 1976-77, at which time the progression rate to junior secondary reached 92 percent and to senior secondary 64 percent.

After 1976 the numbers of rural schools and students shrank and progression rates fell. This reversal reflected policy changes following the death of Mao. China’s post-Mao leaders criticized the rural secondary school expansion as ill-conceived and as sacrificing school quality (Yang 2006). The shift in emphasis from quantity to quality of education led to new measures scaling back rural schooling, which included setting maximum quotas on rural secondary enrolments and the closure of many rural secondary schools (Pepper 1990, p. 96-7).

The decline in rural secondary schooling in the late 1970s and early 1980s was also partly due to the disintegration of the collective farm system, which had provided the institutional and financial framework supporting rural schools. Rising tuition and fees increased the direct costs of schooling borne by households, and the spread of the household responsibility system and return to household farming increased the opportunity costs of keeping children in school. In the span of only four years (1977-81), the number of rural secondary schools dropped by half, and rural progression rates to junior secondary school fell from over 90 percent to 60 percent.

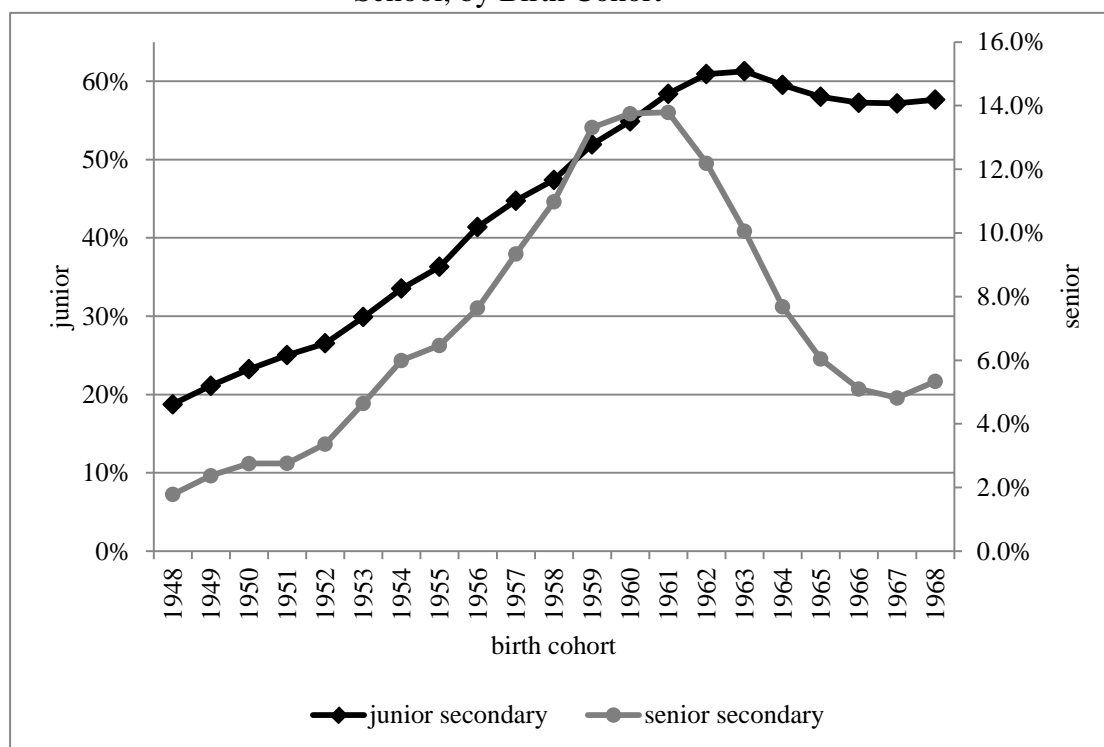




Notes to Figures 1-3: Statistics are for general (*putong*) junior, senior, and combined junior-senior secondary schools. Progression rates are calculated as the number of school entrants divided by the number of graduates from the prior level of school. Sources: Hannum 1999; Department of Planning, Ministry of Education 1984.

Although the expansion of rural secondary schooling during the Cultural Revolution was temporary, it nevertheless led to a broad-based increase in secondary school attainment for those rural children who reached secondary school age at that time. The change can be seen in Figure 4, which shows the shares of rural individuals who attained junior and senior secondary school by birth year (calculated using data from China's 2005 mini-census). Junior and senior secondary school attainment shows an upturn starting with the 1953 cohort and reaches a peak for the 1961-63 cohorts, after which it declines. The decline coincides with the closing of many secondary schools in the late 1970s.

Figure 4. Percent of the Rural Population that Attained Junior and Senior Secondary School, by Birth Cohort



Notes: Authors' calculations using data from China's 2005 mini-census.

### 3 The Data, Definition of Treatment Group, and Estimation Sample

For our analysis we employ data from the 1995 round of the China Household Income Project (CHIP) rural household survey. We use the 1995 round because at that time individuals belonging to the cohorts affected by the Cultural Revolution school expansion were in their prime working-age years. The 1995 CHIP rural survey covers 19 provinces, 8,000 households and 35,000 individuals. The provincial sample sizes are not proportional to the populations, so in all calculations and estimations we employ weights based on provincial rural populations. The dataset contains rich information on individual characteristics including gender, age, education, employment, and earnings as well as on household characteristics such as household demographic structure, economic activities, and income.

We define our treatment group to include those cohorts that entered secondary school during the expansion period. The Cultural Revolution rural secondary school expansion began in 1967 or 1968 (Han 2001). In those years the school entry age was 7, although rural students often entered later and repeated grades. Primary school lasted 6 years until the Cultural Revolution and then was shortened to 5 years, so rural children would have completed primary school and entered junior secondary school when 12 to 14 years old. The earliest affected cohorts would therefore have been born in 1953.

At the far end, children who had completed senior secondary school before school closings began in 1977 would have enjoyed the full benefits of the education expansion. Children who had not completed senior secondary school by 1977 would have had their schooling shortened by the reversal of the policy. Consequently, the latest cohort to enjoy the full benefits of the expansion would have been about age 17 in 1977, or born in 1960.

Based on these timelines, we define the treatment group as individuals born in the years 1953 through 1960. We compare the treatment group to individuals born in the five years before and after, that is, 1948 through 1952 and 1961 through 1965. These before- and after-treatment cohorts serve as the control group. In view of some uncertainty regarding the treatment cohorts, we carry out robustness checks using alternative birth-year cutoffs.

We restrict our estimation sample to males. One reason for restricting our sample to males is that one of our measures of earnings is net household income, which includes income from household activities such as farming that is reported for the household as a whole and cannot be attributed to individual household members. Furthermore, almost all individuals in the sample are married, and the education of husbands and wives is highly correlated. Our other measure of earnings is wage income from off-farm employment. Although we have individual information for wages, in 1995 off-farm wage work was largely done by males. The share of women reporting income from off-farm employment in the 1995 CHIP rural sample is less than 10 percent.

A possible drawback of the CHIP rural survey sample is that it does not include individuals who had migrated permanently to urban areas. It does contain individuals who engaged in migrant work in cities on a short-term basis. In 1995 permanent migration to cities was rare. One of the few pathways to permanent urban residency was through university. Our sample therefore mostly excludes rural individuals who gained entrance to university. The proportion of rural individuals in these cohorts who attended university, however, was very low and disproportionately from urban areas.<sup>2</sup>

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<sup>2</sup> Meng and Gregory (2002) use the 1990 population census data to calculate the shares of individuals (both urban and rural) in each birth cohort who had some university education. They report that, on average, less than 2% of those born in the 1950s and 1960s attended university. A disproportionate share of these individuals was from urban areas.

Table 1. Descriptive Statistics for the Estimation Sample

Variable	Obs	Mean	Std. dev.	Min	Max
Years of education	4833	6.975	2.700	0	17
Senior secondary school attainment	4833	0.200	0.400	0	1
Age (years)	4833	38.96	5.210	30	47
Cohort size (million)	4833	6.401	1.391	3.668	9.504
Ethnic minority	4833	0.0647	0.246	0	1
Married	4833	0.972	0.166	0	1
Household income per adult	4833	2462	2000	0	31498
Off-farm employment, including self-employment	4833	0.395	0.489	0	1
Off-farm employment, excluding self-employment	4833	0.376	0.484	0	1
Off-farm work hours per year	4833	647.1	1061	0	4732
Off-farm wages per year	4833	1350	3298	0	40000
Off-farm wages per hour	4833	2.610	7.715	0	138.5
Off-farm wages per year for subsample with off-farm jobs	1965	3957	7804	3	40000
Off-farm wages per hour for subsample with off-farm jobs	1336	3.684	8.517	0.007	138.5

Notes: The estimation sample includes males born 1948 through 1965 from the CHIP 1995 rural survey; descriptive statistics are calculated using provincial rural population weights. Household income per adult is net household income as defined by the National Bureau of Statistics (NBS), divided by the number of household members age 16 and older. Off-farm work hours and wages exclude self-employment. An individual is considered to have off-farm employment if his or her off-farm wage earnings are positive.

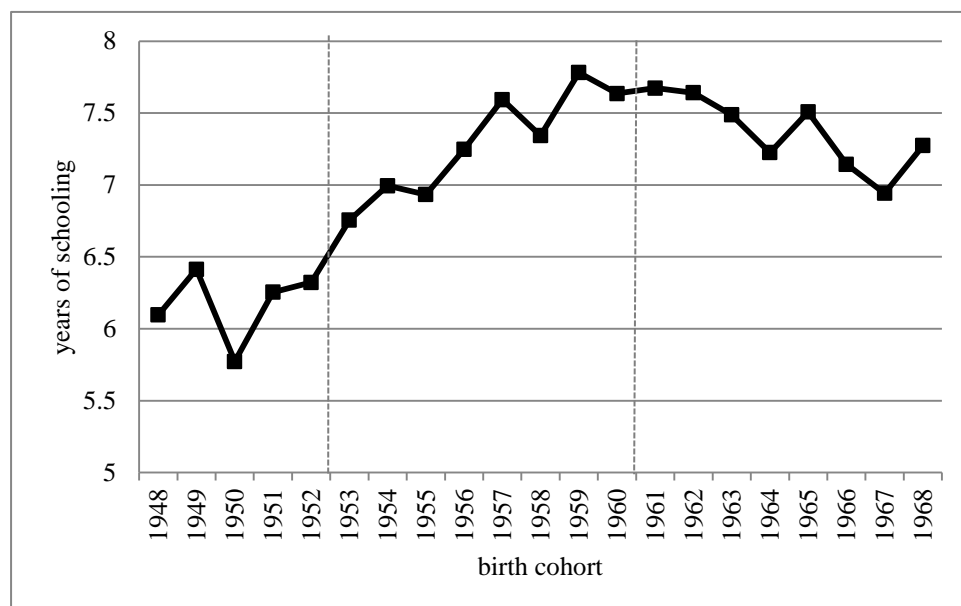
Table 1 shows descriptive statistics for the estimation sample. The average age is 39 years and average length of education was 7 years. 20 percent of the sample had attended some senior secondary school. Almost all individuals in the sample were married. Almost 40 percent of the sample participated in off-farm employment.

Our analysis includes cohort size as an independent variable to control for differences in labor supply across birth years. Cohort size, measured as the nationwide population of rural males for each birth year as reported in the 1995 1 percent population sample survey, varied substantially, ranging from 3.7 to 9.5 million (National 1% Population Sample Survey Research Office 1997). This variation is associated with the Great Leap Forward famine, which we discuss further in section 6.

The impact of the Cultural Revolution education expansion on schooling across cohorts can be seen in the sample. Figure 5 shows average years of schooling for males by birth year. The vertical dashed lines delineate the treatment and control groups. Mean years of education are 6.3 for those born in 1952, increase to a peak of 7.8 for those born in 1959, stabilize for a few years at about 7.6-7.7, and then

decline but remain higher than before the expansion.

Figure 5. Average Years of Schooling of Males, by Birth Cohort



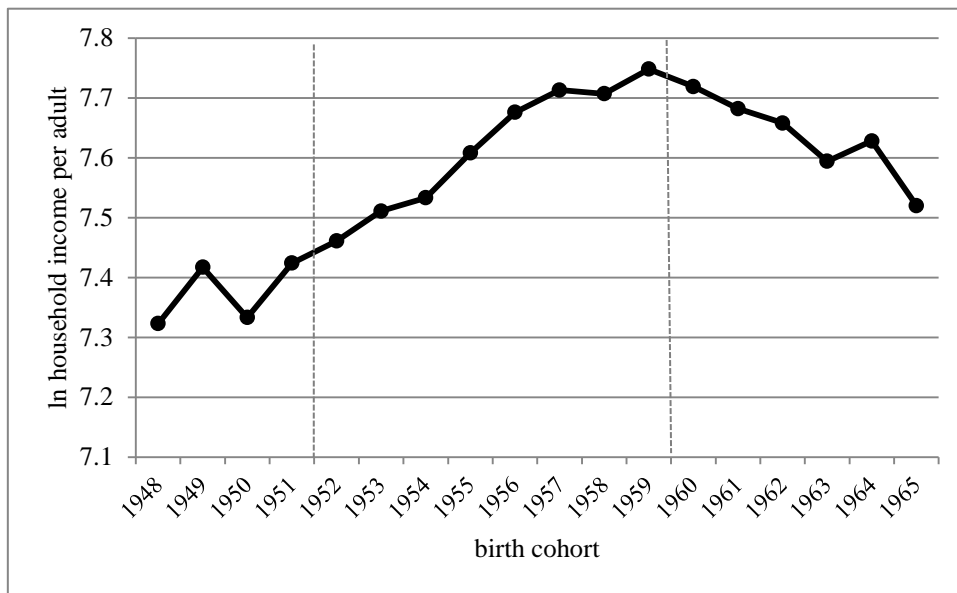
Notes: Dashed vertical lines indicate birth cohorts affected by the Cultural Revolution education expansion. Calculated using the CHIP 1995 rural survey data, with weights.

If the returns to education are positive, then, all else equal, we would expect the cohorts affected by the Cultural Revolution education expansion to have higher incomes than other cohorts. Existing estimates of earnings functions for rural China in the 1990s indeed report a positive relationship between education and income. They also report that an important mechanism underlying this relationship was the increased likelihood of off-farm employment, which had higher returns than farming (Yang 1997, Knight et al. 2009).

Figures 6 and 7 provide some evidence from our sample on these relationships. Figure 6 shows mean ln net household income per adult by birth cohort. This measure of earnings includes income derived from all household farm and non-farm activities as well as wage employment. It increases until the 1959 birth cohort and then declines. Figure 7 shows mean ln yearly off-farm wage earnings excluding self-employment income by birth cohort for the subset of individuals in our sample who had off-farm wage employment in 1995. The means do not display a clear a pattern across cohorts.<sup>3</sup>

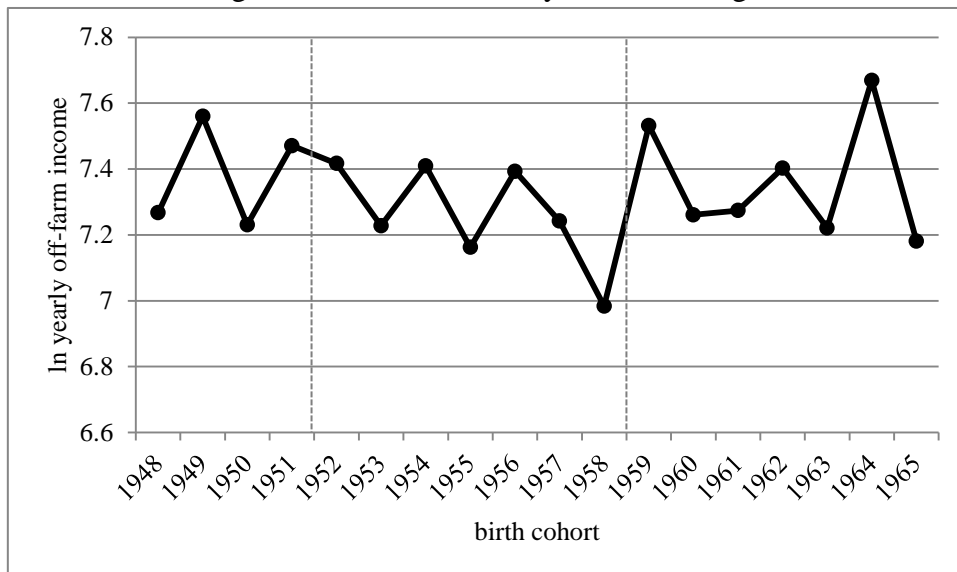
<sup>3</sup> The pattern of medians across cohorts (not shown) is similar to that for means.

Figure 6. Mean Ln Household Income per Adult



Notes: Calculated using the CHIP 1995 rural survey data, with weights, for males.

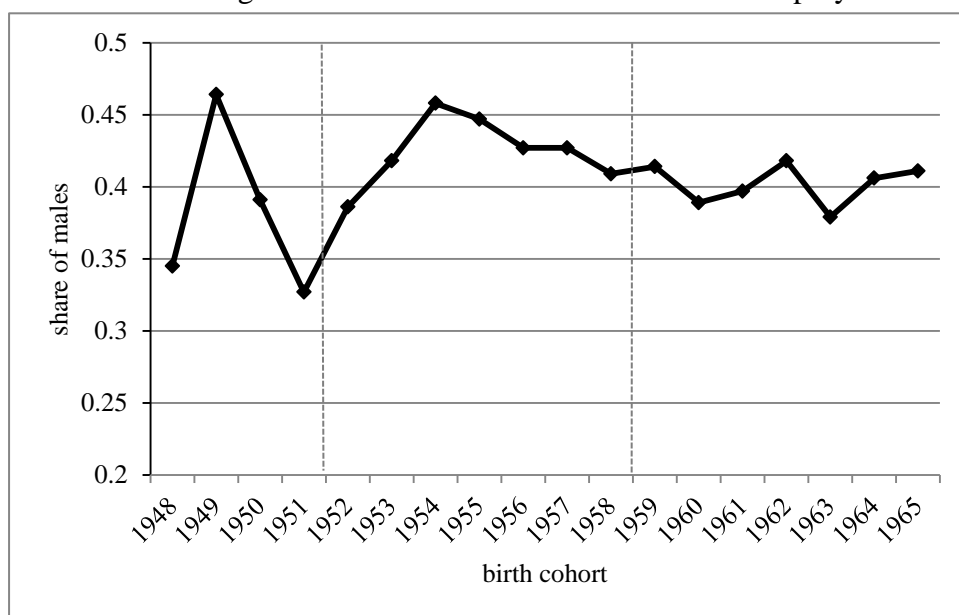
Figure 7. Mean Ln Yearly Off-farm Wages



Notes: Calculated using the CHIP 1995 rural survey data, with weights, for males. Means exclude non-farm self-employment earnings and are calculated over the subsample with off-farm employment (excluding self-employment).

Only about 40 percent of males had off-farm employment, so the pattern in Figure 7 may be affected by selection. Figure 8 shows the share of individuals in the sample with off-farm employment by birth cohort. Off-farm employment participation is variable for pre-expansion cohorts, but some increase is visible for the early treatment cohorts. As will be discussed later, probit regressions with controls for other characteristics yield significant correlations between participation in off-farm employment and belonging to the treatment cohorts.

Figure 8. Share of Males with Off-farm Employment



Notes: Calculated using the CHIP 1995 rural survey data, with weights.

#### 4 Empirical Strategy

Our aim is to estimate the effects of the Cultural Revolution education expansion on rural educational attainment and labor market outcomes for the affected cohorts. The Cultural Revolution education expansion took place over several age cohorts. Devereux and Fan (2011), which examines a similar case of education expansion in Britain, postulates that, in the absence of the education expansion, the impact of education on earnings across age cohorts would be captured by a low-order (quartic) polynomial of age, and that the deviation from this polynomial trend for the treatment cohorts reflects the impact of the education expansion on labor market outcomes. The quartic function of age is commonly used in other similar studies (e.g., Oreopoulos, 2006). Dummy variables for the treatment cohorts are then used as instruments in an IV analysis of the returns to education. We follow this approach.<sup>4</sup>

Our starting point is a standard Mincer equation:

$$\ln Y_i = \alpha + \beta ED_i + f(\text{age}_i) + g(Z_i) + \mu_i, \quad (1)$$

where for each individual  $i$ , the log of income  $\ln Y_i$  is a function of years of education  $ED_i$ , a quartic function of age  $f(\text{age}_i)$ , other individual characteristics  $Z_i$ , and a residual  $\mu_i$ . The coefficient  $\beta$  can be interpreted as the return to education, but unobserved characteristics such as ability could cause bias in its estimation. We use the Cultural

<sup>4</sup> Unlike Devereux and Fan (2011), we do not distinguish school cohorts from age cohorts based on month of birth and school entrance rules regarding month of birth. We do not have month of birth information and, anyway, in rural China month of birth rules would not have been strictly enforced.

Revolution education expansion to address this bias.

Years of education are a function of whether individuals belong to a cohort affected by the education expansion as well as other characteristics:

$$ED_i = \gamma + \sum_{c=1953}^{1960} \delta_c Cohort_i^c + \delta_p Post_i + h(M_i) + \varepsilon_i. \quad (2)$$

$Cohort_i^c$  is a dummy variable that equals one if the individual is born in an affected birth year  $c$ , with separate cohort dummy variables for each of the affected birth years 1953 through 1960.  $Post_i$  is a dummy variable that equals one if the individual is born after 1960; the omitted dummy variable is for pre-expansion cohorts.  $M_i$  is a vector of other observed characteristics that influence education, and  $\varepsilon_i$  is the residual.

Substituting equation (2) into equation (1) yields

$$LnY_i = \varphi + \sum_{c=1953}^{1960} \theta_c Cohort_i^c + \theta_p Post_i + l(age_i) + m(Z_i, M_i) + \eta_i. \quad (3)$$

Equation (3), which excludes education, can be interpreted as the reduced form relationship between income, education expansion cohort, and other characteristics.

We use IV to estimate the returns to education, with the education equation (2) as the first stage and the earnings equation (1) as the second stage. The cohort and post-expansion dummy variables are the instruments. An unbiased estimate of the returns to education requires that the education expansion affects earnings only through education. We believe this is the case. The Cultural Revolution education expansion was independent of individuals' ability and was unlikely to have otherwise influenced incomes of the treatment cohorts differentially versus the control cohorts in 1995, nearly 20 years later.

In our earnings regressions we use three alternative measures of income as the dependent variable: annual net household income per adult of the individual's household, yearly off-farm wages of the individual, and hourly off-farm wages of the individual. Each measure has its strengths and weaknesses. Net household income per adult captures income from all sources, including self-employment in household farming, sidelines and businesses, but it is not reported for individual members of the household. Off-farm wage earnings are reported for individuals, but exclude potentially important earnings from self-employment in household farming, sidelines and businesses. Hourly off-farm wages equal annual wage earnings divided by hours worked. Information on hours worked is missing for some individuals, so the sample size is smaller for hourly than for yearly wages.

In the 1990s many rural adult males did not participate in off-farm work, which raises the possibility of selection bias in estimates of the returns to education in terms of off-farm wages. We postulate that off-farm employment is a function of education and other characteristics:

$$off - farm_i = a + bED_i + c(age_i) + e(V_i) + \vartheta_i, \quad (4)$$



Since education is a function of birth cohort, substituting equation (2) into equation (4) gives us the reduced form relationship

$$off - farm_i = k + \sum_{c=1953}^{1960} \lambda_c Cohort_i^c + \lambda_p Post_i + n(age_i) + w(Z_i, V_i) + \pi_i, \quad (5)$$

where participation in off-farm employment is a function of affected birth cohort and other variables. We estimate the off-farm participation equation both in reduced form and using IV. Also, we estimate the off-farm wage earnings equation with and without a Heckman procedure to correct for selection in off-farm wage job participation.

## 5 Empirical Results

### 5.1 Schooling

Table 2 reports estimates of the coefficients on the treatment cohort and post-expansion dummy variables for the schooling equation (equation 2). We report results for two measures of schooling, completed years of school (column 1) and senior secondary school attainment (column 2). Regressions include controls for age (quartic), cohort size, minority ethnicity, and province of residence.

The results show that the treatment cohorts had significantly more education than men born before 1953. The impact is largest for men born in 1959, who received about 1.5 years more schooling and were 25 percentage points more likely to attend senior secondary school than those born before 1953. The coefficients on the post-expansion dummy variable are smaller than for the 1959 cohort dummy variable but remain significant, indicating that schooling levels declined after the Cultural Revolution but did not fall back to the levels prevalent before the education expansion.

### 5.2 Income, wage earnings and employment: Reduced form estimates

Table 3 shows estimates from the reduced form income and off-farm wage regressions (equation 3) and for the off-farm employment participation probit (equation 5). Due to incomplete information on individual earnings from self-employment, our measures of off-farm earnings and employment participation exclude non-farm self-employment; however, less than 2 percent of the estimation sample reported participation in non-farm self-employment.

Control variables include the treatment cohort and post-expansion dummy variables, age (quartic), cohort size, and dummy variables for minority ethnicity and province of residence. The regression for household net income per adult also includes control variables for contracted farmland per adult, household size, and the proportion of adults among household members. The coefficients on the cohort dummies can be interpreted as the increase in income, wages, or employment participation of the treatment cohorts relative to that of pre-expansion cohorts.

The first column shows the results for household net income per adult. The estimated coefficients on the cohort dummy variables are not significant. The second and third columns show the results for yearly and hourly wages. Again, the coefficients on the cohort dummy variables are not significant.

We estimate a participation equation to check whether education differs between treatment and control cohorts. Column 4 shows the results. Control variables include age (quartic), cohort size, contracted farmland per adult, household size, the proportion of adults among household members, and dummy variables for marital status, minority ethnicity, and province of residence. The coefficients on the Cultural Revolution cohort dummy variables are uniformly positive and significant. Cohorts affected by the Cultural Revolution education expansion had significantly greater probability of employment in off-farm wage jobs than pre-expansion cohorts, and the probability of such employment remained high for post-expansion cohorts.

The last two columns in Table 3 report the results of the off-farm wage regressions after correcting for sample selection bias using a Heckman procedure. Contracted farmland per adult, household size, the proportion of adults among household members, and marital status are the instruments. Once again, the treatment cohort dummy variables are not significant. Correcting for selection bias does not change the basic result that the coefficients on the Cultural Revolution cohort dummy variables are not significant.

Table 2 The Education Expansion and Schooling

	Completed years of school (OLS)	Senior secondary school attainment (probit, marginal effects)
cohort53	0.440** (0.199)	0.041*** (0.000)
cohort54	0.652*** (0.228)	0.050*** (0.000)
cohort55	0.605** (0.248)	0.051*** (0.000)
cohort56	0.866*** (0.286)	0.084*** (0.000)
cohort57	1.215*** (0.303)	0.143*** (0.000)
cohort58	1.063*** (0.344)	0.131*** (0.000)
cohort59	1.509*** (0.374)	0.253*** (0.000)
cohort60	1.319*** (0.401)	0.191*** (0.000)
post-expansion	0.440** (0.199)	0.201*** (0.000)
Observations	4,833	4,833
R <sup>2</sup> /pseudo R <sup>2</sup>	0.112	0.074

Notes: Estimated using CHIP 1995 rural survey data, with weights. The estimation sample includes men born in the years 1948 through 1965. The omitted cohort dummy variable is for pre-education expansion birth years (1948-52). Controls include age (quartic), cohort size, and dummy variables for minority ethnicity and province of residence. Standard errors are reported in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Table 3 Reduced Form Estimates for Household Income per Adult, Off-farm Employment Participation, and Off-farm Wage Earnings

	Ln household income per adult (1)	Ln off-farm yearly wages (2)	Ln off-farm hourly wages (3)	Off-farm employment (probit, marginal effects) (4)	Corrected ln off-farm yearly wages (5)	Corrected ln off-farm hourly wages (6)
cohort53	-0.076 (0.073)	0.032 (0.264)	-0.059 (0.259)	0.100*** (0.000)	-0.065 (0.288)	0.010 (0.276)
cohort54	-0.088 (0.115)	0.089 (0.420)	-0.180 (0.412)	0.199*** (0.000)	-0.241 (0.447)	0.020 (0.434)
cohort55	-0.060 (0.169)	0.091 (0.611)	-0.460 (0.602)	0.248*** (0.000)	-0.328 (0.633)	0.141 (0.625)
cohort56	-0.129 (0.252)	-0.001 (0.901)	-0.760 (0.899)	0.320*** (0.001)	-0.452 (0.938)	-0.067 (0.931)
cohort57	-0.143 (0.319)	0.102 (1.140)	-1.027 (1.139)	0.384*** (0.001)	-0.571 (1.185)	-0.054 (1.180)
cohort58	-0.306 (0.425)	0.187 (1.504)	-1.778 (1.513)	0.460*** (0.001)	-0.974 (1.576)	0.038 (1.568)
cohort59	-0.297 (0.545)	-0.610 (1.916)	-2.090 (1.937)	0.526*** (0.001)	-1.078 (2.024)	-0.957 (2.008)
cohort60	-0.444 (0.631)	-0.499 (2.213)	-2.716 (2.241)	0.559*** (0.001)	-1.516 (2.341)	-0.841 (2.328)
post	-0.566 (0.747)	-1.134 (2.609)	-3.139 (2.651)	0.684*** (0.002)	-1.761 (2.771)	-1.657 (2.749)
Obs.	4818	1965	1336	4833	1869	1263
R <sup>2</sup> , pseudo R <sup>2</sup> or $\chi^2(33)$	0.328	0.225	0.091	0.035	384.40	136.81

Notes: Estimated using the CHIP 1995 rural survey data, with weights. The estimation sample includes men born in the years 1948 through 1965. Wages and wage employment exclude self-employment. The omitted cohort dummy is for birth years before 1953. All regressions include age (quartic), cohort size, and dummy variables for minority ethnicity and province. Column 1 also includes contracted farmland per adult, household size, and the proportion of adults in the household. Column 4 also includes marital status, contracted farmland per adult, household size, and the proportion of adults in the household; marginal effects are reported at the means. "Corrected" results use a Heckman 2SLS estimation procedure; the instruments are marital status, contracted farmland per adult, household size, and proportion of adults in the household. Sample size is reduced due to missing information on marital status and farmland for some observations. Standard errors are reported in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

### 5.3 The returns to education: IV estimates

We estimate the rate of return to years of schooling using the Cultural Revolution secondary school expansion to instrument for possible endogeneity bias. Table 4 reports the IV estimates of the returns to education for the different earnings measures and for off-farm employment participation. For off-farm wage earnings we report estimates with and without the Heckman correction. Results are shown for 2SLS and LIML estimation procedures as well as un-instrumented OLS for comparison.

Table 4 Returns to Education

	Ln household income per adult (1)	Ln yearly off-farm wages (2)	Ln hourly off-farm wages (3)	Off-farm employment (marginal effects) (4)	Corrected, ln yearly off-farm wages (5)	Corrected, ln hourly off-farm wages (6)
OLS (or probit)	0.002 (0.003)	0.084*** (0.012)	0.036*** (0.013)	0.020*** (0.000)	0.035 (0.029)	0.007 (0.030)
2SLS	0.113*** (0.018)	0.178*** (0.039)	0.147*** (0.040)	0.089*** (0.014)	0.177*** (0.039)	0.145*** (0.030)
LIML	0.163*** (0.018)	0.192*** (0.036)	0.257*** (0.041)	0.099*** (0.016)	0.197*** (0.049)	0.216*** (0.033)

Notes: Estimated using the CHIP 1995 rural survey data, with weights. The estimation sample includes men born in 1948 through 1965. Education is measured as years of schooling. 2SLS and LIML regressions use dummy variables for each affected birth year plus a post-expansion dummy variable as instruments. Control variables in (1) are years of education, age (quartic), dummy variables for minority and province, cohort size, household contracted land area, household size and the proportion of household members who are adults. Control variables in (2) and (3) are years of education, age (quartic), dummy variables for minority and province, and cohort size. For the off-farm employment probit (4) and Heckman corrected regressions (5) and (6), the first stage regression control variables are years of education, age (quartic), dummy variables for minority and province, cohort size, household contracted land area, household size, the proportion of household members who are adults, and marital status; the second stage regression control variables are the same as in specifications (2) and (3). Marginal effects in the probit (4) are reported at the means. Standard errors are in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

The OLS estimates, shown in the first row of the table, are relatively small and not all significant. The 2SLS and LIML estimates are substantially larger and uniformly significant. The 2SLS results suggest that an extra year of schooling increased household income per adult by 11 percent, off-farm wages by 15 to 18 percent, and the probability of off-farm employment participation by 9 percentage points. The LIML estimates are a bit larger: an extra year of schooling increases household income per adult by 16 percent, wages by about 20 percent, and off-farm employment participation by 10 percentage points.

A finding of larger IV estimates than OLS estimates is common in the literature.

Such a difference between IV and OLS estimates may reflect the fact that OLS assumes an average return to years of schooling for all individuals in the treatment group, whereas the instrumented estimates measure the local average treatment effect for the subset of individuals in the treatment group whose status was affected (Card 1999, Imbens and Angrist 1994, Oreopoulos 2006). The size of the difference between local average treatment effects (LATE) and average treatment effects (ATE) will depend on the proportion of the treatment group affected. In the case of the Cultural Revolution education expansion, the aggregate statistics suggest that by the mid-1970s this proportion was large, as the share of children attending junior secondary school increased from about 20 percent before the expansion to 90 percent during (Figure 3).

We check whether such considerations are relevant by redoing the OLS estimation for household income and wages using restricted samples in which the majority of individuals were affected by the treatment. First, we restrict the sample to later treatment cohorts (1958-60), in which the majority of individuals continued past primary school and so were likely affected by the treatment. The OLS coefficients on education for this restricted sample are 0.002, 0.145\*\*\*, 0.097\*\*\*, 0.128\*\*\*, and 0.067, respectively, for the household income and wage regressions (columns 1, 2, 3, 5 and 6). Second, we further restrict the sample to individuals in the later treatment cohorts (1958-60) who did not attend senior secondary school. We drop individuals who attended senior secondary school as they were likely to have attended secondary school even without the education expansion. The OLS coefficients on education for this second restricted sample are 0.009, 0.172\*\*\*, 0.116\*\*\*, 0.160\*\*\*, and 0.174, respectively, for the household income and wage regressions.

For both these restricted samples the OLS coefficients are more significant than for the full sample, and they approach the IV estimates in magnitude. These results suggest that the differences between the OLS and IV estimates in Table 4 reflect differences between ATEs and LATEs.

## **6 Robustness Checks**

### **6.1 Alternative specifications**

To check the robustness of our estimates of the returns to education, we estimate some alternative specifications. Results are reported in Table 5. For brevity, Table 5 shows only the 2SLS estimates for household income per adult and hourly off-farm wages (corrected for selection). The LIML estimates were consistent with the 2SLS, and the estimates for yearly wages were consistent with those for hourly wages.

The first column of Table 5 gives the results from our base 2SLS specification (Table 4, row 2). In column (2) we drop the cohort size control, and in column (3) we drop the post-expansion cohort dummy variable. In both cases the return to education remains significant and similar in magnitude to our base specification.

In column (4) we replace the quartic age function by linear age. The

coefficients on education remain positive but are smaller and no longer significant. Quadratic age (not reported here) yields a similar result to linear age. We conclude that the significance of the coefficient on education is sensitive to treatment of the age variable, which may arise because omitting higher order terms forces the effects of age to coincide with the effects of the cohort dummy variables.

In column (5) we reduce the number of instruments by replacing the eight separate dummy variables for each affected birth year by a single dummy variable for all individuals born 1953 through 1960. The coefficient for household income per adult is similar to that in the base specification, and the coefficient for hourly wages increases a bit; both are statistically significant.

Table 5 Returns to Education: Alternative Specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln household net income per adult	0.113*** (0.018)	0.114*** (0.018)	0.116*** (0.018)	0.082 (0.056)	0.107*** (0.015)	0.116*** (0.018)	0.114*** (0.018)	0.116*** (0.018)
Corrected, ln hourly wages	0.145*** (0.032)	0.146*** (0.033)	0.150*** (0.032)	0.045 (0.109)	0.195*** (0.032)	0.150*** (0.032)	0.146*** (0.032)	0.150*** (0.032)
Cohort size control	yes	no	yes	yes	yes	yes	yes	yes
Post-expansion dummy	yes	yes	no	yes	yes	yes	yes	yes
Quartic replaced by linear age				√				
Single treatment dummy for 1953-60					√			
Treatment cohorts 1956-1960						√		
Treatment cohorts 1953-1961							√	
Treatment cohorts 1956-1961								√

Notes: All columns are estimated using IV and 2SLS. Estimated using the CHIP 1995 rural survey data, with weights. The estimation sample includes men born in the years 1948 through 1965. Column (1) is the same as in our base specification (row 2 of Table 4). Column (2) is the same as (1), but the cohort size control is dropped. Column (3) is the same as (1), but the post-expansion dummy variable is dropped. Column (4) is the same as (1), but quartic age is replaced by linear age. Column (5) is the same as (1), but the eight birth year dummy variables are replaced by a single treatment dummy variable for all individuals born 1953-60. Columns (5), (6) and (7) are the same as (1), but use alternative birth year cutoffs for treatment cohorts. Standard errors are in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

Columns (6), (7) and (8) show the results from specifications that use alternative birth year cutoffs for the treatment cohorts. Based on Figures 4 and 5, which show a second upswing in education levels after the 1955 cohort, we use an alternative cutoff of 1956 for the start of treatment. We use an alternative birth year cutoff of 1961 for

the end of treatment. Estimates of the return to education remain significant and stable in magnitude for different combinations of these alternative cutoffs.

## 6.2 Controlling for effects of the Great Leap Forward famine

Some of our treatment cohorts were affected not only by the Cultural Revolution education expansion but also by the Great Leap Forward, a radical rural policy program implemented in the late 1950s that caused a severe famine during 1959-61. The long-term effects of famine on children who were in utero or early infancy at the time have been discussed in the literature. Meng and Qian (2009) finds evidence of such consequences for the health, education and labor participation of individuals who were born during the Great Leap famine years. Shi (2011) finds some evidence of lower education and incomes of those who were young infants during the famine. Our treatment cohort birth years overlap with the Great Leap famine years, so our estimates may be influenced by the famine.

We use several alternative specifications to control for possible effects of the famine. All specifications are estimated using IV/2SLS. Results are shown in Table 6. First, we drop the famine-affected cohorts (birth years 1959-61) from the estimation sample. The results are in column (2). Dropping the Great Leap birth cohorts increases the estimated return to education as compared to our base specification (column 1). This result is consistent with the view that in utero or early infancy exposure to the famine had long-term negative consequences for labor market outcomes.

Second, we retain the Great Leap cohorts in the sample and add a dummy variable  $glf_i$  for the famine-affected birth cohorts (1959, 1960 and 1961). We first check whether belonging to a Great Leap cohort had a direct effect on years of education by adding  $glf_i$  to the education equation:

$$ED_i = \gamma + \sum_{c=1953}^{1960} \delta_c Cohort_i^c + \delta_p Post_i + \theta glf_i + h(M_i) + \varepsilon_i. \quad (2a)$$

The estimated coefficient on  $glf_i$  in this education equation is negative but not statistically significant (not reported).

We then add the dummy variable  $glf_i$  to our base specification. The results are in column (3) of Table 6. Controlling for the Great Leap cohorts does not substantially alter our estimates of the returns to education, which remain significant and similar in size to the base specification in column (1). Moreover, the estimated coefficients on the Great Leap dummy variable (not reported) are insignificant for both household income and hourly wages.

Third, we further add to our base specification an interaction between  $glf_i$  and years of education. The results are in column (4) of Table 6. The returns to education remain significant and similar in size to our base specification. Also, the coefficients on the Great Leap dummy variable (not reported) were again insignificant; however, the coefficient on the interaction between the Great Leap dummy and



education was significant at the 5 percent level and negative in the hourly wage equation (-0.025\*\*), indicating that the returns to education in terms of wage earnings were lower for the Great Leap cohorts than for other cohorts. The interaction term was not significant in the household income equation.

All in all, the results in Table 6 suggest that our basic finding of large, significant returns to education are robust to controls for the Great Leap famine.

Table 6 Returns to Education: Accounting for the Great Leap Forward Famine

	(1)	(2)	(3)	(4)
Ln household income per adult	0.113*** (0.018)	0.121*** (0.019)	0.094*** (0.019)	0.090*** (0.011)
Corrected, ln hourly wages	0.145*** (0.032)	0.167*** (0.034)	0.147*** (0.057)	0.140*** (0.032)
Drop Great Leap (1959-61) cohorts		√		
Include dummy variable for Great Leap cohorts			√	√
Include interaction between dummy variable for Great Leap cohorts and education				√

Notes: All columns are estimated using IV with 2SLS. The estimation sample includes men born in the years 1948 through 1965. Column (1) shows the results from our base specification (Table 4, row 2). In column (2) we drop observations born in the famine-affected years 1959-1961. In column (3) we add a dummy variable for the Great Leap famine-affected birth cohorts (1959-61). In column (4) we also add an interaction between the Great Leap cohort dummy and education. Standard errors are reported in parentheses. \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .

## 7 Discussion and Conclusions

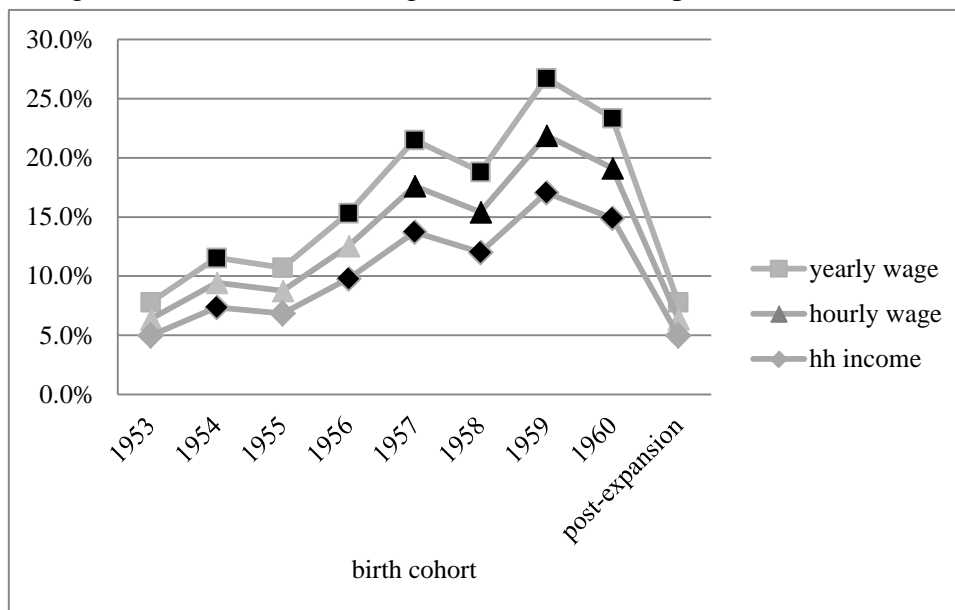
### 7.1 Discussion

Our findings indicate that the education expansion changed labor market outcomes for cohorts affected by the Cultural Revolution education expansion. Using the estimated coefficients on the treatment cohort dummy variables from the education regression (Table 2, OLS) and the IV-2SLS estimates of the returns to education (Table 4, row 2), we calculate the magnitude of the education expansion's impact on earnings for the treatment cohorts relative to the pre-expansion cohorts. The results of these calculations are shown in Figure 9. Points on the graph with black markers are significantly different from zero.

Figure 9 reveals that the benefits of the education expansion were significant and quite substantial. The percentage gain in household income per adult relative to the pre-expansion cohorts is low and not statistically significant for the 1953 cohort, but becomes significant and increases to a peak of 17 percent for the 1959 cohort. After 1959 the gain declines; for the post-expansion cohorts it is no longer significant. Hourly and yearly wages show a similar pattern, although the benefits are slightly

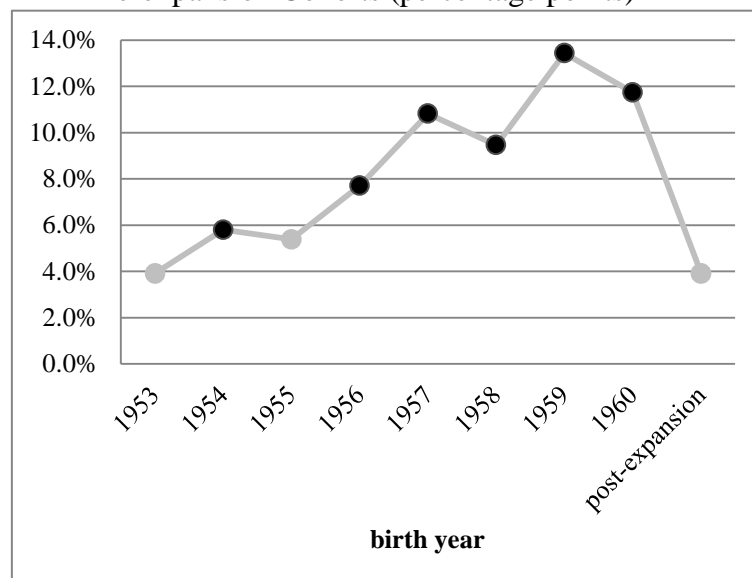
larger, reaching a peak of 22-27 percent for the 1959 cohort.

Figure 9 Increases in Earnings Relative to Pre-expansion Cohorts (%)



Note: Calculated as the increase in years of education for each cohort (the coefficient on the cohort dummy variable in the education regression, Table 2, OLS) times the return to years of education (the coefficients on years of schooling in Table 4, IV 2SLS). Points with black markers are significantly different from zero at the 1% confidence level. Standard errors are calculated using the delta method.

Figure 10 Increases in Off-farm Employment Participation Relative to Pre-expansion Cohorts (percentage points)



Note: Calculated as the increase in years of education for each cohort (the coefficient on the cohort dummy variable in the education regression, Table 2, OLS) times the coefficient on years of education in the off-farm employment probit (Table 4, IV 2SLS). Points with black markers are significantly different from zero at the 1% confidence level. Standard errors are calculated using the delta method.

The gains in off-farm wages shown in Figure 9 reflect relative wages for the subset of men who participated in off-farm employment. The Cultural Revolution education expansion also affected participation in off-farm employment. Figure 10 shows the magnitude of the education expansion's impact on the off-farm employment participation for the treatment cohorts relative to the pre-expansion cohorts. The impact on off-farm employment participation is small and insignificant for the 1953 cohort, increases and becomes significant, and reaches a peak of 13.4 percentage points for the 1959 cohort. After 1959 the gain in off-farm employment probability drops off and is no longer significant.

Figures 9 and 10 reflect local average treatment effects, that is, they apply to those individuals in the treatment cohorts whose years of schooling were affected by the education expansion. As discussed earlier, most individuals born in 1958-1960 were probably affected by the expansion, so that the average and local average treatment effects for these cohorts are similar. We also note that the gains shown in Figures 9 and 10 are relative gains, that is, they measure the gains of affected cohorts relative to the pre-expansion cohorts. It is possible that the labor market outcomes of the pre-expansion cohorts were also affected by the education expansion. For example, changes in the educational composition of the labor supply due to the education expansion may have had general equilibrium effects that reduced earnings for the pre-expansion cohorts.

## 7.2 Conclusion

Our analysis of the impact of the Cultural Revolution rural education expansion finds that it substantially increased schooling of the affected cohorts, who enjoyed long-term benefits in terms of employment and earnings. This conclusion is based on estimates of the returns to schooling that control for endogeneity using the Cultural Revolution education expansion as an instrument.

We find returns to schooling of 11-16 percent for household income per adult and of 15-22 percent for off-farm wages. These estimates are robust to alternative specifications, including ones that control for possible effects of the Great Leap Forward famine on some of cohorts, and they are substantially higher than most available estimates for rural China. An exception is Fang et al. (2012), the only other study to date that estimates the returns to education in rural China using an IV approach, although for more recent cohorts. It reports returns to schooling of similar magnitude. We conclude that the returns to education in rural China are higher than previously thought. Our estimates are generally in line with estimates for other developing countries (Psacharopoulos and Patrinos 2004).

These relatively large returns to education for cohorts educated during the Cultural Revolution may seem at odds with the standard view that rural education during this era was of poor quality. Why would poor quality education yield large, positive returns? One possibility is that schooling did not raise labor productivity but nevertheless served as a sorting device used by local officials or employers in the 1990s to allocate relatively scarce jobs, resources and opportunities. If this is the

case, then our estimates of positive returns to education may simply reflect changes in relative earnings between those with less and more schooling.

A second possibility is that the expansion of rural education during the Cultural Revolution in fact imparted useful academic and non-academic skills beyond what they would have received otherwise by children in the affected cohorts. An in-depth case study of education during the Cultural Revolution in a rural county by Han (2001) provides local evidence drawn from interviews and county records that is consistent with this interpretation. Han reports that before the Cultural Revolution rural secondary school curriculum in the county focused on preparation for college entrance examinations and had limited practical application. Curriculum reforms during the Cultural Revolution shifted the substance of secondary school education to practical knowledge and skills such as the operation and repair of machinery, development and planting of new seed varieties, and basic veterinary skills for care of livestock. Local evidence indicates that these curriculum reforms, in combination with substantial increases in secondary school attainment, dramatically changed the county's labor force composition and consequently opened the way for growth in agricultural output and the development of rural township and village enterprises.

It is possible, then, that our estimates of the returns to education for cohorts educated during the Cultural Revolution reflect net gains in labor productivity. In this case, China's rural education expansion during the Cultural Revolution may have generated not just private benefits, but broader gains in the form of sectoral and macroeconomic growth, thus contributing to China's economic achievements subsequently during the reform era.

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