The Impact of a Senior High School Tuition Relief Program on Poor Junior High School Students in Rural China

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Abstract

A significant gap remains between rural and urban students in the rate of admission to senior high school. One reason for this gap may be the high levels of tuition and fees for senior high school. By reducing student expectations of attending high school, high tuition and fees can reduce student academic performance in junior high school. In this paper we evaluate the impact of a senior high tuition relief program on the test scores of poor, rural seventh grade students in China. We surveyed three counties in Shaanxi Province and exploit the fact that, while the counties are adjacent to one another and share similar characteristics, only one of the three implemented a tuition relief program. Using several alternative estimation strategies, including Difference-in-Differences (DD), Difference-in-Difference-in-Differences (DDD), Propensity Score Matching (Matching) and Difference-in-Differences Matching (DD Matching), we find that the tuition program has a statistically significant and positive impact on the math scores of seventh grade students. More importantly, this program is shown to have a statistically significant and positive effect on the poorest students in the treatment group compared to their wealthier peers.

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After more than a decade of effort focused on universalizing access to primary education,

policymakers in developing countries are changing their focus towards expanding access to

secondary education (UNESCO, 2011). One major challenge for policymakers in developing

countries in expanding access to secondary education (including junior and senior high school),

however, is that students from rural areas are underrepresented in senior high school compared to

students from urban areas (e.g. see Carneiro et al., 2011; Ohba, 2011). Since students from rural

areas attend senior high schools less than students from urban areas, they may be less likely to

benefit from the high economic returns associated with both senior high school and college

(Psacharopoulos and Patrinos, 2004). The lack of access to senior high school among rural

students can thus, in turn, lead to greater income inequality between urban and rural areas as well

as lower economic growth (Sala-i-Martin et al., 2004).

As in the rest of the world, low educational attainment in poor rural areas is an important

and emerging issue in China. Students in most poor rural counties in China enroll in senior high

school at a far lower rate than urban students (Yang, 2006). Nearly 90 percent of students in

large cities in China attend senior high school. By contrast, only roughly 1 in 4 students attend

senior high school in poor rural areas (Liu et al., 2009).

 This gap in school participation may challenge China's education system in meeting its

goals and, in the longer run, harm the economy. In 2010, China's Ministry of Education set a

goal of having all students achieve 12 years of schooling (including primary, junior high and

senior high education) by 2020 (Ministry of Education, 2010). While progress has been made in

parts of the country, high rates of dropping out from junior high school (Mo et al., 2011) and low rates of matriculation to senior high school in poor rural areas (Yi et al., 2012) mean that educators are facing challenges if they are to meet its senior high school matriculation goals.

Lack of interest by poor rural students in attending senior high school also has implications for China's equitable development in the long run. When poor rural children end up working in factories or in construction sites to obtain short-run returns rather than studying math, language, English and computers, there is serious concern that the children are not learning the skills that will be needed to be gainfully employed in China's labor market in future (Rozelle et al., 2012). If China's economy continues to grow for the coming decade or more, wages (which has been rising fast over the past several years—Cai, 2007) will almost certainly continue to increase. However, employers will only be willing/able to hire workers who have the sets of skills that are worth high hourly rates. Workers that lack such skills will either be forced to find employment in the informal economy (in which returns are low and expectations of future rises of income are negligible) or become unemployed (or drop out of society and possibly drop into organized crime). Hence, as rich urban students reap high returns, students from poor rural families might be left behind and China might face high rates of chronic unemployment, embedded inequality and, even possibly, growth-reducing instability.

A major barrier preventing rural students from attending senior high school in developing countries in general is high tuition fees. High tuition fees are obviously a problem because poor, rural families have limited resources to pay for tuition and other direct costs of education (Banerjee et al., 2000). Poor, rural families may also not be able to borrow money to pay tuition fees because of limited access to well-functioning credit markets (Banerjee, 2004). Where well-functioning credit markets do exist, families may still not be able to borrow money,

due to market imperfections: for example, human capital cannot easily serve as collateral for educational loans (Deininger et al., 2003; Jacoby, 1994). Even when families can locate the funds to pay tuition fees, tuition combined with the opportunity costs of going to school can make the total cost of schooling prohibitively expensive (Lincove, 2012; Angrist and Lavy, 2009; Angrist et al., 2002).

Under the backdrop of high tuition fees, the highly competitive nature of education systems in many developing countries can further prevent poor, rural students from attaining higher levels of schooling (Glewwe and Kremer, 2006). Educational systems in developing countries (such as China) often use competitive entrance exams to determine student access to a limited number of schooling places. Poor, rural students, who on average score lower on achievement tests (Sirin, 2005; White, 1982), may fail to qualify for places in higher levels of schooling. Poor, rural students may also perceive that they will have fewer opportunities to qualify for higher levels of schooling or more selective schools, and thus may be discouraged from staying in school well before they reach the stage of taking entrance exams (Chuang, 1997; Reardon and Galindo, 2002; Valenzuela, 2000). Since schools in these competitive education systems are often incentivized based on their exam results, schools and teachers may further push at-risk poor students to drop out in an effort to raise overall test scores (Velez and Saenz, 2001). On the whole, in educational systems in which schools are allowed to select students based on student ability and competition between schools, poor students are more likely to attend lower quality schools, reduce effort, and attain lower levels of schooling (MacLeod and Urquiola, 2009).

High tuition fees and a competitive entrance exam system appear to be major reasons behind the low matriculation rates to senior high school among students from poor rural areas in

China. Most notably, the tuition rates of rural public senior high schools in China are among the highest in the developing world and are often unaffordable for students from poor rural areas (Liu et al., 2009). Not only are tuition fees high, but students from poor rural areas appear to overestimate the actual costs associated with attending senior high school (Loyalka et al., 2010). Altogether, the perception of high tuition fees, combined with the rigors of China's competitive education system, may discourage students from poor rural areas from exerting effort to learn in junior high school and lower their chances of attending senior high school (Yi et al., 2012; Wang et al., 2011).

Our senior high tuition relief program is designed to improve our understanding of the impact of high tuition on the low matriculation rates of poor rural students and to counteract the negative effects of high tuition. In China, senior high school is non-compulsory and tuition (at least until recently) must be almost fully paid out-of-pocket. When tuition is expensive, poor families and students may make a decision not to go to senior high school (Liu et al., 2009). Indeed, the cost of sending a student to senior high school is many times more than a poor rural family's per capita annual income. In poor rural areas in Shaanxi Province, the annual income per capita was only 2,400 yuan in 2008 (Ankang Statistics Bureau, 2009). However, senior high school tuition and fees cost an average 8,000 yuan per year—more than 3 times the annual income of a poor family. Moreover, the opportunity cost of going to senior high school has increased. That is, a student attending high school cannot work or otherwise earn an income for his or her family. With the earnings of a typical unskilled worker reaching over 11,000 yuan per year (Huang et al., 2011), opportunity costs more than double the direct (cash) costs of going to senior high school. Waiving tuition thus has high potential in increasing enrollment rates. Indeed,

since tuition was waived for primary and junior high students, the enrollment rate of junior high students in rural China has increased significantly (Ministry of Education, 2009).

The overall goal of this paper is to evaluate the effectiveness of a senior high school tuition relief program in promoting education in poor rural areas and encouraging students to exert more effort in preparing for senior high school. More precisely, we are interested in knowing whether students will respond to the tuition reduction program by (working harder and) performing better if a school district offers tuition relief and informs students in junior high school of this fact.

To accomplish this goal, we draw on the fact that one poor county in southern Shaanxi Province—the County of Ningshan—implemented a senior high tuition relief program. In contrast, two neighboring (and quite similar) counties—Shiquan and Hanyin—did not implement any tuition relief programs. Hence, we believe that this arrangement can serve as a quasi experiment, allowing us to evaluate the impact of Ningshan's senior high tuition relief program on the academic achievement of poor rural seventh grade students. To analyze our data and address concerns that we do not conduct a perfect experiment (that is, although similar, there may be other differences between Ningshan and Shiquan/Hanying besides the tuition relief program), we conduct Difference-in-Differences (DD) estimation, Difference-in-Difference-in-Differences (DDD) estimation, Propensity Score Matching (Matching), and Difference-Differences Matching (DD Matching). Above all, we are interested in examining whether the impact differs for the poorest students and the richest students. In other words, we also investigate whether the poorest students, who are from families that are more likely to be liquidity constrained, are affected by this program more than their richer peers.

In seeking to achieve such an ambitious goal, we also acknowledge certain limits. By the time of the endline survey in September 2010, the first cohort of students that would enjoy the benefits of the Ningshan tuition relief program, which officially started in September 2009, had only completed their first year of junior high school. Because of this, we are unable to quantify the impact of the program on how many students actually matriculated to high school due to the program. Indeed, we are restricted to being able to evaluate the effect of the tuition relief program on the effort of first year junior high school students, or more precisely, on their performance on two standardized math tests developed and executed by the research team (one conducted before the start of the tuition relief program in September 2009 and the other conducted after one year of the program in September 2010). We are also aware that this quasi experiment covers only three counties in poor areas of rural China. There are hundreds of counties in other parts of China's poor rural areas. We believe that our work can inform the debate of whether tuition relief should be offered or not in these counties. However, we do not claim full external validity for other poor areas.

The rest of the paper is organized as follows. The first section introduces the tuition relief program, followed by our data collection and sampling methodology. We then turn to describe our analytic approach. Finally, we present the results of the study and discuss their implications.

Ningshan County's Tuition Relief Program

A tuition relief program implemented in the County of Ningshan provided us with an opportunity to examine the effect of such programs on the academic performance of junior high students in China's poor rural areas. Ningshan is a nationally designated poor county where rural per capita income was 3201 yuan (US$ 500) in 2009.

Like other rural areas, the annual costs of attending senior high school far exceed the income of poor families. According to an official website administered by the Ankang Prefecture Bureau of Education, tuition for senior high schools in 2010 was 1500 yuan per year.[1] There were also fees and other miscellaneous expenses. In interviews with Ningshan, Shiquan and Hanying officials, we were told that about 80 percent of students lived in the dormitories on campus in their senior high schools. According to a survey of senior high school students elsewhere in Shaanxi Province, on average, a typical senior high student had to pay additional 8000 yuan per year for accommodation, food, and learning materials (Liu et al., 2010).

The Ningshan tuition relief program was announced at the end of July in 2009 during summer vacation. The local government promised to pay annual tuition (1500 yuan) for three years in senior high school for students who were among the top 500 students in the entrance examination to the senior high school. As the average annual enrollment in the only senior high school in this county was about 550, program coverage was 91 percent. In effect, the program meant that most students enrolling after August 2009 did not need to pay tuition.

Moreover, all junior high students were informed of the tuition relief program. Although in September 2009 only 15% of junior high students knew about the program, when we revisited the schools in March 2010, 100 percent of students that we randomly selected from grade 7 (or the first year of junior high school) were aware of the program and could generally describe the nature of the program. According to interviews with officials in the bureau of education, the government conducted an intensive promotional effort to make this program known to all junior high students in early October 2009. Hence, if there were any effect of the program, it is possible that it could have appeared as early as grade 7.

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[1] All the study counties in this paper, i.e. the county of Ningshan, Shiquan and Hanyin are located in the same prefecture of Ankang in Shaanxi Province.

The neighboring counties of Shiquan and Hanyin are located in the same prefecture as Ningshan. In China, students in the same prefecture usually are required to take the same courses, use the same textbooks, take the same entrance examination to senior high school and pay the same amount of tuition. This is true in the case of Ankang Prefecture.

There were other similarities between Ningshan and Shiquan/Hanying counties. Like Ningshan, Shiquan and Hanying counties are nationally- or provincially-designated poor counties.[2] In 2009, the rural per capita income was 3323 yuan ($519) in Hanyin and 3338 yuan ($522) in Shiquan. All three counties are extremely mountainous. Per capita fiscal revenues are nearly zero in all three counties, meaning that almost all educational expenditures are financed by transfers from governmental units in the prefecture, province and national levels. Moreover, more than 98 percent of the rural populations in all three counties are Han. In sum, in terms of characteristics like poverty rates, geography, fiscal capabilities and ethnic make up, the three counties are almost identical.

The sample students also appear to be similar in nature to what would be expected in a poor, rural setting in China. For example, we find 6% more boys than girls, a ratio similar to that cited in the Ministry of Education's 2010 Annual Yearbook: 7% more boys than girls. Approximately 98% of the seventh graders in our sample are aged between 11 and 15 years.

Although the main sample at the time of the baseline survey (September 2009) included a total of 36 schools and 3121 students, there was some attrition by the time of the endline survey in September 2010 (Figure 1)[3]. For various reasons (dropouts, absences, death, etc.), by the time

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[2] In 1994, China's government launched a poverty-reduction initiative under the "8-7 Plan" and designated 592 counties as national designated poor counties. Provinces followed with their own initiatives. In our sample, Ningshan and Hanyin counties are nationally designated poor counties, and Shiquan is a provincially designated poor county.
[3] It is possible that because of the leaking of information about the program, fewer students in the Tuition Relief Program county schools dropped out prior to the start of Grade 7 (that is, prior to the baseline). Two things suggest this is not a problem. First, during the baseline, we discovered only 15% of the students and their parents knew

of the endline survey we were only able to follow up with 2742 students—672 students in Ningshan County (the treatment group) and 2070 students in Shiquan and Hanyin counties (the control group). In spite of attrition of 379 students, the attrition rate is almost the same (12%) in both groups, thus reducing the probability of attrition bias,[4]

Table 1 shows that study students were balanced in the key dependent variable (raw math test score in 2009—row 1). To be specific, the mean math score in the County of Ningshan (the treatment group) was 54.82 and the mean math score in the Counties of Shiquan and Hanyin was 54.29. There was no statistically significant difference between them. In addition, rows 2 to 13 show that there were no statistically significant differences at the level of most control variables: the preschool history of the student, the sibling dummy for the student and the occupation dummy for the parent.

However, there was one fundamental difference between Ningshan and Shiquan/Hanying. There was no tuition relief program in either Shiquan or Hanying. Because of this, we believe we have a quasi experiment, designating students in Ningshan as treatment students and students in Hanyin and Shiquan as control students. That is, unlike the 7th graders in Ningshan County that knew about the tuition relief program in senior high school, students in the control group who are in their first year of junior high school were well aware of the fact that if they wanted to go to high school they (or their parents) would have to pay tuition.

Sampling and Data Collection

about the Program. Second, consulting records from Grade 6, June 2009 and Grade 7, September 2009, we discovered two things: one is that the drop out rate between the end of grade 6 (June) and the beginning of grade 7 (September) is low—less than 1%; and the other is that the drop out rates were almost identical (1.03% in the County Tuition Relief Program county schools and 1.09% in the Control schools).

[4] The attrition rate, while high, is not unusual. In a working paper based on data from a county in Shanxi province (Di et al., 2011), the drop out rate of poor rural students between the first month of the first year of junior high (grade 7) and first month of the second year of junior high (grade 8) is reported to be 13.3 percent.

To evaluate the effectiveness of the tuition relief program, we collected data in Ningshan County and two control counties, Shiquan and Hanyin. All 36 junior high schools in the three study counties were surveyed. In addition, in Ningshan County, all seventh grade classes in all six junior high schools were selected. In Shiquan and Hanyin counties, a subset of seventh grade classes in each of the 30 junior high schools was randomly selected because Shiquan and Hanyin had a larger population (and it would have been too costly to survey all students in all classes).

In every sample class, we surveyed all the students. In total, our survey covered 3121 seventh graders. These students were in 69 classes and spread over 36 junior high schools.

Two surveys were conducted. Our baseline survey occurred in early September 2009 at the beginning of the autumn semester, and our evaluation survey occurred almost precisely one year later in September 2010. During each round of survey, the enumeration team visited each school and conducted a two-block survey.

The first block of the survey was a 30 minute standardized math test. This test was given to all sample students in the treatment group and the control group. Because we designed, printed and administered the survey/test ourselves, we know that there was no coaching for the test before our survey. Since the test was administered at the start of the school year, we also know that neither students nor teachers shifted their efforts from other subjects to math. In addition, even if the students knew about the program, rural students seldom take extra tutoring classes during summer vacation. As such, the math test scores we collected in early September can reasonably be used as the pre-program outcome. When we gave the standardized tests, the connection to the treatment (the tuition relief program) was kept blind in both the treatment and control schools. In order to do so, none of the enumerators were informed about the goal of the survey except for a core staff of the two lead enumeration team managers.

In our analysis, we report raw math test scores (full score equal to 100) without any further manipulation for the ease of interpretation. As a robustness check, we also used the normalized z-score of math score. The normalized score was created by subtracting the average test score of all sample students from the raw score for each student and then dividing it by the standard deviation of the test scores of all sample students in the same grade. With this transformation, the normalized test score is interpreted as the units of standard deviations from the mean score of all students in the same grade. When we replicate our empirical analyses using normalized scores, the results are almost the same. Using normalized scores has the one advantage of facilitating comparison with other educational programs.

In the second block enumerators collected data on the demographic and socioeconomic characteristics of students and their families. From this part of the survey we are able to create our control variables. The dataset includes measures of each student's *age* (measured in years), gender (described by an indicator *gender*, which is equal to one for boys, and zero for girls), sibling information (described by an indicator, *no sibling* which is equal to one for student had no siblings, and zero for students who had siblings), and student pre-schooling and kindergarten information (described by the indicator of *preschool* and *kindergarten*, which equals to one if students attended either preschool or kindergarten), father and mother's *age* (measured in years), father and mother's *education level* (*completed at least middle school*) and father and mother's occupation (described by an indicator variable called *occupation*, which equals one if a student's parent works in agriculture, and zero for the parent who works in the non-agricultural sector).

As part of the second block students were also asked to indicate which assets their family owned from a list of 30 household asset items. Using these data, we generated an asset index using principal component analysis to measure the wealth of each household. Following the

method by Filmer and Pritchett (1998), we used scoring factors from the first principal

component to create the asset index. It is in fact a weighted average of the observed 30 variables

of assets, and variables with higher coefficients have more weight in determining the score. The

higher the asset index is, the wealthier the household is. Based on this asset index, we divided the

students into five equal-sized groups and created the variables of *Poorest, Second, Median,*

Fourth and Richest to represent the students whose household wealth was among the bottom 0-

20%, top 60-80%, top 40-60%, top 20-40% and top 20 % and above.

Analytical Approach

In this section we introduce our analytical approach. In the analysis we use a number of

alternative estimation procedures to examine the impact of the tuition relief program. In

particular, we use DD, DDD, Matching and DD Matching.

Basic Estimation Methodology

We are interested in understanding the mean impact of "treatment on the treated" or TT,

which is the average impact of the program among those treated (Smith and Todd, 2005). Thus

we use the following DD model to estimate the average treatment on the treated.

$$\Delta Score_i = \alpha + \delta Program_i + \gamma Score\_09_i + \beta X_i + \varepsilon_i \tag{1}$$

where, i is an index for the student, $\Delta Score_i$ is the change of the score of student i between 2009

and 2010; $Program_i$ is the treatment variable (which makes δ the parameter of interest). In our

analysis, $Program_i = 1$ if the student i participated in the program ($Program_i = 0$ if the student i

did not participate in the program). Finally, the term X_i is a vector of covariates that are included

to capture the characteristics of student, his/her parent and household which includes the age,

gender, preschool history, number of siblings of the student, the educational attainment,

occupation, age of the student's father and mother, and wealth status of the household.

It is important to remember that the identification of the causal effect using DD relies on the

"parallel trend" assumption. That is, absent the policy change (or intervention of the program in

our case), the average change in the outcome variable would have been the same for the treated

and the comparison groups.

As might be expected, the effectiveness of DD depends on the validity of this assumption.

In this study, the difference in these differences can be interpreted as the causal effect of the

tuition relief program under the assumption that in the absence of program, the differences in the

test scores of students would not have been systematically different in the treatment and control

groups. This identification strategy might be invalid if the pattern of differences in student scores

varies systematically across counties.

To validate our estimates, we can further draw on the assumption that rich students were

not financially constrained when making decisions to go to senior high school and therefore were

not affected by the tuition relief program. We can thus use rich students as an additional control

group to look at the effect of the tuition relief program on the test score of the poor student who

might be affected by the tuition program. In this way we can define the Difference-in-

Difference-in-Differences (DDD) estimator. The model to be estimated is:

$$\Delta Score_i = \alpha + \delta \Pr ogram_i + \vartheta 1 \Pr ogram_i * Poor_i + \vartheta 2 Poor_i + \gamma Score\_09_i + \beta X_i + \varepsilon_i \quad (2)$$

where $Poor_i$ is the wealth indicator dummy for student i. It equals 1 if the student's asset index

is lower than the median and zero if the asset index is higher than the median. Here $\vartheta 1$ is the

coefficient of our interest.

Sensitivity Analysis

In our paper we also use different methods to obtain more robust findings. To begin with, we use the method of propensity score matching (PSM), an approach that does not require the parallel trend assumption. With a sufficient region of support (or common support), it is possible to estimate the propensity scores of all students and compare the outcomes of students who participated in and students who did not participate in the program that have similar propensity scores.[5]

PSM is a more general method than standard linear regression since it does not require assumptions about linearity or constant treatment effects, and thus improves bias correction. Moreover, imposing common support in PSM can lead to efficiency improvements, especially when the sample size is small. It should be noted, however, that PSM estimates are only unbiased if the unobservables are correlated with the observables upon which the matching is based.

Even though we control for the individual observable differences estimating the propensity score, there may still be systematic unobservable differences between the outcomes of students who participated and students who did not participate in the program. The systematic differences could arise, for example, because the student's decision to participate is based on some unmeasured characteristics. Such differences could violate the identification conditions required for matching (Smith and Todd, 2005).

To eliminate the bias due to time-invariant unobservable differences between students who participated in and students who did not participate in the program, we will extend the cross-sectional PSM approach to a longitudinal setting and implement a difference-in-differences matching (DDM) strategy. With DDM we can exploit the data on the students in the treatment in

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[5] We need to note, however, that a recent study found that the propensity score matching method is sensitive to the covariates used to estimate the scores and that combination of matching with DD was superior (Smith and Todd 2004).

2009 to construct the required counterfactual, instead of just using the data in 2009 (as is used in the PSM analysis). The advantage of DDM is that the assumptions that justify DDM estimation are weaker than the assumptions necessary for DD or the conventional PSM estimator. DDM removes time invariant unobservable differences between students who participated in and students who did not participate in the program conditional on the propensity score to participate in the program, a clear advantage over cross-sectional PSM.[6]

In performing DDM we match by using the log odds-ratios and the same nearest neighbor matching methods with replacement used in our PSM approach. In addition, we will also compute the "adjusted" version where the control units are weighted by the number of times that they are matched to a treated unit. The standard errors are bootstrapped using 1000 replications.

Results

Effect of the Tuition Relief Program: Descriptive Statistics

The descriptive statistics suggest that the Ningshan tuition relief program had a significant impact on students. As discussed above, the baseline test scores of the students in the treatment (54.82) and control group (54.29) were almost the same in 2009 (Table 2, row 1). If one had just looked at the rise of test scores of the control group (the endline score was 69.55, significantly higher than the baseline by 15.26 points—column 3, rows 2 and 3), one might be tempted to say that students were still learning better despite knowing that they would have to pay high levels of tuition in senior high school. However, when comparing the performance of the treatment and control students, it can be seen that the improvement in test scores of the control students was less than the progress made by the treatment students. The mean of the

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[6] Using outcomes from experimental data as a benchmark, Smith and Todd (2004) found that DDM performed better than DD or PSM methods.

endline test scores of the treatment students was 73.19 (column 2, row 2). This was 18.37 points higher (and statistically significant) than the baseline (row 3). Most importantly, the rise in the tests scores of the treatment students (18.37) was higher than the rise of the test scores of the control students (15.26—row 3). Moreover, the 3.11 point higher rise in the test scores of the treatment students is statistically different at the 1 percent level of significance (column 4). From these basic descriptive statistics, it appears as if the Ningshan Tuition Relief program succeeded in stimulating the interest/effort of the average student in Ningshan relative to the average students in Shiquan and Hanying.

Since poor students are more likely to be financially constrained (indeed the tuition relief program is primarily motivated by the benefit it will bring to the children of poor families), we are interested in knowing if students from poor families are likely to be most affected by the program. To test this proposition, we divided the sample of students in the study counties into five equal sized groups (from poorest to richest), based on a ranking by their asset index. When examining the descriptive statistics, we find that while the poor did benefit, it appears that all students, whether rich or poor, benefited from the tuition relief program. According to Table 3, the test scores of all the students in each of the wealth status groupings rose between the baseline and endline surveys (column 7).

While Table 3 demonstrates that students in all Wealth Categories that enjoyed tuition relief (those in Ningshan County) benefited, the average point rise in some increased more than others. A little surprisingly, the richest students seemed to benefit most from the program. After the program, the difference in the rise of score between the two groups was 4.38 points (column 7, row 5). This does not mean that the poorest students did not benefit. In fact, ignoring the scores of the students in the richest categories, the poorest students saw their average scores rise

the most (the difference in the rise between the treatment group and control group was 3.82—row 1). The puzzle arises in the nonlinearity from the poorest to the richest. The second poorest students seem to benefit least from the program since the difference in the rise between the treatment and control groups was only 1.17 points (column 7, row 2). After this (as one moves from the second to the fifth group), scores generally rise (rows 3 to 5).

Why is it that we see that the richest students are responding most to the program? There are two possible explanations. First (potential explanation 1), in Table 3, we are looking only at descriptive statistics. As such, we are only comparing trends in single variables (that is, they are not conditioned on other factors). Hence, it could be that the rises in the scores of the richer students are due to factors that are enjoyed by the richer students, which are in turn correlated with the treatment (in this case enjoyed by richer students in Ningshan), but actually unrelated to the treatment. Second (potential explanation 2), it could be that the treatment is actually triggering a response among richer students that is leading to higher test scores. For example, it might be that the richest students, who heretofore have not had to compete with poorer students (since poorer students were effectively rationed out of going to senior high school by the high tuition rates) begin to realize that they are losing one of the advantages that they have had in the past in gaining entrance to high school. In response, it could be that they began to work harder. While we are never able to fully isolate the reason, in the next section we seek to control for the number of the observable characteristics of students (using the regression models spelled out from model (1) to model (4)). If we control for factors as many as possible that differ between poor and rich students (e.g., the educational levels of their parents, etc.), we may be able to validate or invalidate potential explanations. Unfortunately, since the motivation that drives the

potential explanation is not observable, we will not ever be able to confirm exactly what is driving our findings.

In sum, based on the descriptive statistics, the tuition relief program seems to increase the academic performance of students in the treatment schools. However, the effect of this program differs across different students in terms of wealth status, and while the poorest students do gain from the program, the richest students are, surprisingly, gaining most from the program.

Effect of the Tuition Relief Program: Multivariate Results

When analyzing the effect of the tuition relief program using a multivariate approach based on equations 1, the results are largely consistent with the descriptive statistics in terms of the overall impact (Table 4). According to our analysis (and consistent with the findings in Table 2), there is a positive and statistically significant impact of the tuition relief program on the test scores of students. In the estimation of equation 1, the results demonstrate that the estimated treatment effect of the tuition relief program on math test scores is equal to 0.17 standard deviations and the impact is significant at 0.05 level[7] (row 1, columns 1). That is, when we use a Difference in Differences approach, we find that the tuition relief program has had a positive and significant effect on improving the academic effort (as measured by the scores of the standardized tests) of the average student.

Importantly, the results of our findings of the multivariate analysis when we examine the effect of the tuition program on the poorest students in the sample (those with the lowest Asset Indices) differ from the descriptive findings. As seen in Table 4 (Column 2), when we control for all of the covariates and then add an interaction terms between the treatment variable (Tuition

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[7] Because there may be too few clusters to run the regression this way, we executed the bootstrapping tests as delineated in Cameron, Gelbach and Miller (2008). When doing so, we find that the bootstrapping results are similar to the results from the regression approach (the estimated effect of the tuition relief policy is still significant at the 1% level). We thus find that the Tuition Relief Program reduces significantly drop outs from junior high school. Full results are available from the authors on request..

Relief Program dummy) and a dummy variable representing the poorest students, we find that the program's effect is primarily on the poor. This result may have been "disguised" when only examining the descriptive statistics. Specifically, while the average treatment effect (which in this case is the average treatment effect for all of the students except the poorest) is still positive (0.14), the standard error is relatively large. In other words, we cannot reject the hypothesis that the tuition relief program's effect on all but the students in the poorest asset category is zero. However, the positive (and large) coefficient on the Poorest * Program interaction variable (0.23) means that the test scores of the poorest junior high students are 0.23 standard deviations higher (and significantly so) than that of other students. Hence, if the multivariate results are to be taken seriously, the results as a whole (that is, both descriptive and multivariable one) demonstrate that the tuition relief program increased student academic performance in junior high. More importantly, the poorest students, or those who were most likely to be from families that were financially constrained, benefitted most from the program.

Effect of the Tuition Relief Program: Matching Results

As mentioned, a difference-in-differences methodology relies on assumptions of parallel trends. That is, we assume that students in Ningshan (the treatment county) would have improved at the same rate as students in Hanyin and Shiquan had there been no policy. However, some may argue that Ningshan County may be unique. For example, Ningshan students (and in particular poor students in Ningshan) may be receiving more attention in junior high school and—even without the tuition relief policy—would have improved their test scores at a higher rate. In order to examine the robustness of our results using other approaches, in this section we employ PSM and DDM analysis to see if results from these different estimation strategies are consistent with those from the DD estimates above.

In fact, the results of both PSM and DDM analysis are qualitatively identical and quantitatively similar with the DD results[8] (Table 5). Rows 1 to 3 present the estimated average treatment effects on the treated (ATT) of different treatment groups. Columns 1 and 2 show the estimation results from PSM and DDM respectively. The PSM results show that the program has a positive effect on the math scores of the average students in Ningshan (compared to the average students in the control counties). The effect is 0.18 standard deviations and significant at the 1% level (Row 1). Likewise, when using Difference in Difference Matching (DDM), the average treatment effect is 0.15 standard deviations and significant. As seen, the average impact on test scores when using PSM (0.18) and DDM (0.15) is close to and brackets the average impact when using DD by itself (0.17).

The results of the PSM and DDM also reveal that the greatest impact of tuition relief appears to be on the scores of the poorest students (Table 5, rows 2 and 3). When we use PSM, the average test scores of the poorest students in the treatment group improved by 0.28 standard deviations when compared to the poorest students in the control group. Moreover, this result is statistically significant (row 2, column 1). By contrast, although the point estimate of the impact of the tuition relief program on the richest students in the treatment group improves by 0.12 standard deviations relative to the richest students in the control group, the gain is statistically insignificant (row 3, column 1). Echoing these results, the difference-in-differences matching results show that the tuition relief program has a statistically significant impact on the test scores

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[8] We achieve good balance between the treatment and control groups after matching. The standardized percent bias (see Rosenbaum and Rubin, 1985) for each of the covariates across our matched treated and control groups is small, especially for the covariates that have a relatively large difference in treatment and control means (a large bias) in the pre-matched sample. The standardized percent bias (for each covariate) is defined as the % difference of the sample means in the treated and non-treated (full or matched) sub-samples as a percentage of the square root of the average of the sample variances in the treated and non-treated groups (see Leuven and Sianesi, 2003). Full results are available from authors upon request.

of junior high students. Moreover, this impact is significant for the poorest students, but the program seems to have no effect on the richest students (column 2, rows 2 and 3).

In sum, all three estimation strategies show that the program improves junior high students' math scores by more than 3 points. Moreover, the poorest students are indeed benefitting from the program. The only discrepancy is that the difference-in-differences results suggest that the richest students gained most from the program, whereas the PSM and DDM results suggest that the richest students may not have benefitted.

Effect of the Tuition Relief Program by Test Scores

In one final empirical exercise we further narrow the impact of the tuition relief program. This last exercise tests a hypothesis that is motivated by taking into account both the institutional realities of China's competitive schooling system and observations on the behavior of parents and students within the competitive system. Specifically, in this section we want to test the hypothesis that the one of the largest impacts of the tuition relief program might be expected to appear on the students in the middle of the test score range (that is, not on the worst students or the students with the lowest test scores, and not on the best students, but rather on the students in the middle of the test score distribution).

This exercise is motivated by the fact that—even if senior high school were free— China's high schools still require students pass a competitive entrance exam. If a student's test score is too low (indicating that the student is among the poorest performing students in the county), the student would have little hope of getting a score high enough to enter high school even if he/she worked harder (because of the tuition relief program). This would be especially true of the poor (and perhaps less true for the rich who are able to purchase points to raise the effective scores for entering high school). Alternatively, if the student is among the best in the

county, even when families are poor (and certainly when they are rich), there seems to always be a way that families can find the resources to get keep their child in school. Indeed, in a number of recent studies (e.g., Wang et al., 2011), it was found that high performing children—even those that are among the poorest—find a way to keep going to school. By this logic, poorly performing students have given up and the best performing students already have decided to go to high school no matter the cost. Hence, it seems from this discussion that a tuition relief program might be expected to not only have the largest effect on the poor, it might have an even larger effect on students from poor families that score in the middle of the test score distribution.

In fact, when we look at Table 5, the PSM results show that the program has a positive effect on the math scores of the poorest students who scored in the middle of the test score range in Ningshan (compared to the poorest students who scored in the middle in the control counties). The effect is 0.43 standard deviations and significant at the 5% level (Row 4). Likewise, when using Difference in Differences Matching (DDM), the average treatment effect is 0.37 standard deviations and significant. In sum, both PSM and DDM results show that the tuition relief program improves the score of poorest junior high students who score in the middle of the test score distribution.

Summary and Discussion

In this paper we have exploited a quasi experiment to examine the effect of a senior high tuition relief program on junior high students in poor, rural schools in Shaanxi province in China. Seeking to understand whether a tuition relief program improved the academic performance of junior high students, we compared seventh grade students in Ningshan County, where a tuition relief program was implemented, to seventh graders in nearby Shiquan and Hanyin counties. We

fielded a survey and administered a standardized math examination, then analyzed these data using varied estimation strategies, including Difference-in-Differences, Difference-in-Difference-in-Differences, Propensity Score Matching, and Difference-in-Difference Matching.

The descriptive and econometric results of the program effect were robust. In general, we found that the Ningshan tuition relief program positively impacted students' academic performance. Indeed, in the descriptive results and all of the models, we discovered a statistically significant rise in the change of the math scores between the control and treatment students.

More importantly, we also found (in all of the different approaches using the multivariate analyses) that the tuition relief program had the largest (and only) significant impact on poorest students. In short, and perhaps unsurprisingly, our findings demonstrate that the test scores of poorest students rose more (and significantly so) than that of other non-poor students. Our data also show that the tuition relief program did not have a statistically positive impact on the richest students, who are seldom financially constrained when making decisions whether to go to senior high school or not. This result renders additional support to the validity of the assumption in the DD analysis.

Taken together, these results may suggest that poor students work harder when they realize their families can afford high school tuition. However, it is important to realize that other potential mechanisms exist: teachers—whose wages are linked to student matriculation in highly ranked high schools—may invest more time teaching poorer students who would have otherwise dropped out after ninth grade due to financial reasons. Whatever the mechanism, the tuition relief program clearly and positively impacts students' academic performance far before ninth grade. The final results of the paper also suggest that the impact is even more narrowly focused on

students in the middle of the grade distribution. As such, if China wants to encourage students—even poorly performing students—to stay in school, other means need to be used.

As cautioned above, our conclusions must be tempered by the limitations of this study. Even though we drew upon multiple estimation strategies that consistently pointed to the positive impact of the Ningshan tuition relief program, we believe that it is important to carry out further studies in order to confirm the robustness of the findings of this quasi experiment. Additionally, as a program implemented in only one county, we are limited in the generalizations we can make from the study. Even if students in Ningshan benefitted from the program, the fact is that it might be a result that is unique to this one county.

Nonetheless, to our knowledge, this is the only study that explores the impact of a tuition relief program in China. Moreover, this study shows that a tuition relief program in senior high school has impacts as early as seventh grade. To truly improve the odds of poor rural students in their senior high school participation, strategies that have impacts early in students' educational careers are particularly important. By reducing the academic performance gap early in students' career, poor students have a much better chance at senior high participation.

Finally, the results of this study contribute to a broader policy debate about how to effectively invest in rural education. Recently there has been an increasing support in the Ministry of Education (MOE) for greater investment into rural education. Opinions are divided on how money should be invested. Our results suggest that China's top educational officials should at least provisionally expand tuition relief programs in poor rural areas as an additional way to improve the human capital in rural areas. If future evaluations of tuition relief programs also show results consistent to ours, China should consider waiving senior high tuition for all poor students.

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Table 1. Sample Average for the Students in the Treatment Group and Control Group in 2009 [a]

		(1)Treatment group	(2)Control group	(3) Difference in mean (1)-(2)
(1)	Raw math test score in 2009 (full score=100)	54.82 (15.29)	54.29 (17.33)	0.54 (0.72)
(2)	Age of the student (year)	12.92 (0.81)	13.06 (1.00)	-0.14 (3.28)***
(3)	Boy Student (%)	49.18 (0.50)	53.20 (0.50)	-4.02 (1.81)*
(4)	Student attended Kindergarten (%)	16.47 (0.37)	15.15 (0.36)	1.31 (0.82)
(5)	Student attended the Preschool (%)	93.26 (0.25)	93.19 (0.25)	0.07 (0.06)
(6)	Student without any sibling (%)	28.27 (0.45)	25.89 (0.44)	2.38 (1.21)
(7)	Age of the father (year)	39.48 (4.78)	40.62 (5.08)	-1.14 (5.02) ***
(8)	Age of the mother (year)	36.73 (4.26)	37.64 (4.72)	-0.91 (-4.34) ***
(9)	Father completed the middle school, (%)	44.13 (0.50)	38.33 (0.49)	5.79 (2.65) ***
(10)	Mother completed the middle school, (%)	36.87 (0.48)	24.52 (0.43)	12.35 (6.16) ***
(11)	Father mainly worked in agriculture (%)	33.04 (0.47)	30.10 (0.46)	2.94 (1.43)
(12)	Mother mainly worked in agriculture (%)	51.34 (0.50)	49.86 (0.50)	1.48 (0.67)
(13)	Number of family members (person)	4.25 (1.07)	4.47 (1.15)	-0.23 (4.42) ***

Data: Authors' survey.
Note:
a. Standard deviations are reported in parentheses for columns (1) and (2);
absolute values of t-statistics are reported in column (3);
* significant at 10%; ** significant at 5%; *** significant at 1%.

Table 2. Change in Student Math Score between 2009 and 2010 [a]

		Full Sample	Treatment group	Control group	Difference (t-statistics in parenthesis)	
		Panel A Change in Raw Math Score				
		(1)	(2)	(3)	(4)=(2)-(3)	
(1)	Mean Score in 2009	54.42	54.82	54.29	0.53	(0.72)
		(16.85)	(15.29)	(17.33)		
(2)	Mean Score in 2010	70.44	73.19	69.55	3.64	(4.96)***
		(16.61)	(15.49)	(16.87)		
(3)	Difference=(2)-(1) (t-statistics in parenthesis)	16.02 (35.45) ***	18.37 (21.88)***	15.26 (28.71)***	3.11	(2.96)***
		Panel B Change in Normalized Math Score [b]				
(4)	Mean Score in 2009		0.02	-0.01	0.03	(0.72)
(5)	Mean Score in 2010		0.17	-0.05	0.22	(4.96)***
(6)	Difference=(2)-(1) (t-statistics in parenthesis)		0.15 (2.82) ***	-0.04 (1.45)	0.19	(2.99)***

Data: Authors' survey.
Note:
a. Standard deviations are reported in parentheses in row (1) and (2); and absolute values of t-statistics are reported in parentheses in row (3) and column (4). * significant at 10%; ** significant at 5%; *** significant at 1%.
b. The normalized scores were created by subtracting the average test score in one year of all sample students from the test for each student and then dividing each score by the standard deviation of the test scores of all sample students in the same grade.

Table 3 Change in Student Math Score between 2009 and 2010 by Wealth [a] 2009, Shaanxi Province, China

		Treatment Group			Control Group			(7)	
		(1)	(2)	(3)	(4)	(5)	(6)		
		Score in 2009	Score in 2010	Diff.=(2)-(1)	Score in 2009	Score in 2010	Diff.=(5)-(4)	Diff.=(3)-(6)	
				Change in Raw Score by Wealth					
(1)	Poorest	54.86	75.00	**20.14**	51.99	68.31	**16.32**	**3.82**	(1.81) *
(2)	Second	55.34	73.53	**18.20**	52.86	69.88	**17.02**	**1.17**	(0.69)
(3)	Median	55.43	73.15	**17.72**	55.13	69.13	**14.00**	**3.72**	(2.35) **
(4)	Fourth	52.68	71.60	**18.92**	54.30	69.69	**15.39**	**3.52**	(2.22) **
(5)	Richest	56.22	73.93	**17.70**	57.57	70.89	**13.32**	**4.38**	(2.39) **
				Change in Normalized Math Score by Wealth					
(6)	Poorest	0.03	0.28	0.25	-0.14	-0.12	0.02	**0.23**	(1.84) *
(7)	Second	0.05	0.18	0.13	-0.09	-0.03	0.06	**0.07**	(0.71)
(8)	Median	0.06	0.16	0.10	0.04	-0.08	-0.12	**0.22**	(2.37) **
(9)	Fourth	-0.10	0.07	0.17	-0.01	-0.05	-0.04	**0.21**	(2.22) **
(10)	Richest	0.11	0.21	0.10	0.19	0.03	-0.16	**0.26**	(2.39) **

Data: Authors' survey.

Note:

a. Asset Index is created to measure the wealth using principle component analysis. To be specific, following the method by Filmer and Pritchett (1998), we use the scoring factors from the first principal component to create the asset index. It is in fact a weighted average of the observed 30 variables of assets and variables with higher coefficients have more weight in determining the score on this component. The higher the asset index is, the wealthier the household is. In Panel A and B, the sample students are divided into five groups based on the asset index, ranging from the poorest to the richest.

b. Absolute values of t-statistics are reported in parentheses in column (7). * significant at 10%; ** significant at 5%; *** significant at 1%.

Table 4 Difference-in-Differences Regressions Evaluating the Effects of Tuition Relief Program on the Normalized Math Score of the Average Students and the Poorest Students, Shaanxi Province, China [a]

		(1)	(2)
	Dependent Variable ($\Delta Score_i$) = $Score_{i, 2010} - Score_{i, 2009}$		
(1)	Program dummy (1=participated in the program)	0.17 (5.65)**	0.14 (1.50)
(2)	Poorest dummy [b] (1=Poorest)		-0.04 (0.73)
(3)	Interaction term of Poorest and Program dummy (Program*Poorest)		0.23 (2.99)***
(4)	Normalized Math score in 2009	-0.58 (24.50)***	-0.58 (28.85)***
(5)	Age of the student (year)	-0.13 (5.16)**	-0.13 (6.25)***
(6)	Gender dummy(1=boy,)	0.16 (4.46)**	0.16 (2.95)***
(7)	Kindergarten dummy (1=attended the kindergarten,)	0.11 (0.98)	0.11 (1.87)*
(8)	Preschool dummy (1= attended preschool)	0.18 (0.98)	0.18 (2.02)*
(9)	One child dummy (1= one child)	-0.08 (1.33)	-0.08 (1.35)
(10)	Age of the father (year)	0.01 (1.36)	0.01 (1.31)
(11)	Age of the mother (year)	-0.00 (2.61)	-0.00 (0.86)
(12)	Education dummy for father (1= father completed middle school)	0.05 (1.99)	0.05 (1.23)
(13)	Education dummy for mother (1= mother completed middle school)	0.06 (1.10)	0.06 (1.28)
(14)	Occupation dummy for father(1=work in agriculture)	-0.05 (1.64)	-0.05 (0.89)
(15)	Occupation dummy for mother(1=work in agriculture)	0.03 (0.54)	0.03 (0.61)
(16)	Number of family members (person)	0.00 (0.26)	0.00 (0.14)
(17)	Second poorest dummy [c] (bottom 20%- bottom 40%)	0.03 (0.53)	
(18)	Median dummy [c] (bottom 40%- bottom 60%)	-0.01 (0.20)	
(19)	Second richest dummy [c] (Top 20%- Top 40%)	0.01 (0.08)	
(20)	Richest dummy [c] (>Top 20% quintile)	0.00 (0.02)	
(21)	Observations	2264	2264

(22) R-squared	0.31	0.31

Data source: Authors' survey.

Note:

a. The dependent variable is the change in the normalized math test score.

Absolute values of t-statistics are in parentheses. *Significant at 10%; ** significant at 5%; *** significant at 1%

b. The poorest dummy is the same as table 3. It equals 1 if the asset index of the household is among the bottom 1/5.

c. The dummies indicating the wealth are the same as table 3 and the comparison group is the poorest (bottom 0-20%) students.

Table 5. Evaluating the Effects of Tuition Relief Program on the Efforts of Students in using Propensity Score Matching and Difference-in-Difference Matching, Shaanxi Province, China [a].

		Propensity Score Matching [a,b]		Difference-in-Difference Matching	
		(1) Average Treatment Effect for the Treated	t-stat/ z-value [b]	(2) Average Treatment Effect for the Treated	t stat/ z-value [b]
(1)	Students in the treatment group Vs. Students in the Control group	0.18	(2.95) ***	0.15	(2.42) ***
(2)	Poorest students in the treatment group Vs. Poorest students in the Control group	0.28	(1.80)*	0.28	(1.69)*
(3)	Richest students in the treatment group Vs. Richest students in the Control group	0.12	(0.82)	0.08	(0.53)
(4)	Poorest Students scored at the average (20-80%) in 2009 in the treatment group Vs. Poorest Students scored at the average (20-80%) in 2009 in the comparison group	0.43	(2.04)**	0.37	(1.88)*

Data: Authors' survey.
[a] Propensity scores are estimated using the same set of covariates as in Table 4. And In all the cases, the balancing property is satisfied.
And poorest students are the students whose asset value is the lowest (0-20%) among all students.
[b] The matching method used is nearest neighbor matching method (random draw version) with replacement. And the balancing property was satisfied with the following specification
c. t statistics are reported for propensity score matching. The standard errors were bootstrapped using 1000 replications. * denotes significant at 10% level, ** denotes significant at 5% level, ***denotes significant at 1% level.

Baseline (Sept. 2009)

All 6 junior high schools in the County of Ningshan (treatment Group) and all 30 junior high schools were selected in the County of Shiquan and

Within each school, in the County of Ningshan all 20 classes were selected and in the County of Shiquan and Hanyin, 49 classes were randomly selected. And within each class, all the students were surveyed (In total, there are 3121 students).

49 classes in the control group (2356 students)

20 classes in the treatment group (765 students)

Follow-up (Sep. 2010)

Attrition: 286 students

Attrition: 93 students

Analysis

2070 students analyzed

672 students analyzed

Figure 1: Experiment Profile