

## Research Proposal:

# Impact of school bus system on health and education outcomes in rural Shaanxi, China

## Motivation

Huge gaps in human capital are emerging in China. Rapidly growing coastal areas develop world-class universities but in lagging interior regions, less than five percent of students from poor rural areas attend university (Wang et al. 2011). Problems start as early as primary school, where rural students have to commute to larger centralised primary schools in towns and county seats. As many poor, rural families cannot afford this daily commute, students have to board at these schools, from as young as age five.

In the Shaanxi province, 45 per cent of schools in poor areas are boarding (Luo et al. 2009). However, many primary schools with boarding facilities lack designated professionals in charge of dormitories. The safety, hygiene, supervision, diet and nutrition of children are all serious problems at these boarding schools. Research at Stanford University shows negative effects of boarding on children's emotional and physical needs, which in turn affects their educational learning. Carefully conducted, randomised-control trials have shown that the nutrition and health of boarding students is much worse than that of day students (Luo et al. 2009).

Studies by Yue et al. (2012) find that with an improvement in supervision of dormitory students, there are significantly lesser student misbehaviours and tardiness after class. Not only does being in a new environment in boarding schools take a toll on the psychological and physical health of students, Luo et al. (2009) argue that boarding school students are more likely to be anemic, which is likely due to poor diet. The Rural Education Action Program (REAP) finds that the national intervention of providing one egg a day, while nutritious, is not enough to significantly decrease anemia rates in rural China. A parallel REAP study shows that chewable multivitamins are more effective in tackling malnutrition to improve educational performance. Sylvia et al. (2013) report that direct rewards for anemia reduction nearly doubles the impact on education outcomes.

A proper school bus service could enable children to attend centralised schools while still living with their families. Currently, China has an unregulated industry of over-crowded minibuses driving children to private kindergartens and schools, with a tragic record of fatal crashes. However, with a proper, state-funded, and regulated school bus system, results could be rather different, as the experience of countries like Australia, New Zealand and the United States has shown. A proper, state-funded, and regulated school bus system will result in improved academic performance, improved nutrition and better psychological health, all of which lead to higher chances of completing school and attending university, and are ultimately rewarded in the labour market.

## Policy intervention

This study assesses the impact of providing school bus systems in primary schools on students' nutrition and school performance, and simultaneously increasing demand for school buses using non-cash and cash incentives.

The intervention will be evaluated in four sample counties in Northern Shaanxi, China. Using information from Olivia et al. (2011), figure 1 shows the predicted poverty rates of the sample counties and townships in the Rural Household Income and Expenditure Survey (RHIES) in Shaanxi. The four sample counties chosen have predicted poverty rates of more than 50 per cent in the Yan'an prefecture (darkest shaded areas).

The 240 primary schools are randomly divided into two groups. In each of the sample counties (Yanchuan, Yanchang, Luochuan, and Yichuan), the research team randomly selects 60 primary schools – 30 of which are to receive school bus services (treatment group), while the other 30 schools serve as the comparison group.

**Treatment group:** The team will inform principals in sample schools about providing school bus services, and connect bus services (Shaanxi Automobile Group) to these schools. Within the treatment group of 30 schools in each county, all grade 1 (G1) and grade 3 (G3) students from 50 per cent of the treatment schools will receive the information treatment; and stratified by the distance from home to school, 50 per cent of 'G1' and 'G3' students from all treatment schools will receive the financial intervention. There will be three stratified groups: (a) living within five km from school ('near'); (b) living between five and ten km from school ('mid'); and (c) living more than ten km from school ('far').

*Financial treatment:* Within 50 per cent of 'G1' and 'G3' students from all treatment schools, parents will be randomly provided with cash, ranging from CNY10 to CNY45<sup>1</sup> (US\$1.65 to US\$7.40), when parents register their children to the school bus service. The financial incentives are reasonable given that the average rural net income is approximately CNY660 per month<sup>2</sup> (US\$108).

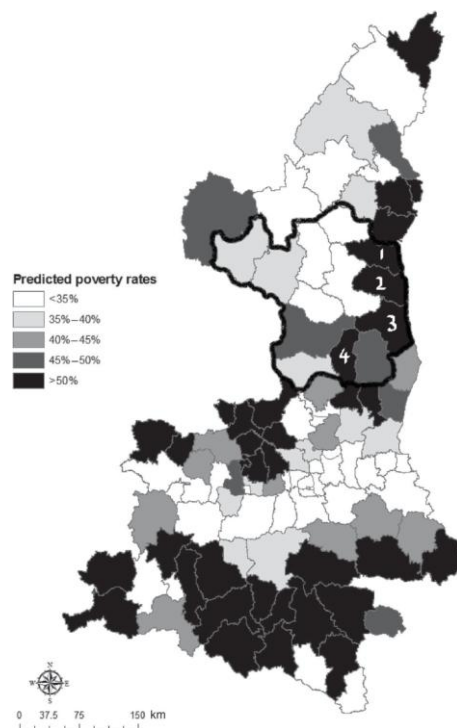
*Information treatment:* A letter with information about the boarding situation and the benefits of taking school buses will be sent to parents of 'G1' and 'G3' students. Information included will be the share of enrolled students who are anemic or have behavioural problems; details about boarding situation – conditions of schools, nutrition provided in canteens; and details about boarding condition's and anemia's relationship to school attendance, educational performance, and cognitive development.

**Existing programs in Shaanxi Province:** A randomised control trial (RCT) in Shaanxi Province reports that the students in treatment group receiving a daily multivitamin with mineral supplements (MMS) improved significantly in their anemic situation and in the test for anxiety (Zhang et al. 2013). To control for this existing program, I randomly select a

**Figure 1. Predicted poverty rates with environmental variables**

**Note:** Outlined area is the Yan'an prefecture in the Shaanxi province. The sampled counties are: (1) Yanchuan county, (2) Yanchang county, (3) Yichuan county, and (4) Luochuan county.

**Source:** Olivia et al. 2011, 'Mapping poverty in rural China: How much does the environment matter?'



<sup>1</sup> According to Sylvia et al. (2013), who conducted a RCT in Qinghai and Ningxia Provinces (rural Northwest China), CNY1.5 (about US\$0.22) per day is sufficient to buy two to three ounces (55 to 85 g) of red meat in local markets (p. 5).

<sup>2</sup> According to Zheng (2013), per capita rural net income in 2012 was CNY7,917 (US\$1300).

small, even number of schools with MMS programs, assigning half with information intervention, and the other half without. I then select the same number of schools without MMS programs – matched paired with similar characteristics, and then assign half with information intervention, and the other half without.

**Control group:** With the other 30 comparison schools in each county, 'G1' and 'G3' students will have their baseline and evaluation health status and performance monitored by the research team.

**Evaluation:** The first evaluation will take place one year after the start of the program. Evaluation surveys will test the effects of school bus uptake on the cognitive, psychological, behavioural and physical development of primary school students. The next evaluations will occur annually for the next three years, evaluating the same cohort of grade 1 and grade 3 students. This intervention will last for four years.

**Expected outcomes:** The expected impact of taking school buses on school performance and nutrition should be positive, and increasing over the four years. As most psychological and behavioural problems occur at early stages of childhood, the benefits of taking school buses earlier in the childhood years will have a greater impact on the cohort of 'G1' students, compared to the cohort of 'G3' students.

## Research question and Hypothesis

This research project will ask two questions:

School bus uptake: What might be the patterns and determinants of school bus uptake?

*Testable hypothesis:* There will be varying patterns and determinants across groups. The distance from home to school will have differential impact on school bus uptake.

Impact of school bus uptake: What is the impact of school bus uptake on students' nutrition and school performance?

*Testable hypothesis:* The improvement on students' nutrition and school performance will increase over the four years, and will have greater impact on the younger cohort.

Key outcomes for impact assessment related to the above questions include school bus uptake, cognitive, psychological and behavioural test results, and hemoglobin levels in the short and medium terms.

## Research design and Methodology

**Empirical model and methodology:** This research is an impact evaluation and the design will be a randomised controlled experiment. Simply randomising schools, stratified by counties, for providing school bus services will result in selection problem at the household level as students and households can choose to take the bus service or not. Therefore, by creating two instruments, randomising "encouragement for bus uptake" will solve self-selection and should give an unbiased estimate of the impact. The two  $Z_i$  created are: financial intervention (CNY10-45, household level); and information intervention (50% of treatment schools).

### 1) Summarise data:

Compare baseline (pupil, school, teacher and family) characteristics between the pupils in the treatment and control schools. Compare hemoglobin levels (health outcome) and cognitive, psychological and behavioural test scores (education outcomes) between pupils in the

treatment and control schools; and between the assigned and actual treated pupils within the treatment schools.

**2) 2SLS (1st stage) - To measure the impact on school bus uptake:**

$B_{sit} = \alpha + \beta_1 F + \beta_2 I + \beta_3 (F * I) + d_1 far + d_2 mid + \sigma Home_i + \gamma V_i + \delta X'_{sit} + \theta C'_{sit} + \epsilon_{sit}$   
 where  $B_{sit}$  is the dummy variable of individual  $i$  in school  $s$  taking school bus services;  $F$  and  $I$  are the dummy variables for receiving the financial and information treatments, respectively;  $far$  and  $mid$  are the dummy variables for students living 'far' (>10 km) and 'mid' (5-10 km) from school, respectively;  $Home_i$  is the dummy variable for students with both parents at home (parents' migration status);  $V_i$  is the distance from home to the bus stop;  $X_{sit}$  are school, pupil, teacher and family characteristics; and  $C_{sit}$  are region-specific characteristics.

**3) 2SLS (2nd stage) - To measure the impact of school bus uptake on education and health output:**

*Intention-to-treat effect:*  $Y_{sit} = \alpha + \beta T_{st} + \delta X'_{sit} + \theta C'_{sit} + \epsilon_{sit}$

where  $Y_{sit}$  is the individual health or education outcome, where  $s$  refers to the school,  $i$  to the student, and  $t \in \{1, 2, 3, 4\}$  is the year of the program;  $T_{st}$  is the indicator variable for school assignment of school bus services, respectively. Here,  $\beta$  is the program impact in treatment schools.

*Treatment-on-the-treated effect:*

$Y^z_{si(t+z-1)} = \alpha + \beta^z_1 B_{sit} + d_1 MMS + c^z_2 (B_{sit} * MMS) + d_2 far + c^z_3 (B_{sit} * far) + d_3 mid + c^z_4 (B_{sit} * mid) + d_4 G1 + c^z_5 (B_{sit} * G1) + \delta X'_{sit} + \theta C'_{sit} + \sigma^z G'_{si(t+z-1)} + \epsilon_{sit}$

where  $z \in \{1, 2, 3, 4\}$  is the number of years since the start of the program;  $MMS$  is the dummy variable for schools with Multiple Micronutrient Supplementation (MMS) programs;  $G1$  is the dummy variable for students in grade one; and  $G_{sit}$  are time-varying characteristics.

Here, for one to four years since the start of the program:  $\beta^z_1$  are the direct effects of the treatment on the treated (TT) on students in non-MMS schools, students 'near' from school, and the 'G3' cohort. Relative to the 'base' dummies,  $c^z_2$  are the direct effects of the TT in MMS schools;  $c^z_3$  and  $c^z_4$  are the effects of the TT for students living 'far' and 'mid' from school, respectively; and  $c^z_5$  are the effects of the TT for the 'G1' cohort.  $Y^z_{si(t+z-1)}$  are the education or health outcome.

**Data collection:** From an initial canvas survey, enumerators will first identify all rural primary schools satisfying three requirements: (a) including six grades (*wanxiao* – complete schools from grade one to six); (b) having boarding facilities; (c) enrolling a minimum of 150 students, including at least 50 boarding students. Schools selected for inclusion in the study will be allocated randomly to control and treatment groups.

School bus uptake will be collected after two weeks of the "encouragement" interventions. To establish a baseline of health and learning abilities, the data collection instruments include: cognitive (math) and psychological tests; behavioural records; 24-hour food (nutrition) intake recalls; student, household, teacher surveys, and school surveys. Additionally, hemoglobin levels will be measured by a finger-prick HemoCue Hb 201+ blood test, which will be administered by certified professional nurses. The HemoCue Hb 201+ system is known to provide rapid, in-the-field measurements of Hb levels with high degrees of accuracy. These instruments are repeated for end-line data collection.

- *Standardised math test:* Based on questions drawn from a pool of questions that were originally created for the Trends in International Maths and Science Study (TIMSS). Enumerators are required to finish the 29-questions test in 30 minutes, without any extra time given.
- *Primary school surveys:* Enumerators collect information from principals about (a) nutritional characteristics of school meals, and (b) school characteristics.
- *Household surveys:* Enumerators visit each child's home and interview their parents, collecting information about (a) household socio-economic characteristics, (b) individual health behaviours, (c) nutritional characteristics of household meals, and (d) distance away from home to school and to bus stop.

## Expected outcomes and potential challenges

### Expected outcomes:

RQ1. School bus uptake:  $\beta_1$  and  $\beta_2$  will be positive and significant, which means that there is a higher chance of households receiving these interventions to uptake school bus services.  $d_1$  may be negative as students living 'far' from school would be less likely to uptake bus relative to students living 'near'.  $d_2$  will be positive as students living 'mid' from school is more likely to uptake bus relative to students living 'near'.  $\sigma$  will be positive as households with both parents staying at home will increase the likelihood of bus uptake.  $\gamma$  will be negative as the smaller the distance from home to bus stop, the more likely students will take the bus.

RQ2. Impact of school bus uptake:  $\beta_1^z$  will be positive, significant and increasing over the four years, as taking school bus daily should increase health and education outputs, and the results should incrementally increase as the period of time the student has taken the bus increases.  $c_2^z$  will be positive and increasing over time, as students in MMS schools will have higher results, and their results should increase much greater than non-MMS schools over time due to lower rates of anemia (better concentration at school).  $c_5^z$  will be small and insignificant for the first year, but will be positive, significant and increasing over time, as the younger cohort, with lesser behavioural and psychological problems compared to the 'G3' cohort, will have better results than 'G3' cohort, the longer the students take the bus.

### Potential challenges:

- Students assigned to comparison schools could potentially transfer to treatment schools to receive school busing services through the program. However, I can use an intention-to-treat estimation strategy, in which students are assigned the treatment status of the school in which they were initially enrolled in even if they switched schools later, to address *potential transfer bias*.
- There might be *potential outliers*. Students living too far away from school might find that the cost of taking school bus (accounting for travel time cost) exceeds the cost of boarding.
- Another potential challenge is *attrition bias*. With the program lasting for four years, it is expected that there will be some students who choose to drop out from the treatment schools. This can be due to unforeseen circumstances such as the family experiencing a shock, where the children are needed to stay at home or go to work.
- The information intervention for "encouragement for bus uptake" will have *spillover effects*, as households will talk about the benefits of school bus system to neighbours.
- It will be difficult to convince principals of treatment schools to agree to school bus services, as well as allowing the team to write a letter to parents about the boarding situation, due to *moral issues*.

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