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A Cross-National Study

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McMaster University

DEPARTMENT OF ECONOMICS

IMPACT OF INTERRUPTED EDUCATION ON EARNINGS

—The Educational Cost of the Chinese Cultural Revolution

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Abstract

Impact of school interruptions on earnings through lower subsequent educational attainment and lower quality of education is investigated using the Chinese Cultural Revolution as a natural experiment. During the Cultural Revolution, most schools in China stopped normal operation for 3 to 4 years, universities stopped normal student recruitment for an even longer period. Such large scale school interruptions reduced the opportunity of the cohort to obtain university degrees. We find that individuals who did not obtain a university degree because of the Cultural Revolution on average lost 46 per cent of their potential earnings. In addition most of the cohort experienced missed or interrupted schooling, at a given level of education and we show that this reduced earnings of degree holders of the Cultural Revolution cohort by 7.3 per cent on average. The findings in this paper also indicate that the quality of schooling affected earnings of individuals in a non-linear way, that is, only missed schooling at junior and senior high level reduced subsequent earnings and it only reduced earnings of those with university degrees.

IMPACT OF INTERRUPTED EDUCATION ON EARNINGS

The Educational Cost of the Chinese Cultural Revolution

1 Introduction

In 1966, the Chinese Communist Party began a political event — the Cultural Revolution — during which most schools in China stopped normal operation for 6 years. Universities stopped normal student recruitment for an even longer period. Over the entire course of the 11-years of the Cultural Revolution a whole generation of young people were affected in terms of school outcomes.

There is not an extensive literature on the effects of large scale school interruptions on subsequent labour market outcomes of those affected. Recently, however, Ichino and Winter-Ebmer (1998) found, for a number of European countries, that individuals, who would have obtained higher education, but because of the WW II did not, suffered a considerable loss of earnings. We add the Cultural Revolution experience to this literature.

We begin by following Ichino and Winter-Ebmer (1998) and examine the Cultural Revolution (CR) impact on subsequent earnings of those of school age. We adopt the instrumental variable (IV)/local average treatment effect (LATE) framework suggested by Angrist (1990), Angrist, Imbens, and Rubin (1996) and Angrist and Imbens (1995). The initial focus is on the impact of reduced incidence of university degree attainment on the subsequent earnings of individuals.

This study, however, take one step further to investigate whether other channels may also affect earnings of the Cultural Revolution cohort. In particular, we investigate the impact of school quality on subsequent earnings of individuals of the Cultural Revolution cohort. School quality is usually measured by the level of school resources, or perhaps days per annum spent at school (see, for example, Card and Krueger, 1992, 1996, Heckman, Layne-Farrar, and Todd, 1996, Altonji and Dunn, 1996). We adopt school interruption as a different and new measure of school quality. It is found that school quality, measured by school disruptions, affected earnings of the individuals of the Cultural Revolution cohort who managed to obtain a university degree despite the adverse impact of the Cultural Revolution. For those without a university degree their subsequent labour market earnings appear not to have been affected by interrupted education. The paper provides possible explanations for these results.

Using this information, we then identify the possible bias which may be introduced to the LATE estimate by the second channel of the Cultural Revolution effect—the effect of the quality of schooling. Some attempts are made to correct for the bias.

The paper is structured as follows: The next section provides some background on the schooling impact of the Cultural Revolution. Section 3 estimates the earnings effect of a lower incidence of university degree acquisition due to the Cultural Revolution. Section 4 explores other channels, which may affect earnings of the Cultural Revolution cohort and in particular investigates the impact of reduced schooling quality. Section 5 discusses the relationships between the findings of the two previous sections and investigates bias in our estimate of the local average treatment effect of those who did not attain a university degree because of the Cultural Revolution. Section 6 concludes the paper.

2 Background

The Cultural Revolution began in 1966 and lasted for eleven years. At the beginning of the Cultural Revolution all schools were closed for about three years. No teaching was carried out and no new students were recruited. Schools were re-opened during 1968–1969 so that those who under normal circumstances would have completed primary school during 1966–1968 could go on to high schools and children aged 7–9 could begin primary school. However, teachers were not allowed to follow the standard curricula. Instead, students spent considerable amount of time learning farming and manual labouring from workers and peasants. Students spent most of their school time going to factories and to the countryside to do manual work.

Those of junior high school or senior high school graduation age during the school interruptions of the Cultural Revolution were given qualifications even though they had missed a traditional junior or senior high education. Most of them were then sent to the countryside to become peasants. A limited number were given factory jobs, other city jobs, or army jobs. Junior high graduates were not allowed to proceed to senior high school. This situation continued until about 1972, when the standard school curricula were gradually resumed, although factory and farm work was retained as a very important part of the curricula, especially in high schools. At about the same time senior high schools gradually began to recruit students.

Universities were closed from 1966 to 1970–71 (Deng and Treiman, 1997). No recruitment and no teaching was undertaken in this period. Those who began university

before the Cultural Revolution, and had not completed their degrees, were allowed to stay there without formal teaching until 1970–71. They were then given their degree and assigned jobs. Most of this group became school teachers, factory workers, or joined the army.

After 1970–71, universities began restricted recruitment, based upon political attitudes or family background rather than on academic merit. New students were drawn only from those who were workers, peasants, or soldiers. No senior high school graduates could go to university directly. The quality of university education dropped dramatically as a result of the low quality of student intake and lack of qualified lecturers and professors, many of whom had been sent to the countryside for re-education.

The quality of university education and student intake did not recover until 1977 when, after 11 years, universities resumed entrance exams and began recruiting on academic merit. Everyone who had missed a chance to go to university because of the Cultural Revolution was entitled to sit the exams. Thus, over 11 years of accumulated candidates began to compete with new senior high school graduates for the limited number of positions. This lasted for 4 years until 1981 when those who were older than 25 years were excluded from university entrance

There were three distinct education effects of the Cultural Revolution: school years were missed, students attended schools but were not taught normal curriculum and university access was delayed beyond the normal age. Our analysis suggests that we can group together school years missed and the years during which students were not taught a normal curriculum. We refer to this combination as missed schooling.

Table 1 presents for each age group the level and number of school years missed and the age at which university entrance was a possible choice. Almost 16 age groups were affected: those who were aged between 3–19 years when the Cultural Revolution began. Missed schooling was most serious for those in the middle of these age groups. Some missed all six years of junior and senior high school. Some missed most of primary schooling, and others missed various combinations of primary and high school.

Those who just finished senior high school in 1966 could not go to university directly. Most of them were sent to the countryside and eleven years later were permitted to compete in university entrance exams with others. Their first opportunity to sit the university entrance exam occurred when they were 31 years of age. For those aged seven years in 1966 there was

a one year gap between leaving senior high school and the opportunity to sit the entrance exam.

Table 1: The Cultural Revolution and interrupted education for different age groups

<i>Years of schooling in 1966</i>	<i>Age in 1966</i>	<i>University entry age (Age in 1978)</i>	<i>Number of years missed primary school</i>	<i>Number of years missed junior high</i>	<i>Number of years missed senior high</i>	<i>Number of years missed university</i>
	3	18	1			
	4	18	2			
	5	18	3			
	6	18	4			
	7	19	5			
1	8	20	5	1		
2	9	21	4	2		
3	10	22	3	3		
4	11	23	2	3	3	
5	12	24	1	3	3	
6	13	25	0	3	3	
7	14	26		2	3	
8	15	27		1	3	
9	16	28		0	3	
10	17	29			2	
11	18	30			1	
12	19	31			0	

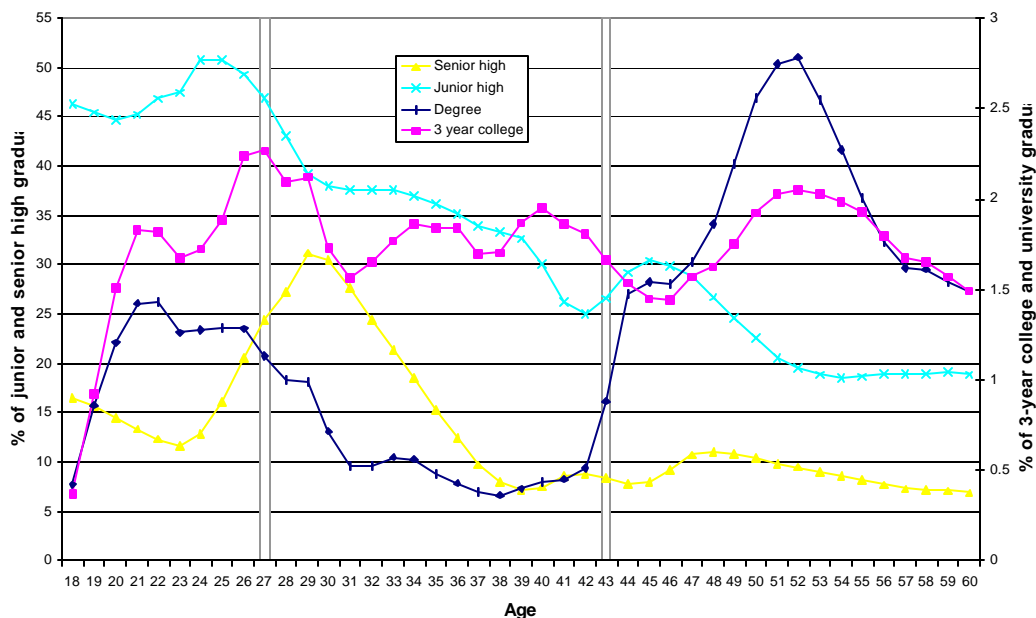
Source: Authors' own estimates.

Figure 1 presents the level of acquired education by age as reported by individuals to the 1990 census. Those age groups affected by the Cultural Revolution fall between the two grey bars. There is no obvious adverse Cultural Revolution effect on the proportion of individuals who reported that they completed Junior or Senior High School (left hand scale). Indeed the proportion of the Cultural Revolution cohort that reported to the Census that they completed Senior High School begins to increase rapidly after the first few years of the Cultural Revolution and reaches an historic peak just before the Cultural Revolution ends.

The Census data therefore seems to suggest that the Cultural Revolution had no obvious adverse effect on the completion rate of these schooling levels. Why is that? The answer seems to be as follows. Although a significant proportion of the Cultural Revolution cohorts did not complete junior or senior high school they still received certificates for the level of high school education they would have attained for their age, if the Cultural Revolution did not occur. It appears therefore that most people reported to the census the level and years of schooling according to their school certificates. As a result it is difficult to

utilize these data to analyse the effect of the Cultural Revolution on the number of school years completed.

Figure 1: Percentage of different level of education by age, 1990



Source: Population Statistical Yearbook, 1993.

The most reliable data reflecting the Cultural Revolution impact is the incidence of university degree holders (Right hand scale). There are three degree types in China; a formal 4-year full-time degree, a 3-year full-time degree and a degree by correspondence (via television). Unfortunately neither census nor other surveys distinguished between three year degrees and degrees by correspondence. Thus, in Figure 1 we refer to the aggregate as a semi-degree.

Access to all degrees was limited in much the same way during the Cultural Revolution. But in Figure 1 the impact is not evident in the proportion of the Cultural Revolution cohort who acquired a semi-degree once the Cultural Revolution had passed. One reason is that after the Cultural Revolution the cost of investing in a semi-degree was substantially lower than investing in the formal four year degree. The cost of investing in a semi-degree in terms of forgone earnings are lower than investing in a four year degree either because the semi-degree can be completed part-time or over a shorter period of full-time studies. Entry requirements are also lower and consequently less time investment is needed to prepare for the university entry exam and when enrolled in a semi-degree course less time has to be taken from family responsibilities. There were also administrative constraints that diverted people towards semi-degrees. After universities re-opened for recruitment, based on

academic merit, the Cultural Revolution cohort was only allowed to sit the entry exams for 4-5 years. But there was no age restriction for the correspondence degree. Consequently, those denied entry to a four year degree could enrol in a correspondence degree.

The Cultural Revolution, however, appears to have had a marked effect on the acquisition of four year degrees. On average, 1.1 per cent of the 22–60 years age group in 1995 hold a four year degree (Figure 1, Right hand scale). But for the Cultural Revolution cohorts the average incidence of degree holders is 0.61. This figure is further reduced to 0.40 per cent for those who missed both junior or senior high school years (those aged 35 to 39 years in 1990). The least affected of the Cultural Revolution age groups appears to be those who missed three or less years of primary school (aged 27–29 in 1990). The average incidence of degree holders for this group is 1.04. This group had the least years of schooling missed, the least years of delayed university entrance and most of its schooling was undertaken after the Cultural Revolution when the quality of education was normal.

In this study we focus on the impact of the Cultural Revolution on the attainment of four-year university degrees.

3 The earnings effect of lower educational attainment

For those of school age during the Cultural Revolution the experience of interrupted schooling can be thought of as an experiment to which students were assigned. We indicate membership of the assignment group as $Z=1$. For the non assignment group, those not of school age during the Cultural Revolution, $Z=0$. The treatment, which can be chosen by those subject to the assignment, is not to attain a university degree. Whether the assigned are subject to treatment is measured as a binary variable $D=0$ if there is no treatment and a university degree is attained, 1 otherwise. There is no one to one correspondence between assignment and treatment.

The outcome of the treatment is a change in labour earnings, Y , for each individual. For each individual we write:

$$Y = Y(Z, D(Z)) \tag{1}$$

where, Z , indicates whether the individual is subject to assignment and, $D(Z)$, indicates the education decision taken in the two possible situations defined by the Cultural Revolution indicator, Z . We group those subject to assignment into three groups: compliers, never takers

and always takers and at this stage make the following assumptions that relate the earnings of these groups to education outcomes¹.

Compliers are of those of the Cultural Revolution cohort who in normal times would have attained a university degree but failed to do so because of the Cultural Revolution. They change their treatment status in response to the assignment. The change in expected earnings, H , that occurs because of their changed education outcome, is written as:

$$H = E(Y(1,1) - Y(0,0)) < 0 \quad (2)$$

Never takers are those who, despite the Cultural Revolution, attained a university degree and would have done so without the Cultural Revolution. This group did not accept the treatment. We assume that the change in their expected earnings is zero and is written as:

$$H = E(Y(1,0) - Y(0,0)) = 0 \quad (3)$$

Always takers are those who did not attain a university degree and would not have done so in the absence of the Cultural Revolution. The change in their expected earnings is written as

$$H = E(Y(1,1) - Y(0,1)) = 0 \quad (4)$$

Of the three groups subject to assignment, the never takers and always takers, referred to as non-compliers, do not respond to the Cultural Revolution by choosing a different education level and, at this stage, are assumed to experience no subsequent reduction in earnings. It is assumed that only compliers bear the earnings cost of the Cultural Revolution. The impact of the Cultural Revolution on earnings therefore operates only through a change in education attainment measured by failure to attain a university degree. That is, the assignment, Z , only impacts on the outcome, H , through its effect on the change in the education decision, D .

We cannot identify the compliers and obviously cannot observe what their income would have been if they attained a degree. To estimate their earnings loss therefor we must

¹ There is a possible fourth group referred to as defiers. These are workers who would have stopped at a lower level of education in the absence of the Cultural Revolution. Although there may be some defiers who gained entry to a university during the Cultural Revolution and would not have gained entry during normal times these individuals, by law, must describe their degree as a three year degree and are therefore included in our low educational category.

rely on comparisons between different individuals and this is done the following estimation framework.

The expected loss of earnings for a complier is estimated from the following two equations:

$$\ln W_i = \mathbf{f} + \mathbf{a}E_i + \mathbf{b}X_i + \mathbf{e}_i \quad (5)$$

where $\ln W_i$ indicates log hourly earnings of individual i , E_i is a binary variable indicating individual i 's educational attainment, X_i is a vector of other earnings related characteristics and e_i is a residual term. The educational choice variable E_i is treated as endogenous and determined by:

$$E_i = \mathbf{j} + \mathbf{g}Z_i + \mathbf{d}X_i + u_i \quad (6)$$

where Z_i is the Cultural Revolution cohort indicator, $Z_i=1$ indicates that an individual belongs to the Cultural Revolution cohort, 0 otherwise, X_i is other individual characteristics included in the earnings equation (1).

Equations (5) and (6) can be estimated using an Instrumental Variable approach with Z_i being the excluded instrument in the earnings equation. This specification treats attainment of a university degree as endogenous and determined by equation (6). Under certain assumptions, which we discuss later, the Instrumental Variable estimate of the coefficient attached to E_i in equation (5) provides an estimate of the Local Average Treatment Effect (LATE) of the Cultural Revolution. The LATE indicates the average earnings loss incurred by those who did not attain a formal four year university degree because of the Cultural Revolution.

The principal data set employed is the Urban Income Distribution Survey (UIDS95), a nation wide survey of rural and urban households conducted by the Institute of Economics at the Chinese Academy of Social Sciences in 1996. The adverse education impact of the Cultural Revolution was mainly borne by urban residents (Deng and Treiman, 1997, Meng and Gregory, 1998), so the rural sub-sample is excluded from our analysis.

The vector of individual characteristics of equation (5) and (6) includes age and its quadratic term, period of party membership, the number of days of sick leave and a dummy variable indicating whether an individual worked in a loss making enterprise. The regression also includes 69 regional dummies to capture the effects of different regional price levels,

economic environments and quality of schooling.² The summary statistics are reported in Table A1, Appendix A. Around half of the sample of individuals belong to the Cultural Revolution cohort. For the non-Cultural Revolution cohort more than 11 per cent of urban residents are degree holders and for the Cultural Revolution cohort the proportion is about 5 per cent.

The IV estimates of equation (5) are presented in Table 2.³ In general, coefficients have the right sign and are statistically significant. The estimated coefficients appear to be similar to those that might be found in the west and similar to other studies based on the same Chinese data (see, for example, Gustafsson and Li, forthcoming). There is a significant age earnings profile that increases with age, reaches a peak and then declines.⁴

Table 2: IV/LATE Estimations, UIDS95

<i>Instrumental Variable</i>	<i>Total</i>		<i>Males</i>		<i>Females</i>	
	<i>Coeff.</i>	<i>S.E</i>	<i>Coeff.</i>	<i>S.E</i>	<i>Coeff.</i>	<i>S.E</i>
Dummy for lower than uni education	-0.7698	0.1829	-0.5937	0.2094	-1.0350	0.3301
Age	0.0700	0.0063	0.0532	0.0080	0.1142	0.0102
Age ²	-0.0008	0.0001	-0.0005	0.0001	-0.0014	0.0001
Dummy for married	0.1690	0.0239	0.2182	0.0347	0.0817	0.0328
Duration as a party membership	0.0047	0.0007	0.0034	0.0008	0.0070	0.0015
No. of days sick leave	-0.0012	0.0003	-0.0012	0.0004	-0.0012	0.0004
Dummy for work in loss making firms	-0.1908	0.0154	-0.1977	0.0214	-0.1923	0.0216
Gender dummy		Yes		No		No
Regional dummies		Yes		Yes		Yes
Number of observations		10005		5341		4664
F		81.44		48.2		34.7

There is a significant and relatively large marriage premium for men of around 25 per cent. We do not know whether this is a general characteristic of the Chinese labour market. There is also a positive 8 per cent marriage premium for women. A positive marriage premium for women is very unusual in western labour markets where marriage is usually associated with less labour market experience, particularly among older women. In China, however, most women of work force age are employed full-time in the labour market and this

² Ideally, one would like to use a place of birth variable to capture quality of schooling (Card and Krueger, 1992) but this is not available in the data. However, as there has been little urban labour mobility in China, current place of residence may be a close proxy for birthplace. The SURFS data from Shanghai indicates that among urban residents surveyed 81 per cent were born in that city.

³ The estimation of equation (6) indicates that all the X variables significantly affect the attainment of a university degree and the Cultural Revolution significantly reduced the rate of degree acquisition. This impact is discussed more fully in Meng and Gregory (1998).

⁴ It has not been usual to include age rather than potential work force experience in an earnings equation. Age is included here, rather than potential work force experience, because by construction work force experience is partly determined by educational attainment. Occupation and industry affiliation, which are often included in an earnings equation, are also excluded because they are partially explained by education (Lemieux and Card, 1998; and Ichino and Winter-Ebmer, 1998).

is one obvious difference that would have implications for the marriage premium (Meng 1999).

The duration of party membership increases the earnings of men and women but the effect is not as large as the marriage premium. Every additional year of party membership adds 0.5 per cent to earnings. Those who take more days of sick leave earn less and the effect is very similar for men and women. There is also a 20 per cent mark down of earnings if the employee is working in a loss-making firm.⁵

The estimated average earnings loss to compliers is substantial. If the assumptions needed to interpret the IV estimator as a LATE are reasonable then the data suggest that in 1995 there is a 53.7 per cent earnings reduction for those who did not attain a university degree because of the Cultural Revolution.⁶ The effect is much greater for females than for males, 64.5 per cent and 44.8 per cent, respectively.

These estimates are similar to those of Ichino and Winter-Ebmer (1998) who analyse the impact of WW II on cohorts of school age during this period. Within their framework they adopt a similar assignment (the large political upheaval is WWII) and a similar treatment (failure to attain a university degree). They estimate a 45–52 per cent reduction in 1986 earnings for those males born in Germany between 1930 and 1935 who failed to obtain a university degree because of the effect of World War II. Their estimate for the 1983 loss of earnings for compliers among Austrian male employees, born between 1930 and 1935, is 61 per cent. The similarity of the WW II and Cultural Revolution outcomes is quite striking.

To interpret the Cultural Revolution effect as a LATE estimator requires five important assumptions that are fully discussed in Angrist and Imbens (1995). These assumptions may be described in the context of this paper as follows:

⁵ We have applied this analysis to another set of data; a 1995 sample of Shanghai Urban Resident and Floating Population Survey (SURFS) conducted by the Institute of Population Studies at the Shanghai Academy of Social Sciences. The SURFS data is narrower in geographical focus than UIDS95 but includes a wider range of data including mother and father's education, occupation, and party affiliation. Parental background may have been an important determinant as to whether an individual subject to school interruption because of the CR subsequently acquired a university degree. Equations (5) and (6) are estimated with variables that include all the individual characteristics of Table 2 and a dummy variable for those born in Shanghai, mother's years of schooling, father's years of schooling, and a dummy variable indicating whether the father was a managerial worker. The Instrumental Variable estimation indicates that individuals who did not attain a university degree because of the Cultural Revolution earned 69.5 per cent less than they otherwise would have earned. This estimate is higher than that from the UIDS95 data. When we exclude parental background from the SURFS data the estimate is unaffected. These results are reported in Appendix B.

⁶ Here the effect of the dummy variable has been obtained by using the transformation e^{b-1} of the estimated b

Assumption 1: Potential incomes of each individual i are not related to whether other individuals belong to the Cultural Revolution cohort or not. It may be argued that the fact that the Cultural Revolution cohort receives less education may affect incomes of earlier or later cohorts due to the complementarities between workers in different cohorts. This, however, may be less of a problem in China. Up until recently wages in China were more or less administratively determined (see Meng and Kidd, 1997). Labour demand and supply had little to do with individual earnings as the market mechanism did not start to work in the labour market until the early 1990s (Meng, 2000). By then, the Cultural Revolution cohort had been in the labour market for more than 10-20 years and the substitutability among cohorts should have strengthened significantly (Freeman, 1976, 1977 and Welch, 1979).⁷

Assumption 2: Whether an individual belongs to the Cultural Revolution cohort is randomly determined. The Cultural Revolution affected the entire cohort and this assumption should be satisfied.

Assumption 3: The probability of being in the low education group is much higher for the Cultural Revolution cohort. In the last section we show that acquisition of university degrees was much lower for the Cultural Revolution cohort.

Assumption 4: No one reaches a high education level because of the Cultural Revolution or stops at a low education level in the absence of the Cultural Revolution. It is hard to imagine that the Cultural Revolution induced some people who otherwise would not obtain a university degree to subsequently complete a four year university degree. All university graduates who were admitted during the Culture Revolution can only report themselves as 3-year degree holders.

Assumption 5: Any effect of the Cultural Revolution on earnings has to be via its effect on educational attainment. This is the exclusion restriction. To this point we have assumed that only compliers suffered an earnings loss and this effect operated only through failure to obtain a university degree. But is it reasonable to assume that there is no other source of earnings loss flowing from the Cultural Revolution. Were the earnings of non-

⁷ It might be argued that the fact of the Cultural Revolution cohort received less education will affect incomes of later cohorts through the influence of low parental education on the acquisition of education by their children. This does not seem plausible. At the time the survey was conducted, the Cultural Revolution cohort was in their late 30th to late 40th. According to SURFS Survey 1995, where information on year of marriage is available, we also know that the average age at which the cohort was first married is around 27. This information implies that the number of children of the Culture Revolution cohort who are in the labour force when the survey was conducted should be limited.

compliers also affected?

The Cultural Revolution might have reduced earnings of the whole cohort through changes in health, the nature of work experience during the Cultural Revolution, and a lower quality of schooling measured as the interruptions to education of all those of school age.

Changes in health may be important because many from the Cultural Revolution urban cohort were sent to the countryside for extended periods to work on farms where the work was hard and the diet often limited.

Farm work also gave the cohort a different kind of work experience, which may have been less valuable than non-agricultural work experience and may have affected subsequent earnings. Gregory and Meng (1996), for example, have shown that previous labour force experience in agriculture was not as valuable as non-agricultural labour force experience as a contributor to the earnings of those employed in the Town and Village Enterprise sector of China. In western labour markets, Angrist (1990) and Angrist and Krueger (1994) have shown that military experience is not a perfect substitute for normal labour market experience. Perhaps the Cultural Revolution cohort has been affected in a similar way with farm work being the counterpart to military service.

Finally, an additional channel that may have affected earnings of the Cultural Revolution cohort of school age is that interrupted education might have reduced school quality for the Cultural Revolution Cohort. According to recent studies of the US (Card and Krueger, 1992, 1996, Heckman, Layne-Farrar, and Todd, 1996, Altonji and Dunn, 1996), education quality can have a significant effect on earnings quite separate from the level of schooling achieved.

If these factors also reduced earnings of the Cultural Revolution cohort our estimate of the cost of the Cultural Revolution from reduced degree attainment is biased upwards (Angrist, Imbens, and Rubin, 1996).

4. Possible sources of bias in the estimate of the LATE

According to Angrist and Krueger (forthcoming), one way to check whether exclusion restriction is satisfied is to look for an association between the instrument and outcomes in samples where there is no reason to expect such a relationship. In our case, if we estimate an earnings equation separately for the high education and low education sub-samples, we should not detect a relationship between the dummy variable for the Cultural Revolution

cohort and earnings. This exercise is conducted using the UID95 data. The earnings equation is specified as:

$$\ln W_i = \mathbf{a} + \mathbf{b}_1 \text{exp}_i + \mathbf{b}_2 \text{exp}_i^2 + \mathbf{b}_3 \text{party}_i + \mathbf{b}_4 \text{sick}_i + \mathbf{b}_5 \text{lossmk}_i + \mathbf{b}_6 \text{Dmar}_i + \mathbf{b}_7 \text{Dsex}_i + \mathbf{b}_8 \text{City}_i + \mathbf{b}_9 \text{Dculture}_i + \mathbf{n}_i \quad (7)$$

where *Dculture* is a dummy variable for the Cultural Revolution cohort. *Texp* is the measure for total labour market experience. *Party* is period of party membership. *Sick* is days of sick leave during 1995. *Lossmk* is a dummy for work in loss making firm. *Dmar* is a dummy for married, *Dsex* is a dummy for males, and *City* is a group of dummy variables indicating region of resident.

Equation (7) is estimated for the low and high education groups separately. There appear to be no statistically significant relationship between the Cultural Revolution dummy and log hourly earnings for the low education group, the t-ratio is 1.42, but for the high education group, there is a negative and significant effect.⁸

The question, then, is whether any of the above mentioned three channels are responsible for this additional negative impact of the Cultural Revolution on the earnings of university degree holders. Fortunately, the UID95 data includes the number of days of sick leave taken during 1995. The data also identify those who went to the countryside because of the Cultural Revolution.⁹ In addition, we are able to construct a variable, which indicates for each individual in the Cultural Revolution cohort the years of schooling missed during the Cultural Revolution (see Table 1).

We first look for any correlation between countryside experience and health as measured by sick leave in 1995 and fail to find a relationship either for the full sample or for the sub-sample of university degree holders.

We then test whether ‘country work experience’ or ‘low quality of previous schooling’ contributes to the negative effect of the Cultural Revolution on earnings of the

⁸ It is possible, though, that the separate estimation of the earnings equation for the low and high education groups may involve some selection bias given that education is an endogenous variable. To handle this problem we employed another data set, the Shanghai Urban Resident and Floating Population Survey 1995, where the information on parental background is available. A Heckman two-stage selection model is estimated with mother’s years of schooling, father’s years of schooling, father’s party membership status, and father’s occupation as instruments in the first stage of educational decision model. The results from this estimation confirm our findings from the UID95 data. The selection term is marginally significant for the high education group but not for the low education group.

high education group. To do this, we use an interaction term between ‘total experience’ and a dummy variable for those who were sent to the countryside to proxy the ‘country work experience’ and a continuous variable for ‘years of schooling missed’ to proxy the quality of previous schooling. We re-estimate the earnings equation (7) excluding the Cultural Revolution dummy but including these two variables. The results show that the interaction term is not statistically significant but the years of previous schooling missed is.¹⁰ It appears, therefore, that the negative Cultural-Revolution-effects working through a change in health status, or a change in the nature of labour force experience, are unlikely to be important factors reducing the subsequent earnings of degree holders in the Cultural Revolution cohort. The main effect is the quality of the previous schooling.¹¹

To what extent, and at which level, does school interruption affect individual earnings of the Cultural Revolution cohort who obtained a university degrees? To begin to address this question we estimated earnings equation for the high education group with different measures of school interruptions: the years of schooling missed and the level of schooling missed. The level of schooling missed is indicated by 5 dummy variables: missed primary school only, missed both primary school and junior high school, missed both junior high school and senior high school, missed senior high school only, and those who were in the last year of senior high school when the Cultural Revolution started. This last group did not miss any schooling but their possible university entry time was delayed for more than 10 years and this may have affected the quality of their degree.¹² The estimated results using UID95 data are reported in Table 3.

The coefficients attached to variables other than school quality and their statistical significance level are as expected. For the high education group the earnings are related in the usual way to, party membership, employment in a loss-making firm, marital status, and labour force experience.

⁹ The data do not include the number of years each individual spends in the country-side but the average time spent in the country side varies by individual age cohorts.

¹⁰ Different functional forms with the country dummy alone and with both the country dummy and the interaction term are also estimated. None of the variables are statistically significant for both men and women.

¹¹ We also estimated earnings equation for the low education group with missed schooling variable as well as the interaction term for experience and the country dummy. None of them turns out to be significant. In this estimation, the variable ‘year of schooling’ is included to control for the vast variation in years of schooling among the low education group.

¹² The construction of these dummy variables is presented in Appendix A.

When interrupted education is measured by the number of school years missed there is a 2 per cent reduction in earnings for each additional year of schooling missed previously. This penalty is 4.1 per cent for women and 1.5 per cent for men. The data also suggest that among never takers from the Cultural Revolution cohort the earnings effect of interrupted schooling varies with the level of schooling missed. In general, missing primary school years seems not to impact on subsequent earnings of degree holders, a particularly interesting result given the stress that educationalists often place on the importance of high quality primary education. Of course, when a whole cohort misses primary schooling there is some scope for higher level class teaching and curricula to adjust and compensate for the earlier education missed. This result, however, does not seem to be true for women.

Table 3 Results from earnings equation estimated for the high education group¹³

	Total		Males		Females	
	Coeff.	S.E.	Coeff.	S.E.	Coeff.	S.E.
Constant	2.3974	0.0968	2.6131	0.1309	2.1153	0.1690
Years of schooling missed	-0.0198	0.0058	-0.0153	0.0071	-0.0406	0.0140
Total experience	0.0476	0.0080	0.0390	0.0091	0.0835	0.0223
Total experience ²	-0.0009	0.0002	-0.0007	0.0002	-0.0019	0.0006
Dummy for work in loss mk. firm	-0.2702	0.0523	-0.2918	0.0659	-0.1336	0.0959
Days of sick leave	0.0001	0.0007	0.0003	0.0007	-0.0002	0.0021
Period of party membership	0.0027	0.0016	0.0015	0.0018	0.0110	0.0036
Dummy for married	0.2406	0.0635	0.1945	0.0856	0.2402	0.1214
Dummy for males	0.0627	0.0302				
Regional dummies	Yes		Yes		Yes	
Number of observations	883		612		271	
Adjusted R2	0.47		0.45		0.60	
Constant	2.3993	0.0977	2.6161	0.1331	2.0965	0.1712
Dummy for missing primary	-0.0665	0.0466	-0.0396	0.0568	-0.1765	0.0924
Dummy for missing P&J	-0.1354	0.0540	-0.0957	0.0658	-0.3427	0.1350
Dummy for missing J&S	-0.1136	0.0412	-0.0879	0.0487	-0.2154	0.0951
Dummy for missing S	-0.1094	0.0761	-0.0488	0.1159	-0.2366	0.1290
Dummy for delayed uni entry	0.0257	0.0641	0.0212	0.0854	0.0039	0.1026
Total experience	0.0483	0.0084	0.0385	0.0094	0.0895	0.0242
Total experience ²	-0.0009	0.0002	-0.0007	0.0002	-0.0021	0.0006
Dummy for work in loss mk. firm	-0.2716	0.0529	-0.2927	0.0663	-0.1251	0.0963
Days of sick leave	0.0001	0.0007	0.0003	0.0007	-0.0002	0.0021
Period of party membership	0.0027	0.0016	0.0015	0.0018	0.0115	0.0036
Dummy for married	0.2455	0.0648	0.1972	0.0871	0.2485	0.1213
Dummy for males	0.0597	0.0304				
Regional dummies	Yes		Yes		Yes	
Number of observations	883		612		271	
Adjusted R2	0.47		0.45		0.60	

Delayed university entrance, as long as more than 10 years, also seems to have no adverse impact on the return to a university degree both for male and female samples. This

¹³ The results using Shanghai data with selection correction are reported in Appendix C.

result seems to indicate that the decay of human capital between completing school and entering university many years later is not very significant for this group of individuals.

Missing high school matters, however. The combination of missed primary and junior high school has a negative and statistically significant effect on the return to a university degree. Missed junior and senior high school is also statistically significant and reduces the earnings of degree holders (never takers) by 11 per cent. The effect is larger for women than for men. Missing senior high school has a larger negative and statistically significant effect than missing junior high school, although the significant coefficient is attached only to the female equation.

The results obtained from this section so far indicate that interrupted education had no effect on non-degree holders' earnings and that it affects degree holders' earnings significantly. These results are particularly interesting and deserve further comment.

First, why might very large interruptions to primary and secondary schooling among non-degree holders - compliers and always takers – not have a statistically significant effect on earnings twenty years later? This is probably not the result one might expect. For example, in their study of US data, Angrist and Krueger (1991) suggest that even a few months less schooling depress earnings. We suggest two conjectures.

During the first decade and a half after the Cultural Revolution the promotion procedures, job allocation and the wage determination process were primarily determined by the government. Market demand and supply played little role in these. When the labour market deregulation process begins this group of less educated individuals were already in their 30s or early 40s and perhaps the time had passed at which an adverse impact of interrupted education on earnings might occur. This group may have learnt enough on-the-job to offset their poor education experiences. In other words, by preventing an initial impact under a regulated system a subsequent earnings impact in a less regulated market may have been avoided. This, however, seems only applicable to less skilled jobs. For degree holders, the story is different.

In addition, China is a low income country and perhaps at this level of economic development interrupted schooling for the less skilled jobs is not important. Perhaps in a high income country the adverse impacts of interrupted education for non degree holders would be larger.

Second, why does interrupted schooling negatively impact on the earnings of degree holders – the never takers? We were surprised on two counts. First, to enter university, this group competed successfully with individuals who had not been exposed to an interrupted education and, despite the adverse school experience of the never takers, they were judged by exam to be at least the equal of other university entrants with normal schooling. Therefore perhaps there should be no effect of interrupted schooling. Second, our initial presumption was that there would be a positive earnings premium for never takers, not because the Cultural Revolution affected them in a positive way, but because they might be expected to be an exceptional sub-group. On average, we expected never takers to have a relatively high innate ability, or to come from an above average family environment. In normal times their labour market earnings might be expected to be higher than the average university graduate and we thought this high ability effect would dominate the interrupted education effect.

With these considerations in mind, the estimate of the impact of low education quality on the rate of return to a university degree may be an under estimate¹⁴. It does not seem possible at this stage, however, to untangle the relative quantitative importance of the selection of this exceptional group and the interrupted education effect.

Why is a positive ability effect not dominant and not observed for the never takers. This is an area that needs further investigation. One possibility is that perhaps those who missed considerable schooling chose courses that did not require a good background in the more technical subjects such as maths, chemistry, science and physics. These are probably the most difficult subjects to learn by oneself outside a formal education system. Our data, however, do not enable us to identify the nature of the degree courses taken.

5 Correcting for the bias in the LATE estimate

The finding that the Cultural Revolution had two effects on subsequent earnings of the Cultural Revolution cohort means that the interpretation of the Cultural Revolution effect from equation (5) as a LATE estimate is incorrect. There has been a violation of the exclusion restriction and attributing all the earnings loss estimated from equation (5) to the earnings loss experienced by compliers because of lower university attainment is not right. There is a bias.

¹⁴ Some recent studies on identical twins, however, suggest that the difference in innate ability as a source of bias in the estimate of the return to education is either negligible or small (see, for example, Ashenfelter and Krueger, 1994)

The bias, however, may be corrected because the earnings effect of a reduction of school quality appears to be confined to never takers. It is reasonably easy to provide an indication of the size of the bias in our estimate of the LATE because never takers are easily identified. The following formula derived from Angrist, Imbens, and Rubin (1996) may assist the calculation of the size of the bias:

$$E(H_i | i \text{ is a never taker}) \times \frac{\text{Pr}(i \text{ is a never taker})}{\text{Pr}(i \text{ is a complier})} \quad (8)$$

That is, the size of the bias of the IV estimator of equation (5), relative to the LATE, is the average direct effect of the Cultural Revolution on the earnings for the never takers multiplied by the probability of being a never taker relative to the probability of being a complier (Angrist, Imbens, and Rubin, 1996).

We calculate the magnitude of this bias from the estimated ‘school quality effect’ on earnings of never takers from equation (8), based on average years of schooling missed for never takers (see Table 4). The numerator of equation (8) is 0.461 per cent (0.020 x 4.42 x 0.052); one year of missed schooling reduces the income of never takers by 2 per cent, on average this group missed 4.42 years of schooling and the probability of being a never taker is 5.2 per cent. The denominator of equation (8), the estimated probability of being a complier, is 6.33 per cent of the Cultural Revolution Cohort. The bias in the LATE, therefore, is 7.3 per cent for the total sample, and 7.4 and 11.2 per cent for male and female samples, respectively.

Table 4 Bias of estimated LATE caused by violation of the exclusion restriction

	<i>Total</i>	<i>Males</i>	<i>Females</i>
Reduction in earnings due to 1 year missed schooling	0.020	0.015	0.041
Average years of schooling missed	4.420	4.550	4.450
Probability of being a never taker	0.052	0.073	0.031
Mean earnings loss to the Cultural Revolution cohort	0.005	0.005	0.006
Probability of being a complier	0.063	0.067	0.051
Bias	0.073	0.074	0.112
Original estimation of Cultural Revolution cost from equation 5	0.537	0.448	0.645
LATE after correction for bias	0.464	0.374	0.533

We are now in a position to summarise the effects of the Cultural Revolution on the subsequent earnings of those subject to school interruption.

- After adjustment for bias, compliers who failed to attain a university degree lost, on average, 46.4 per cent of their counterfactual 1995 earnings. The loss for women is about 53.3 per cent and for men 37.4 per cent (Table 4 and first row of Table 5).

- The earnings of individuals from the Cultural Revolution cohort who obtained a university degree — the never takers — were reduced as a result of the low quality of previous education. This effect is calculated from the first two terms of the numerator of equation (8). We estimate that never takers lost an average 8.8 per cent of their 1995 counterfactual income. Women lost more than men, 18.3 and 6.8 per cent, respectively (Row 2 Table 5).

The aggregate cost of the Cultural Revolution to compliers and never takers can be estimated relative to the labour market earnings of the entire urban Cultural Revolution cohort. Two steps are required; the average individual complier and never taker cost is multiplied by the complier and never taker proportion of the Cultural Revolution cohort respectively and then these calculations are multiplied by the ratio of the average earnings of each of these groups to the average earnings of the urban Cultural Revolution cohort. As we are unable to identify compliers, neither the actual nor the counterfactual income of the compliers are observed. To provide an indication of the aggregate cost we assume that the counterfactual average income of a complier is equal to the average income of a never taker.

In total, therefore, we estimate that the urban Cultural Revolution cohort lost 4.0 per cent of their earnings: 3.4 per cent due to a lower incidence of university degrees and 0.5 per cent in response to a lower quality of schooling during the Cultural Revolution.

Table 5 Different measures of the educational cost of the Cultural Revolution

	<i>Total</i>	<i>Males</i>	<i>Females</i>
(1) Cost for CR switchers	0.4642	0.3739	0.5334
(2) Cost for CR never takers	0.0884	0.0683	0.1825
(3) Cost (1) shared by the CR cohort	0.0342	0.0280	0.0320
(4) Cost (2) shared by the CR cohort	0.0054	0.0055	0.0067
(5) Total cost share by the CR cohort (3)+(4)	0.0396	0.0335	0.0387

6. Conclusions

The Cultural Revolution interrupted the education process of a whole generation. It reduced the quality and length of education and the incidence of degree attainment. It provides an interesting ‘natural experiment’ for us to investigate the impact of such large scale school interruptions on subsequent labour market outcomes. Our major results are the following.

The incidence of school interruption was very wide. The schooling of all urban children was affected for a considerable number of years. The incidence of the earnings impact of the Cultural Revolution, however, appears to have been very narrow. Although 16 cohort years of school children were affected in terms of interrupted education — and some

missed up to eight years of schooling — we estimate that only 11.5 per cent of this group (the 6.3 per cent compliers and 5.2 per cent never takers) experienced lower earnings in 1995 as a result of their Cultural Revolution experience. There is no clear cut and detectable earnings effect for 88 per cent of the cohort.

All the earnings loss seems to have been born by those who either obtained a university degree, despite the Cultural Revolution, or would have obtained a university degree and failed to do so because of the Cultural Revolution.

By far the largest effect, impacting on 6.3 per cent of the compliers of the cohort, was the earnings loss of 47 per cent associated with not obtaining a four-year degree.

Among the 5.2 per cent of the cohort who obtained a university degree their average earnings was 7.3 per cent less than non-Cultural Revolution degree holders, after adjusting for other characteristics of individuals. The exact source of this earnings loss is not clear. It could be the result of the degree courses chosen by those who missed so much formal schooling. It could be that the group just did less well at university and were not able to fully compensate for their poor pre-university education experience, despite having attained entry by competitive exam.

There are a number of qualifying remarks that should be made to our conclusions.

Until quite recently almost all labour market earnings in China were controlled by government. Consequently, for most individuals most of their career progress, job allocation and salary increases were the outcome of a planned system and as a result the individual costs of mass interrupted education might be less than in a market economy. In addition, we know nothing about the cost to earnings of interrupted education through time, for example, whether the gap between the actual and counterfactual income of individuals increases or diminishes with labour market experience and the opportunity to prove oneself and learn on the job. The earnings loss for 1995 might be very different from the earnings loss for earlier or later years.

Finally, we do not consider a range of wider issues associated with potential macro economic effects of the Cultural Revolution. There are two general equilibrium effects that should be mentioned although we are unable to determine whether they are important. First, as a result of the Cultural Revolution the number of degree holders in China in 1995 is probably lower than it would otherwise have been. Other things being equal this may have increased the return to all degree holders. Under these circumstances we may have

overestimated the counterfactual cost to those individuals who did not attain a degree.

Second, to the extent that the stock of human capital affected the economic growth rate, the labour market earnings of all employees might have been lower as a result of the Cultural Revolution. However, the possible political interactions between the Cultural Revolution and the positive impetus to subsequent economic reform and liberalisation would need to be taken into account. To analyse these issues properly would require a very different focus.

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Appendix A:

Description of variables used in the study:

Dummy variables for missed schooling: These variables are derived from the variable age. The definitions for these variables are presented in the following table:

Description of the missing school dummy variables	Age in 1990	Age in 1995	Number of years missed primary school	Number of years missed junior high	Number of years missed senior high	Total number of schooling missed
Missed primary school	27	32	1			1
Missed primary school	28	33	2			2
Missed primary school	29	34	3			3
Missed primary school	30	35	4			4
Missed primary school	31	36	5			5
Missed P and J high	32	37	5	1		6
Missed P and J high	33	38	4	2		6
Missed P and J high	34	39	3	3		6
Missed J and S high	35	40	2	3	3	8
Missed J and S high	36	41	1	3	3	7
Missed J and S high	37	42	0	3	3	6
Missed J and S high	38	43		2	3	5
Missed J and S high	39	44		1	3	4
Missed senior high	40	45		0	3	3
Missed senior high	41	46			2	2
Missed senior high	42	47			1	1
Delayed uni. entry	43	48			0	0

Dummy variables for regions: In UIDS95 data, Beijing is used as the default group, in SURFS data the rest of the country is used as default group.

Table A1 Summary Statistics of the variables used in Section 4

	Total		Males		Females	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log hourly income	2.64	0.58	2.71	0.56	2.55	0.59
Age	38.54	9.39	39.77	9.91	37.13	8.56
Period of party membership	3.85	8.24	5.45	9.59	2.02	5.84
Days of sick leave	3.92	18.61	3.50	17.84	4.39	19.45
Dummy for lower edu	0.92		0.89		0.95	
% of lower edu in NCR cohort	0.89		0.86		0.92	
% of lower edu in CR cohort	0.95		0.93		0.97	
Dummy for the CR cohort	0.52		0.49		0.55	
Dummy for work in loss mk. firm	0.20		0.20		0.21	
Dummy for married	0.88		0.88		0.88	
Dummy for males	0.53					
Number of obs.	10005		5341		4644	

Note: 69 regional dummy variables are not presented in the table.

Table A2 Summary Statistics of the variables used in Section 5

	Total		Males		Females	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Log hourly income	2.64	0.58	2.71	0.56	2.55	0.59
Total experience	19.50	9.52	20.90	10.01	17.90	8.65
Period of party membership	3.87	8.27	5.47	9.61	2.04	5.88
Days of sick leave in 1995	4.01	19.03	3.59	18.25	4.49	19.87
Years of schooling missed	2.19	2.56	2.07	2.56	2.33	2.56
Primary	0.05		0.04		0.05	
Junior high	0.29		0.27		0.31	
Senior high	0.42		0.39		0.46	
3-year college	0.16		0.19		0.13	
University	0.08		0.10		0.05	
Dummy for work in loss mk. Firm	0.20		0.20		0.21	
Dummy for missing primary	0.15		0.14		0.17	
Dummy for missing P and JH	0.11		0.10		0.12	
Dummy for missing JH and SH	0.20		0.19		0.21	
Dummy for missing SH only	0.05		0.06		0.05	
Dummy for delayed university	0.01		0.01		0.00	
Dummy for males	0.53					

Note: 69 regional dummy variables are not presented in the table.

Appendix B:

IV/LATE estimates of low education effects with and without parental information, SRFS

	OLS		IV	
	Coeff.	S.E.	Coeff.	S.E.
Constant	1.3923	0.3807	1.4169	0.3129
Dummy for lower than uni education	-1.1881	0.5213	-1.1994	0.4713
Age	0.0462	0.0192	0.0460	0.0204
Age ²	-0.0005	0.0002	-0.0005	0.0002
Father's occupation dummy (managerial)	0.0298	0.0662		
Father's years of schooling	0.0039	0.0049		
Mother's years of schooling	-0.0030	0.0053		
Dummy for Shanghai residents	0.1669	0.0505	0.1664	0.0471
Dummy for party member	0.0170	0.0611	0.0167	0.0600
Dummy for health	0.0551	0.0255	0.0551	0.0256
Dummy for married	-0.0395	0.1777	-0.0323	0.1774
Dummy for males	0.2557	0.0265	0.2545	0.0259
Number of observations	1998		1998	
F-Statistics	17.39		21.75	

Appendix C: Estimated results with sample selection correction using SRFPS, 1995

Earnings equation	High edu		low edu	
	Coeff.	S.E.	Coeff.	S.E.
Years of schooling missed	-0.0436	0.0175	0.0081	0.0051
Dummy for healthy people	0.0420	0.0667	0.0511	0.0234
Firm tenure	0.0215	0.0131	0.0166	0.0044
Firm tenure ²	-0.0004	0.0003	-0.0004	0.0001
Other job	0.0269	0.0101	0.0163	0.0032
Other job ²	-0.0006	0.0003	-0.0004	0.0001
Dummy for males	0.1635	0.0687	0.2977	0.0236
Constant	4.2226	0.1773	4.0485	0.0515
Lambda	0.0801	0.1079	0.0871	0.0751
Education selection equation				
Age	0.1150	0.0554	0.0187	0.0578
Age ²	-0.0013	0.0006	-0.0004	0.0007
Dummy for born in Shanghai	-0.3892	0.0987	0.4461	0.1056
Mother's years of schooling	0.0416	0.0141	-0.0405	0.0142
Father's years of schooling	0.0239	0.0144	-0.0269	0.0150
Father's party member	0.0263	0.1262	0.0478	0.1294
Father's managerial	0.3409	0.1875	-0.4258	0.1904
Father's professionals	0.5350	0.1516	-0.4831	0.1545
Dummy for CR cohort	-0.6470	0.1306	0.5940	0.1337
Constant	-3.7402	1.0864	1.0521	1.1394
Number of observation	154		1833	
Wald Chi ²	25.91		217.51	

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