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**Health Care for One Billion:  
Experimenting with Incentives for the Supply of Health Care in Rural China**

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## **Health Care for One Billion: Experimenting with Incentives for the Supply of Health Care in Rural China**

### **Abstract**

Despite successful economic reforms over the past two decades, China's health care system for the nearly one billion people that live and work in rural areas is broken. Having admitted that there is a crisis, the government is now committed to looking for solutions. In this proposal, we have two overall goals to help provide insights on part of the solution. **Our first objective** is to collect an updated wave of highly informative data in Year 1 to build on an existing set of data already collected by our study team (from 2004) to analyze the effects of key health policies and institutions that have emerged over the past several years, including the government's rural health insurance system, the privatization of rural clinics, and new investments into township hospitals. **Our second, more forward-looking goal** for Years 2 and 3 is to set up and introduce an initial experiment on incentives to study one of the most serious flaws in China's health system: the practice in which doctors both prescribe and derive significant profit from drugs. **The main hypothesis to be tested is whether realigning doctors' financial incentives embedded in the current organization of China's rural health system influence:** a) the way doctors treat and manage their patients; b) the time and effort doctors put into patient care; and c) patient satisfaction.

*We believe this proposal is especially exciting in a number of ways:*

- 1) This is the initial inter-departmental collaboration between Scott Atlas, Professor of Radiology in the School of Medicine and Senior Fellow working on public health policy at Hoover Institution, and Scott Rozelle, an economist and China specialist who is a newly arrived Senior Fellow in the Freeman-Spogli Institute (S-APARC);
- 2) The proposed research is both highly important and highly likely to succeed, because we will build on a set of high quality datasets that we already collected with a great deal of care and organization with our existing team within China. We will compile a unique and robust panel data set for evaluating health initiatives by following the health, health care choices and health expenditures of more than 800 households in 100 national representative villages in China as well as the health care practices of 150 doctors/barefoot doctors in village clinics and nearly 250 doctors/barefoot doctors in 50 township hospitals;
- 3) The data collected in the first part of this study will serve as a baseline for a controlled, novel pilot experiment in the second part "New Incentives, Improved Care (NIIC)." We will set up two pilot hospitals to serve as the basis for a larger randomized field experiment. In the "treated" NIIC hospitals, the link between doctors' income and drug sales will be severed, and pharmacy services will be moved outside of the hospital. Two alternative compensations systems will be used: in one, doctors will be paid an annual fixed salary; in the other, doctors will be paid on a "per patient visit" basis. We will establish a rigorous and reliable system to monitor the behavior of doctors, pharmacists and hospital administrators;
- 4) This work promises to form the basis for future experiments to be performed in close collaboration with our longstanding partners in China - the Chinese Academy of Sciences and the Public Health Research Institute - that will lead to meaningful policy changes;
- 5) We foresee this to be the first in a series of randomized intervention experiments that will entail: a) de-linking the delivery of medical care from maligned incentives for that care; b) piloting innovative rural health insurance programs; and c) engaging in four-way collaborative studies in China's health care system (Stanford; Chinese academic partners; policy makers in China; and private industry).

## **Caring for One Billion with Lessons for Four Billion: Experimenting with Incentives and the Supply of Health Care in Rural China**

### **Background and Motivation <sup>1</sup>**

Prior to China's recent transition to a market-influenced economy and its decentralization policies, China was thought to have one of the best records of public health in the developing world. From the 1950s through the 1970s, China achieved significant gains in the reduction of infant and childhood mortality rates, child malnutrition and life expectancy, due to major improvements in broad public health measures including nutrition, water supplies, sanitation, and access to basic health services. This occurred despite the generally low level of medical training among China's health care providers, particularly those serving rural areas.

Unfortunately, the economic reforms of the past two decades have been accompanied by a breakdown of the health care system throughout China. The system is so archaic and dysfunctional in some respects that a national white paper recently emerged calling the nation's health system—especially its rural health system—completely “broken.” The curious thing, however, is that it was not so many years ago that a report was issued saying that much progress was being made. On closer inspection, it is now increasingly clear that reliance on aggregate statistics and national spending trends obscured the decay in institutional coherence that was occurring in many parts of the system. Three examples of the incongruence between the record “on paper” and the reality “on-the-ground” can illustrate why the problems of the health system have been so tardy in emerging.

First, although the overall data still shows that health and nutrition indicators are improving, there are many factors that must be considered in interpreting these trends and assessing the performance of the health care system. For example, more than 300 million people in China have escaped the depths of absolute poverty, leading to a surge in income and increased levels of access to food, water and housing (Park and Wang, 2002). However, the same market forces that offered new pathways out of poverty began to undermine the institutional basis of the rural health care system. When the communes broke down, the network of traditional barefoot doctors and clinics also gradually disappeared, creating a vacuum in health provision without any backup in place.

Second, rising trends in government health spending in China throughout the 1980s and 1990s also makes China look responsive to the new health needs of its population and might suggest that its population is increasingly able to pay for health care (CNBS, 2005). Again, however, there are many reasons why this is misleading. Marked regional variations and severe rural-urban differences in access and health have appeared

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<sup>1</sup> For the reader that is unfamiliar with China's health care system, a short description and set of illustrative diagrams is included in Appendix 1.

which have been attributed to the fact that China has largely focused on urban health insurance schemes and on subsidies to large city hospitals (World Bank, 2004). In fact, the central government has shifted away from financial responsibility for rural health care without having an alternative system of health insurance and other backstops in place. The national government now supports only 3 percent of rural health expenditures. With rising health care costs (increasing more than 5 times the general level of prices), increasingly, people in rural China can not afford health care. Estimates indicate that up to 75% of the population lacks health insurance. In fact, according to a World Bank study, more than 50 percent of rural residents that required hospitalization decided on alternative courses of treatment (or none at all), almost exclusively due to the high cost of medical treatment (Claeson, Wang and Hu, 2004). New reports on a recent initiative to revive the rural health insurance system (New Cooperative Medical System) has been shown to be completely inadequate (only 3 percent of costs are reimbursed and the expected return on subsidized health insurance premiums is negative—Rozelle et al., 2005) and new field work demonstrates that the initial enthusiasm for participating in government health insurance plans is waning rapidly. Moreover, while urban hospitals have been rapidly improving their infrastructures and equipment, rural hospitals too often have been stagnant, since responsibility for funding health care has shifted to regional and local governing authorities, many of which are literally insolvent fiscally (Smith, Wong and Zhao, 2004). Many essential health services and preventative care are often absent in poorer, rural areas.

Finally, while increasing numbers of students are graduating from accredited schools of medicine, the training of health care providers and their staffs are inadequate in many parts of the country (especially in rural areas). According to a masters thesis that used data from a national representative survey run by Rozelle (one of the co-PIs of this proposed research), the average level of education of the presiding “physician” in village-based clinics is less than three years of high school. Few have more than one or two years of specialized training.

### **The Incentive Problem**

Most importantly (at least for this proposal), China’s health system is characterized by the flawed incentives that are almost assuredly leading to inappropriate care at high costs (Eggleston, 2006). Indeed, few medical systems in the world so directly link doctor income to revenue generated from specific diagnostic and treatment decisions for their patients. Shockingly, doctors and hospitals in China rely almost exclusively on the revenues from sales of drugs and testing services. In other words, unlike best practices in all other modern health systems, China’s doctors both prescribe and sell medicines; China’s hospitals both refer patients for testing and sell testing services. The problems with a system based on such ill-conceived incentives are obvious, and it is suspected that there is a tremendous degree of wasteful and even harmful effects as patients are prescribed drugs they do not need and pay for tests that are unnecessary.<sup>2</sup> Unpublished studies in other parts of Asia have indicated that changing some of these

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<sup>2</sup> It is important to note that statements in this section are mostly based on observation and not research-based evidence since there is almost no published research in this area in China.

incentives does significantly impact physician behavior and health care costs (Chou YJ, 2003).

To illustrate the tight relationship between the way that doctors prescribe drugs and their income made from dispensing drugs, we interviewed several doctors and administrators in several township hospitals in China as background for this proposal. We found that only a fraction of the salary of government-hired doctors in the typical rural township is fixed and paid from budgetary transfers. The rest of it is based on the profits of the hospital, which are mostly from income derived from drug sales. The typical doctor in a township hospital earns almost half of his/her bonus based on the volume of drugs that are sold. More than 40 percent of the salary of the rest of the hospital staff, including the head hospital administrator, comes from drug sales. Clearly, financial incentives are misaligned in this system.

### **Will to Reform and the Need for Data**

It is important to note that the list of problems in China's health system is in no way unique to China. In fact, the problems in China are common to almost all developing countries. Inadequate health care delivery to large segments of the population, deteriorating health systems—due to both demand and supply factors—and under-trained health care providers who are responding to poor or counterproductive incentives are more the rule, rather than the exception, in poorer nations in Asia, Latin America and Africa. Besides the enormous cost in human welfare and economic productivity due to poor health care, there are unintended yet grave health effects on a global level. For example, inappropriate incentives leading to inappropriate over-prescription of certain drugs (e.g., antibiotics) could hasten the build-up of resistant bacterial populations.

Although ignored earlier, in recent years the government of China seems to recognize that access to quality health care is essential to its further development and is becoming a major cause of public unrest. The 5th plenary session of the 16th Central Committee of the CPC held in October confirmed that the central government continues to be of the view that “economic development is the top priority”, but wants development to be “comprehensive, harmonious, and sustainable.” This implies a significant shift in prioritization of government spending, from a focus on investment to a focus on health spending. The website of the Ministry of Health in China contains an impressive number of reports that when taken together explicitly demonstrates two things: 1) the health care system—especially in rural areas—is in very bad shape; and 2) the government recognizes the problems and is ready to act, and do so, boldly.

Hence, the time is right for beginning to systematically examine these questions. What is not clear from the plethora of government reports and international papers and proceedings about China's health care system is that there are many fundamental pieces of information that are not known. Moreover, it appears that the lack of knowledge is one of the key stumbling blocks that is holding back action and preventing the pursuit of alternative solutions. This is lack of sound data inhibits solutions pertaining to not only the demand side (or the ability of the population to afford health care services), but also to the supply side of medical care. For example, although many people in China will tell

you that modern medicine demands a separation of health care provision and sales of medications and testing services, they may not necessarily believe it is that significant of a problem. Despite documented evidence of great changes in health care provision in Taiwan after separating the referral for prescription drugs from the sale of those drugs, most Chinese doctors still do not believe there would be a large transformation in their medical system from similar reforms. Others are skeptical about how an alternative system would even work. Until government officials and leaders of burgeoning professional medical associations (e.g., the China-version of the AMA) actually see convincing, data-based evidence of these problems and their potential solutions, bold actions—which are both affordable and do-able in China today—may not be enacted.

### Goals and Objectives

The overall goal of this project is to begin to provide answers to fundamental questions about the role of incentives in the health care system of rural China. This data will serve as a basis for assisting China's health care leaders in devising essential changes that will result in better access and more effective utilization of medical care particularly for rural people in China. The ultimate goal is to re-engineer the health care system so that it will provide appropriate incentives for physicians to provide high quality, sustainable health care to the one billion people that live and work in rural China. Although admittedly this is an enormous undertaking, China is on the threshold of modernization, at a time when important decisions are being made about health care that will determine much about the characteristics of the system over the next several decades. We also realize that the evolution of China's health system will not happen overnight, so information about problems and solutions—though urgently needed—will be useful for many years into the future. Hence, this proposed research can best be thought of as the first step towards a broader collaborative research agenda that will entail work in many areas of the supply and demand for health care in China. Secondly, but perhaps just as importantly, this project will generate results that will have lessons for the four billion people that live in other emerging nations. Indeed, an effective health system will greatly influence the health and subsequent development of China, but beyond China, it could serve as a model for other emerging nations as they grapple with the difficult questions all nations face about health care delivery.

Therefore, without limiting the ultimate ambition of the overall goals, in this specific research project for the PFIIS, we will focus on a small set of narrower objectives. **Objectives 1, 2 and 3**—which will be carried out in the first year of the study—will utilize our existing network set up in rural China in collaboration with researchers in the Chinese Academy of Sciences and the Ministry of Preventive Medicine to expand on our previously acquired survey data from 2004. Besides containing valuable insights into the nature of China's evolving rural health care system (on both the demand and supply sides), it will provide the information to analyze the effectiveness of some of the recent policy efforts of the government to improve rural health care. The work associated with these 3 objectives will also serve as a basis of departure (or baseline) for **Objectives 4 and 5**: which define the motivations for our unique proposal to set up a

*controlled pilot experiment* that will begin in the third funding year using specific *treatments* on incentives within the health care delivery system in rural China:

Objective 1 [*assessment* of demand for health care]: We will make an assessment of the current level and nature of health care being purchased and utilized by residents in rural China and. We also will quantify and document the demand for rural health care and the willingness to pay for health care and insurance for health care.

Objective 2 [*assessment* of supply of rural health care]: We will take inventory of the health services that are being offered in rural areas, including documentation of the quantity and quality of human resources (in village clinics and township hospitals) and the nature of infrastructure—both buildings, equipment and systems of managing health care. Our objective is to understand trends in rural health infrastructure and the way that these health assets (doctors, nurses, clinics and hospitals) are being maintained and supported (e.g., looking at the level of earnings by rural doctors and the sources of income—from fees for office visits to sales of medicines to earnings from diagnostic tests and therapeutic procedures).

Objective 3 [*evaluation* of the effects of recent changes on health care expenditures and health outcomes and quality of care]: We will use modern econometric methods to evaluate the impact of recent shifts in health care (privatization of village clinics; emergence of rural health insurance; management reforms in hospitals; changes in the salaries of doctors; availability of new testing equipment and other new investments) on a variety of measures of rural health, including: (a) expenditures by type of care—medicines and doctor visits to clinics and hospitals; (b) self-reported health outcomes; (c) visits to different health providers; (d) number of patients seen; (e) stocks of drugs and sales of medicines from clinics and hospital and use of testing equipment; (f) training of doctors; (g) earnings of health providers; and (h) other indicators of the quality of health that is consume and supplied. The evaluation will use data collected under this proposed research project (during 2007) and data from our previous data set (from 2004) to determine the impact of recent changes (including government reform efforts) on these factors.

Objective 4 [*creation of baseline* of data for assessment of the New Incentives and Improved Care pilot program, or henceforth called the NIIC Experiment (which is described in the next objective)]: We will collect a high quality baseline of the demand and supply of health care that will be used to assess the success or failure of our NIIC experiment using altered incentives when supplying health care in rural China. The data will cover a sample of people that are in the (randomly) designated experiment townships and villages and in the (randomly) designated control township and villages. The sample will overlap with the data collected for meeting Objectives 1, 2 and 3.

Objective 5 [*set up a pilot alternative health care supply system—or the NIIC experiment—based on breaking the perverse incentives between doctors’ incomes and drug prescription,s and offering a set of more modern (and sustainable) incentives in rural China’s health care delivery* in two townships in rural China]: In collaboration with the Academy of Preventive Medicine and Ministry of Health’s Office on the New Cooperative Health System (a pilot rural health insurance program), we will create a pilot program that will seek to interrupt the link between health care providers (doctors) and pharmacologic prescription utilization in two township hospitals (see *Diagram in Appendix 1* for the relationship between private village health centers and township hospitals, which are government controlled). In our experiment, we will de-link income to doctors from prescription usage and instead set up independent pharmacies. We also will experiment with alternative compensation mechanisms for doctors (that is, set up competing systems of paying doctors for health care services). The longer-run objective will be to implement a larger, controlled field experiment (in 100 villages) that will be used to assess the impact of altered incentives on physician behavior and patient health (note that this will be pursued under research to be supported by future grants).

**The main hypothesis to be tested in pursuing this objective is whether realigning the financial incentives embedded in the current organization of China’s rural health system to incentives that are more in line in international standards affect: a) the way doctors care for their patients (including the mix of drugs and other care); b) the effort doctors put into direct patient care; and c) patient satisfaction.**

### **Project Execution: Methodologies and Approaches**

To meet our 5 specific objectives, the proposed activities can be divided into 3 Steps (or categories of activities): Getting the Data Right; Analysis; Setting up the Pilot Experiments

#### **Step 1**

Getting the Data Right [to meet Objectives 1 and 2 - understanding the demand and supply of health care in rural China; and Objective 4 - creating a baseline for assessing the NIIC experiment]:

The data collected under this part of the project will have two uses. First, they will be used to describe (and the as the basis for formal evaluation of—see Step 2) changes to the rural public health system that have occurred over the past 3 years (2004-2007). Major changes include:

- a.) emergence of a government-support rural health insurance program;
- b.) rise of private practices that will compete with public hospitals/village-supported clinics;
- c.) new regulations on establishment and operation of village clinics;



- d.) new investments into town hospitals (as part of post-SARS town hospital upgrade program);

Second, the data will be part of a baseline data set that will be used to evaluate the effect of our NIIC experiment (see Step 3).

The project will draw heavily on the 6 new data sets. Importantly, although this is ambitious, the work will be simplified by the fact that 5 of the new data sets will be building on existing data sets (and the survey will be executed in the same sample counties, towns, villages, households, hospitals and clinics that were previously visited by the collaborative Stanford-Chinese Academy of Sciences research team). A summary of the data sets is as follows:

*New Data Sets (to be collected in Spring 2007)*

- 100-village community data set (which will be a resurvey of 100 randomly selected, national represented villages in 50 towns; 25 counties and 5 provinces)
- 800 household survey data set (from 800 randomly selected households and 2500 individuals from the 100 sample villages);
- 200 focus group data set (also from the 100 sample villages)
- 50 township hospitals from the 50 sample towns (each sample towns has 2 sample villages)
- 150 village clinics from 100 sample villages (average 1.5 clinics per village; range: 0-4)
- 500 doctor/staff survey in 50 sample township hospitals [new survey]

*Existing Data Sets*

- 2005 Stanford/Chinese Academy of Science *Rural Governance and Public Services Survey*

Timing of Survey: April 2005

Geographical Coverage: 5 provinces/25 counties/50 towns/100 villages/800 hhs

Years of Coverage: 2004 (plus several look-back sections—to 2000)

Enumerators: Ph.D. and M.Sc. students from four Chinese Universities

Blocks of Survey (all respondents were randomly selected):

- 100 Community level questionnaires (characteristics of villages and village leadership)
- Public Goods Investment inventories and engineering evaluations (document nature of each village's infrastructure, including **public investments into clinics**)
- 800 household surveys, documenting income, asset holdings or wealth, economic activities (on-farm; off-farm jobs; family businesses) **PLUS information on health expenditures, health insurance purchases and reimbursement experiences, clinic/hospital visits, self-reported health status and record of Activities of Daily Living (ADLs) for elderly.**
- 200 focus groups (composed of 2000 individuals—½ men; ½ women, including **information on demand for public health services and evaluations of status of public health services**)

- **150 village clinics** (information on 2004 and look-back until 2000, including comprehensive information the hardware (building and equipment), human resources (past training and experience), financial balance sheets (income+expenditures; assets+liabilities), policies, and health care profession-patient relations)
- **50 township hospitals** (information on 2004 and 2000—from interviews and records on hardware, human resources, financial balance sheets and policy environment)
- 100 village and 50 township fiscal managers (2004 and 2000 from accounting records for fiscal revenues and expenditures, **including revenues from and expenditures on public health activities and capital purchases**)
- 100 elementary schools

### Data Collection

Collecting any data in rural areas is a huge challenge. Collecting several different interlinked datasets is even more difficult. Fortunately, however, significant work was already been done during 3 years of preparatory work that went in to design the surveys that were used to collect the existing data sets; choose the samples; and establish enumeration training procedures and workbooks. *In other words, this project is not only feasible but highly likely to succeed, because we will build on a set of high quality datasets that were already collected with a great deal of care and organization.* In the rest of the proposal, the 25 counties, 50 towns and 100 villages and 800 households will be called the *2004 baseline sample* (collected in 2005). The new survey done under this project (which covers the same 25 counties, 50 towns, 100 villages and 800 households) will be called the *2007 baseline sample* survey.

There are basically three major data collection tasks: a) extracting existing questions and blocks of questions from the 2004 baseline sample survey for re-use in the 2007 baseline sample survey; b) adding and refining questions to reflect new issues and the new focus of the 2007 baseline sample survey; and c) creating a new survey form to collect intensive information on the earnings, labor allocation and health care practices of physicians and clinicians.

*New data collection task 1:* Using the existing baseline surveys, new survey forms will be created that employ a large subset of the original questions in order to create a true panel data set. With a true panel data (that is, with data on income, assets, labor allocation, investment, health care expenditure, doctor visits, health status, etc. for both 2004 and 2007), modern, state-of-the-art evaluations procedures (see Step 2 below) can be used by comparing differences in income, health expenditures or health care choices (or any other outcome variable) for those that were in a new program (e.g., a new health insurance program that started between 2004 and 2007 or in a village with a new private clinic) or those that were not. It is possible some of the blocks of the original survey will not be used, but when they are, effort will be made to keep the questions as similar as possible to increase comparability.

*New data collection task 2:* Expanding the existing surveys to insure that they will collect additional data will allow us to track the emergence of new health care institutions, programs and other related “events,” including the interaction of the individuals that are

involved in the NIIC Experiment (see Step 3 below). The expanded versions of the survey need to track in greater detail health care expenditures, purchases of medicines and other health care services, visits to clinics and hospitals, spells of illness and other health problems, use of health insurance programs and experiences in the traditional local hospitals and the new experimental health care organizations.

*New data collection task 3:* Creation of a new, intensive doctor's health care practice survey that seeks to document each physician's earnings, time allocation, practice of drug and testing referrals, investments into pharmacy stocks and testing laboratories and relationships with insurers (etc.). This survey will be a one time survey done during the 2008 data collection effort and will collect information on the physician's activities in 2007. Hospital and clinical records will be used in conjunction with sit down, recall surveys.

**Experience of collaborative team in collecting data.** Fortunately, the research team has a great deal of experience in collecting survey data and doing field work in rural China. In fact, there almost certainly is no other group of social scientists in the world that have more experience. Rozelle, a co-PI, and his collaborators from China, have successfully designed, executed and used data from no less than 20 surveys since they began to work together in the early 1990s. The survey work in the past cover more than 25,000 households, village leaders, firm managers and factory workers in every province in China (except Tibet). The largest and most complex data collection effort to date actually involved the collection of the 2004 baseline samples survey. Therefore, although complicated and time consuming, there is every reason to believe that the effort can be successful again. In fact, since the relationships have already been established with the village leaders, clinicians, hospital managers and rural households in the 50 sample towns and 100 sample villages, the second round of survey data collection (as is typical) is less onerous.

One of the uses of the data from the two baseline surveys will be purely descriptive in nature—to describe changes in the health care system and the demand for health care services during the mid-2000s. Although simple, it is arguable that the descriptive analysis that comes out of the data will be a powerful tool to document and describe to other scholars, officials and health administrators what is actually happening over time and across China in a set of randomly selected villages (a view that surprisingly, to our reading of the literature, is missing).

## **Step 2**

### **Evaluating Past Program/System Performance** [to meet Objective 3]

For most outcome variables (e.g., health expenditures; choice of clinic/hospital; self-reported health status; ever decide to NOT visit doctor when sick; etc.), we will have longitudinal data from before (2004) and after (2007) the implementation of several new health programs and regulations/policy efforts. For these indicators, we can employ the *double-difference* or *difference-in-differences* estimator. This compares the mean before-and-after change among people living in the areas that experienced the policy (e.g., those areas in which the new rural health insurance program was implemented) with the mean before-and-after change among people living in non-project areas (e.g., those in areas in which the new rural health insurance program was NOT implemented). Let  $P_i$  equal one

if period  $t$  is after the “new program” has been implemented. Then the double-difference estimator can be implemented by the convenient regression (cf. e.g. Cameron and Trivedi 2005):

$$(1) \quad y_{it} = a + bP_t + gT_i + dP_tT_i + e_{it} \quad t = 1, 2.$$

where the interaction term  $P_tT_i$  equals one for the treated individuals in the post-intervention period, and the coefficient  $d$  is the difference-in-difference estimate. Or the double-difference estimator can be implemented by regressing the change in outcome over time on a treatment dummy:

$$(2) \quad \Delta y_{it} = b + dT_i + \Delta e_{it} \quad t = 1, 2.$$

where  $\Delta$  is the difference operator. The double-difference estimator sweeps out the effects of time-invariant influences on outcomes, both observed and unobserved, and in effect nets out any changes that could be considered likely to have occurred anyway. One can also add covariates to eqns (1) and (2) (cf. e.g. Cameron and Trivedi 2005), to get, for example:

$$(3) \quad y_{it} = a + bP_t + gT_i + dP_tT_i + \sum_k f_k x_{kit} + e_{it} \quad t = 1, 2.$$

which we refer to as the double-difference estimator with covariates.

Combining differencing with covariates is just one way of controlling for heterogeneity. An alternative—and cleaner and less restrictive—approach is to combine *differencing with matching* (cf. e.g. Heckman, Ichimura et al. 1997; Imbens 2004; Ravallion 2005). In contrast to the regression approach, no functional form for the outcome variable need be assumed. We combine matching with double differencing but also with single differencing for outcomes that we observe only in the new survey (2007). Details can be seen in our previous work (Uchida, Xu and Rozelle, 2005).

### Step 3

#### Setting up 2 Pilot Experiments

Working closely with the Academy of Preventive Medicine, the plan is to set up two pilot hospitals that will serve as prototypes for the actual NIIC experiment (to be conducted in the next phase of the research—not included under this proposal). The townships will be chosen from one of the 25 counties in our original sample. Close collaboration (and potentially follow on funding—for the next phase) is needed with county bureau of health. This will be secured through our contacts (and the contacts of our colleagues in the Academy of Preventive Medicine). We currently have discussed this matter with the Rural Health Care division of the Ministry of Health in Beijing and they are very enthusiastic. After showing them our list of 25 counties, they replied with certainty that they can enroll 2 townships in any of the 25 counties. Therefore, our plan is to choose one county and two townships during the first summer of field work (summer 2007) and these will serve as the pilot NIIC experimental townships.

In order to begin to devise an experiment in this proposal we will follow the doctors, pharmacy sales and expenses and revenues of the hospitals in two regular (non-treated) hospitals and in two treated hospitals. The treated hospitals will be set up to delink the earnings of the doctors and their writing of prescriptions for drugs. Figures showing the organization of Township Hospitals before (currently—Figure 1) and after (Figure 2) the NIIC experiments are shown on the next page:

To set up such a set of NIIC hospitals, the following changes need to be instituted:

1. Doctors will only be allowed to prescribe medicines and not sell them.
2. The hospital will close its pharmacy.
3. Doctors will be paid on one of two bases (one way in one NIIC hospital; another way in the other NIIC hospital)
  - a. Doctor salaries will be paid as a fixed salary of US\$400/month. Doctors will receive no year-end bonus (and none of his/her salary will be tied to drug sales revenues)
  - b. Doctors will be paid on a per visit basis. A per visit standard will be set up based on the record of the previous year. It will be expected that if the doctor sees the same number of patients that he will receive US\$400 per month. The budget will prepare to compensate these doctors up to US\$600/month since doctors may increase the number of patients that they see.
4. A pharmacy will be set up next door to the township hospital and will be kept open 24 hours per day. The pharmacy will not be allowed to see patients and will only be able to dispense drugs on prescription. No over the counter drugs will be allowed to be sold. The pharmacy staff will be paid a fixed hourly wage by the project. Drugs will be ordered from the same sources as before and the price structure will not be allowed to change.
5. The hospital administrator will keep his/her original base salary and a bonus system will be set up to compensate him/her on the basis of the implementation of the pilot experiment. If cheating (by doctors, the pharmacy, the hospital staff) is discovered, the bonus will be reduced. A schedule of infractions and the penalties to the hospital administrator will be produced to ensure that the successful implementation of the project will result in a higher salary for the hospital administrator.
6. Patient satisfaction surveys will be taken periodically during the year, asking patients about the quality of their experience; the expense; etc. These questions will also be asked of patients using non-NIIC experiment hospitals.
7. Close inventories will be kept of pharmacies as will accounting records. We also will pay doctors to keep daily logs of their activities and care records (which will be checked against patient interviews for consistency).

### **On-the-Ground Verification**

One of the key steps of running the pilot NIIC experiments will be to verify if the actors in the hospitals (doctors, administrators and pharmacies) behave in accordance within the rules of our experiments. The most important actions that we can take, of

course, will be to try to design the experiment in a way that minimizes cheating. For example, the pharmacist should be paid a fixed wage, so there is no reason for him/her to collude in increasing the volume of drug sales. Other indicators of performance can be used to pay bonuses, such as measures of optimal inventory control (having enough medicine on hand to serve patients but not too much to be wasteful). In addition, cheating disincentives can be set up (such as, keeping a part of the doctor's salary back until the end of the year and not pay it if cheating is detected).

However, significant on-the-ground effort will also be needed to monitor the behavior of the actors. In essence, it will be important to determine if the behavior of the doctors (or administrators or pharmacists) undermine the nature of the experiment. In other words, we need to know if in the framework of the pilot NIIC experiment, doctors (or others) are cheating. For example, despite getting paid a salary and having the right of selling drugs taken away from them, doctors might still have their own store of drugs and take both the higher fixed salary and earn income from selling drugs. Or, they could collude with the pharmacist and promise to continue to prescribe large volumes of drugs, in return for an under-the-table kick back. If this happened, of course, we might observe no change in the pattern of health care, because, in fact, the real (with cheating) incentives did not change. However, in such a case, we might describe the NIIC experiment as a failure for other reasons (that is, we might conclude that the current system of health care is not distorting the balance between drugs and other treatments). In fact, it is at least as important to detect flaws in the design of the experiment (in this pilot) stage than it is to be able to claim that we have developed a fool proof strategy for experimentation.

In order to detect these flaws in the experimental design, we have prepared a number of steps to monitor the actions of the hospital players. For example, we will conduct random exit interviews with patients. These can be done in their homes in order to avoid any uncomfortable encounters between doctors and patients. We will send in team members who can pose as patients and see if they are offered drugs. We will have our own team members spend time in the hospital working along side of the administrator and doctors in order to get a first-hand view of actual behaviors.

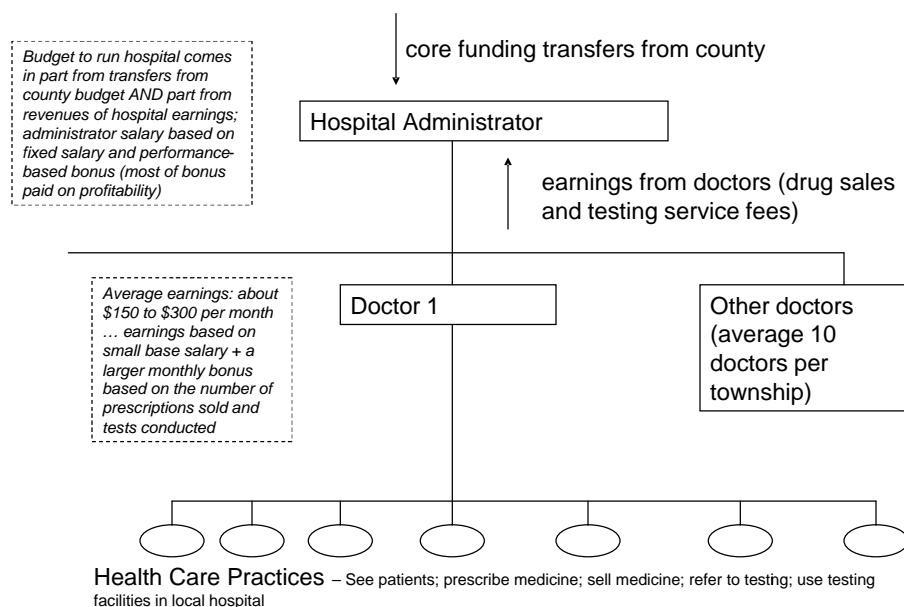


Figure 1. Diagram of *Current* Organization of Township Hospitals in Rural China

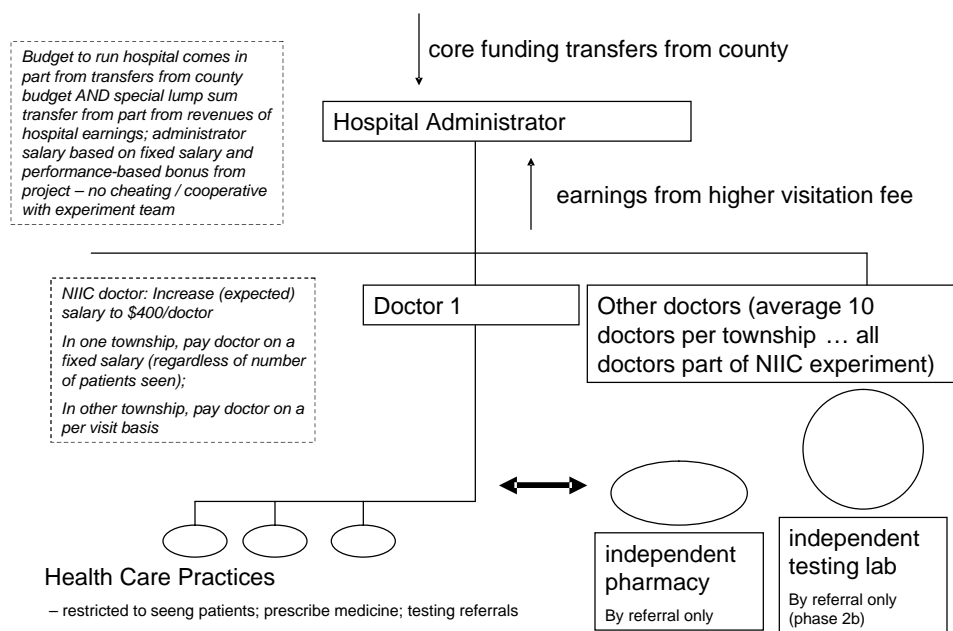


Figure 2. Diagram of Organization of Township Hospitals in Rural China *After the NIIC Experiment*.

## **Output, Plans and Future Research Collaborations and Funding Prospects**

We expect to have at least four publications from the work associated with Objectives 1 to 3. We will have two publications that document in detail the changes to health demand and the changes to health supply at the village and township level. We also will have two analytical papers evaluating the impact of China's new rural health insurance system and the shift of China's village health care system to a private, clinic-based system. There will almost certainly be additional evaluations to do, but emphasis will be put on those issues that are most pressing and of concern to the government.

Importantly, we also will have created baselines that will be used when we scale up the experiments. The baseline will consist of detail patient care, patient satisfaction and doctor earning/time allocation. We also will have information on the finances of rural township hospitals. These will be the “before data” when we do the full scale NIIC experiments in Phase 2 (funded by future projects).

We will undoubtedly accumulate a lot of learning about how to run our follow-up Phase 2 experiments. Our two pilot projects will let us understand how to set up a system of experimental hospitals that will let us formally test the effect of incentives on the provision of health care. We will understand more about the effort and compensation of doctors. We will understand more about health care prescribed by the doctors. We will understand more about the economics of township hospital and the role of the administrator and the importance of connections with county bureau of health officials. We will learn a lot about the cost structures of pharmacies. And, we will understand better if, in future Phase 2 studies, we need to consider the adverse behavior of the actors—administrators, doctors or pharmacy employees. In short, we will gain invaluable experience that will allow us to push forward with our future Phase 2 experiment:

Phase 2 plans [public-private partnerships in NIIC rural health experiments]:

- Set up 10 NIIC experiment hospitals. Seek funding from Chinese government to defray expenses.
- Set up 10 pharmacies next to NIIC township hospitals. We are in discussion with international pharmaceutical companies (e.g., Johnson and Johnson) to fully or partially share in the costs to underwrite the pharmacies.
- Set up 3 to 5 pilot testing laboratories that will be the focus of phase 2b (separating the function of testing referrals by doctors from the provision of the testing services). We already have high interest from General Electric to fully or partially share in the costs to underwrite the new independent testing laboratories.
- Set up 3 to 5 experimental areas that will provide alternative rural health insurance schemes – varying the premia and deductibles and coverages. We will seek cooperation with international or Chinese domestic insurance firms and the Chinese government in Phase 2c.



Assess the impacts on rural health outcomes (Phase 3). This will require both time (additional years of following the sample households/individuals) and larger samples.

In addition to public-private partnerships listed above, we are also already engaged in discussion with the World Bank's research group to fund and help in the analysis of the future experimental work.

**Budget**

Survey work for objectives 1, 2 and 4:		120,000
Presurvey work	25,000	
Implement survey	75,000	
Enter and clean data	20,000	
Analysis for objectives 3 (evaluation work)		30,000
Research assistant at Stanford		
Pilot NIIC township hospitals		100,000
Payment of Doctors	50,000	
Payment of Administrators	10,000	
Payment of Pharmacy Staff	30,000	
Rent room for Pharmacy	10,000	
Monitoring and follow up survey work		50,000
Salary	Scott Atlas [conditional on costs]	
	Scott Rozelle [conditional on costs]	
<b>TOTAL:</b>		<b>300,000</b>

Disbursements by year (for three years):

Year 1: 150,000  
Year 2: 50,000  
Year 3: 100,000

## Time line

Activities	Year 1				Year 2				Year 3			
	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
Project planning	X											
Pre-survey		X										
Conduct Survey			X	X								
Enter / Clean data					X							
Analyze data						X	X					
Initial report								X				
Planning trip						X						
Set up NIIC exp.							X	X				
Monitoring									X	X	X	X
Analysis / final report												X

Years and quarter are counted in quarters after start of project.

## **Appendix 1**

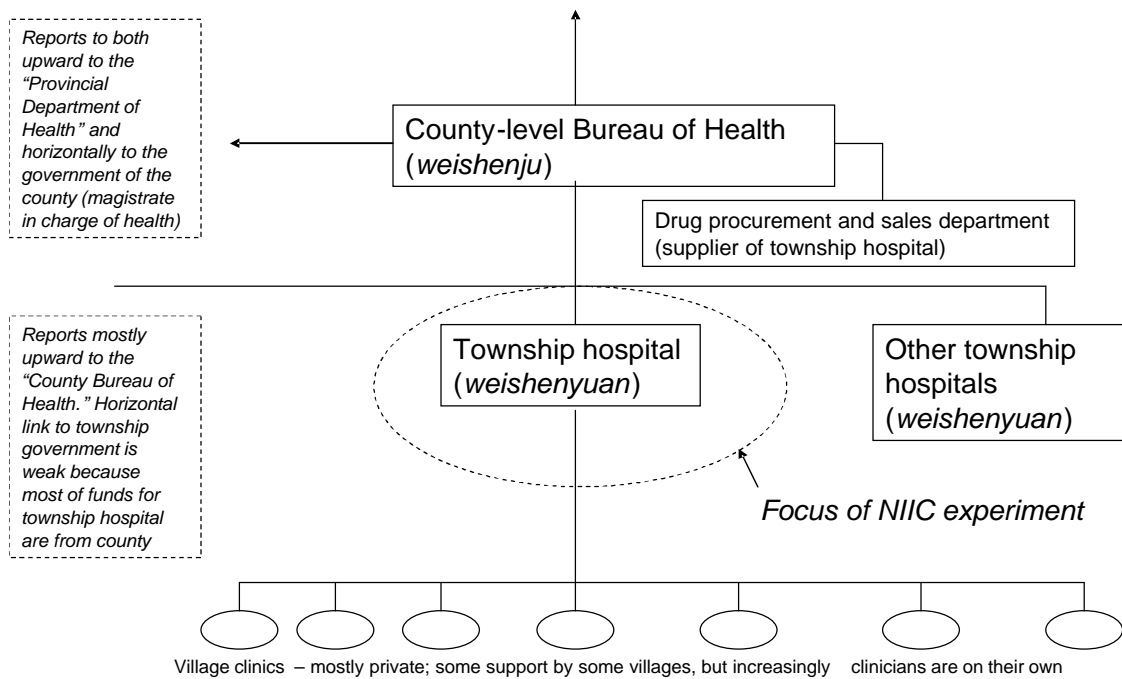
### **China's Current Three-tier Rural Health Care System**

China's rural health care system is based on a three tier system with institutional structures at the county, township and village levels (see Appendix 1, Figure 1). The system's funding (currently) almost fully originates from the county. Managed by health professionals and officials in the bureau of health, (in addition to operating county-level hospitals which are mostly for county urban residents), the county is in charge of planning, regulating and funding (in part) the rural health system. Being mostly a top-down planning system, officials in the bureau of health can send directives to the hospital administrator (including directing a township hospital to change its compensation incentive scheme and scope of health practices).

The heart of the rural health system of each county lies in the chain of hospitals that are built in nearly every township. The head of the hospital, the hospital administrator is appointed by the county bureau of health and is ultimately in charge of rural health care in the entire township. The administrator also is responsible for accounting for and allocating the transfer of funds from the township, setting local hospital policy, hiring new doctors and managing the existing staff of doctors (and the rest of the staff) and oversees the salary bonus system.

The doctors in many township hospital function as individual accounting units. Although they see patients assigned by the township hospital, care and accounting records are kept on a doctor by doctor basis. Doctors not only see patients, prescribe medicine and refer patients to testing services, they also sell drugs and sell testing services. Although the payments for these services do not go "through the doctor's own account," a record is kept about the transaction of each doctor, which is used primarily to set the level of bonus at the end of the year.

Village clinics, while once famous for their barefoot doctors, today mostly run as small, private, individually owned and operated businesses. The number of clinics per village range from zero to three or four. The level of service of village clinics also varies greatly. Most clinicians have low level of training and practice both Chinese and Western medicine. By far most of a clinician's income comes from the sale of drug or herbal medicines.



Appendix 1, Figure 1. Diagram of Organization of Rural China's Current Health Care System.

## **Bios of the Co-PI's [CVs in separate file]**

### **Biographical Sketch: Co PI Scott Atlas**

**Scott W. Atlas, MD** is Professor of Radiology and Chief of Neuroradiology at Stanford University School of Medicine, and a Senior Fellow at the Hoover Institution.

Dr. Atlas is the editor of the leading textbook in the field, the best-selling *Magnetic Resonance Imaging of the Brain and Spine*, now in its 3<sup>rd</sup> edition. He is also editor, associate editor, and a member of the editorial boards of numerous scientific journals and has been a member of the boards of many major national and international scientific societies over the past decade. Dr. Atlas has authored more than 100 scientific publications in leading journals. His research has centered on advanced applications of new MRI technologies in neurologic diseases. He has lectured throughout the world on a variety of topics, most notably advances in MRI of the brain, and the key economic issues related to the future of such technology-based advances. He is recognized throughout the world as a leader in both education and clinical research and is on the Nominating Committee for the Nobel Prize in Medicine and Physiology. He is also an adviser to major industry leaders in medical technology. Dr. Atlas has received numerous awards and honors in recognition of his leadership in the field.

Dr. Atlas's research interests as a Senior Fellow at Hoover center on issues pertaining to public policy in health care. He is investigating the role of government in the emerging era of consumerism in health care, both within the United States and globally. He has particular interests in the evolving health care system of emerging economies, and has a recent Fulbright award to collaborate with academic leaders in China on structuring health care solutions for China. His work also includes investigations into the effects of the changing health care marketplace on technology-based innovations in medicine.

Before his appointments at Stanford University and the Hoover Institution, Dr. Atlas was on the faculty of University of California at San Francisco, University of Pennsylvania, and Mount Sinai Medical Center in New York City.

Dr. Atlas received a B.S. degree in biology from the University of Illinois in Urbana-Champaign and an M.D. degree from the University of Chicago.

### Biographical Sketch: Co-PI Scott Rozelle

**Scott Rozelle, Ph.D.** holds the Helen Farnsworth Endowed Professorship at Stanford University and is Senior Fellow and Professor (by courtesy) in the Shorenstein Asia-Pacific Research Center, Freeman Spogli Institute (FSI) of International Studies. He currently also is on leave from the Department of Agricultural and Resource Economics, University of California, Davis. Dr. Rozelle received his B.S. from UC, Berkely, M.S. and Ph.D. from Cornell University.

Before arriving at Stanford, Scott was a professor at the University of California (since 1998) and an assistant professor in the Food Research Institute and Department of Economics at Stanford University (1990 to 1998). Currently, he is a member of the American Economics Association, American Agricultural Economics Association, International Association for Agricultural Economists, Asian Studies Association and Association of Comparative Economics and is an associate editor of *Economic Development and Cultural Change* and on the editorial board of *Agricultural Economics*, *Contemporary Economic Policy*, *China Journal*, and the *China Economic Review*. Professor Rozelle has received numerous honors and awards in recognition of his outstanding achievements. He was the U.C. Davis 2000 Chancellor Fellow, an award given each year to the university's outstanding faculty professor.

Dr. Rozelle's research focuses almost exclusively on China and is concerned with three general themes; a) agricultural policy, including the supply, demand, and trade in agricultural projects, b) the emergence and evolution of markets and other economic institutions in the transition process and their implications for equity and efficiency; and c) the economics of poverty and inequality. In the past several years his papers have been published in top academic journals, including *Science*, *Nature*, *American Economic Review* and the *Journal of Economic Literature*. He is fluent in Mandarin Chinese and has established a research program in which he has close working ties with several Chinese collaborators and policy makers. He is the chair of the International Advisory Board of the Center for Chinese Agricultural Policy; a co-director of the Agricultural Issues Center (University of California); and a member of Stanford's new Food, Security and the Environment Program. Dr. Rozelle's work is best known for its use of primary data that he and his collaborators collect. He has run over 20 surveys over the past 15 years and has been involved in more than 30 others.

## **Our Collaborative Team in China**

### **Biographical Sketch: Linxiu Zhang**

#### **PERSONAL DETAILS:**

**Professional Title:** Professor and Deputy Director

**Current Address:** Center for Chinese Agricultural Policy (CCAP)

Chinese Academy of Sciences (CAS)

No. 11A, Datun Road, Anwai, Beijing 100101, PR China

Ph: (010)64889834/64889440/Fax: (010)64856533

E-mail: lxzhang.ccap@igsnr.ac.cn

**Nationality:** Chinese

#### **EDUCATIONAL BACKGROUND:**

Professor Linxiu Zhang obtained her Bachelors Degree from Nanjing Agricultural University majored in agricultural economics and management (1982). She completed her Masters in the University of the Philippines at Los Banos (1986). Then, she obtained her final degree (Ph.D.) from Reading University in Great Britain majoring agricultural economics (1995).

#### **PREVIOUS WORK EXPERIENCE**

Dec.1998 – Nov.2000: Deputy director general & Associate professor

Institute of Agricultural Economics (IAE), Chinese Academy of Agricultural Sciences (CAAS).

Oct. 1995 – Oct.1998: Deputy director & Associate professor

Center for Chinese Agricultural Policy (CCAP), Chinese Academy of Agricultural Sciences (CAAS).

Aug.1982 - Sept. 1990 (except the period between Apr.1984 and May 1986): Research Assistant in the Institute of Agricultural Economics, Chinese Academy of Agricultural Sciences (CAAS), Beijing, China.

#### **CURRENT WORK**

Currently, Professor Zhang is a senior research fellow and deputy director at the Center for Chinese Agricultural Policy (CCAP), Institute of Geographical Sciences and Natural Resources Research of the Chinese Academy of Sciences (CAS). Professor Zhang's main research interest concentrates on policy relevant studies on rural development and poverty alleviation in China. In the past five years, she has been leading various research projects related to land tenure rights and its impact on resource degradation, rural labour



market development and its implications, gender issues related to employment, land tenure as well as political participation in rural China, impact of public investments on growth, poverty alleviation and inequality, community governance and public goods provision, rural education and health care, non-point source pollution control in major agricultural areas in China, and etc. She has published widely in both English and Chinese Journals.

#### **OTHER RELEVANT INFORMATION:**

- Social titles held:
- 1) Board of Trustees member (and vice-chair) of the WorldFish Center (ICLARM), 2000 to March, 2006;
  - 2) Board Member of International Agroforestry Center (ICRAF), 2004 to date;
  - 3) Adjunct Professor at College of Economics and Management of Nanjing Agricultural University, 2005 to date;
  - 4) Adjunct Professor at International Food and Agricultural Economics Research Center of Nanjing Agricultural University, 2004 to date;
  - 5) Adjunct Professor at College of Economics and Management, China Agricultural University, Beijing, China, 2005 to date;
  - 6) Member of International Association of Agricultural Economists, 2003 to date;
  - 7) Member of the Editorial Board of Journal of “World Agriculture”, 2000 to date;
  - 8) Executive Board Member of Chinese Society of Agricultural Economics, 1998 to date;
  - 9) Executive Board Member of Chinese Association of Agri-technical Economics, 1998 to date.

#### **RECENT PUBLICATIONS (SELECTED ENGLISH JOURNAL ARTICLES ONLY)**

1. Zhang, Linxiu, Renfu Luo, Chengfang Liu and Scott Rozelle (2006): Investing in Rural China: Tracking China’s Commitment to Modernization, *The Chinese Economy*, Vol.39, No.4, July-August 2006, pp.57-84.
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4. Shen, Minggao, Scott Rozelle and Linxiu Zhang (submitted): Farmer’s Professional

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6. Qiang Li, Alan de Brauw, Scott Rozelle, and Linxiu Zhang (2005): Labor Market Emergence and Returns to Education in Rural China, *Review of Agricultural Economics*, Vol.27, No. 3, pp418-424;
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8. Shenggen Fan, Linxiu Zhang & Xiaobo Zhang (2004): Reform, Investment, and Poverty in Rural China, *Economic Development and Cultural Change*, Vol.52, No.2, 395-421;
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## A Brief Introduction of CCAP

The Center for Chinese Agricultural Policy (**CCAP**), established in December 1995 at the Chinese Academy of Agricultural Sciences (CAAS) and a member of the Chinese Academy of Sciences (CAS) since 2000, is now one of the six leading research areas in the Institute of Geographical Sciences and Natural Resources Research of CAS. **CCAP** is also one of the first to be awarded the distinction of “Innovative Research Group” by China’s National Natural Science Foundation. **CCAP** is comprised of a group of motivated and vibrant young economists dedicated to pursuing **CCAP**’s aims of analyzing policies related to food, agriculture, natural resource and environmental issues in China, and helping formulate practical and feasible policies for the development and modernization of rural China.

**CCAP**’s mission is to expand and develop rigorous basic and applied research to analyze the problems and challenges facing China’s agricultural policy-makers and producers, as well as the factors contributing to constraints on agricultural and rural economic development, so as to 1) provide a scientific foundation for policy-makers (both governmental and private), 2) suggest needed policy choices for realizing the goal of sustainable economic development based on rational use of natural resources and the sustainable development of agriculture, 3) promote the development of agricultural economics and related applied sciences, cultivate highly skilled agricultural economists and policy researchers, 4) bridge the dialogue between Chinese and international agricultural economists and, 5) accelerate the dissemination of **CCAP**’s research results to a wider public as a service to government and society.

**CCAP** has four key Research departments and three support offices. In addition, **CCAP** has a post graduate training programme. The research departments include: Agricultural R & D and Production Policy Research; Natural Resources and Environmental Policy Research; Integrated Rural-Urban Development and Poverty Alleviation Policy Research; and Agricultural Development Policy Research and Decision Support System Research. **CCAP** also conduct policy consultancy work along the line of emerging agricultural and rural development issues. The three support offices include: Office of Administration, Office of Public relations and Office of Data Management.

Over the past decade, **CCAP** has published widely both domestically and internationally. In the last three years, **CCAP** has published about 20 papers in international journals annually, most of which are either SCI or SSCI listed. In the last two years, **CCAP** has consecutively published papers in such prestigious journals as *Nature*, *Science*, *Journal of Development Economics*, and *Journal of Public Economics*. In addition, **CCAP** has published 18 books and regularly produces working papers and policy briefs. All of these works have gained a high level of recognition by both policy-makers and academics.

## **China Collaborative Team (cont'd)**

### **Biographical Sketch: Professor Kaining Zhang**

Professor Kaining Zhang, B.Sc. in Sciences and M.D. in Public Health (Shanghai), was a visiting Scholar in Cambridge University and Leeds University, UK, sponsored by the British Governmental Technical Co-operation Training Award (1991-1993).

Currently he is a Full Professor of medical sociology, in health policy and management studies. He is also the Director of the Institute for Health and Development Studies, Kunming Medical College, and the Director of Yunnan Reproductive Health Research Association (YRHRA). Prof. Zhang served as the Secretary-in-general of the Steering Committee of the Asian and Pacific Network of Social Science in Health (APNET) 2002-2005, and now a member of the Steering Committee of the International Forum on Social Sciences on Health (IFSSH) 2005-2008. He is a member of Public Health Research Institute and a member of the Advisory Group for the China State Population and Family Planning Committee (CSPFPC) in reproductive health and quality of care. He frequently serves as a national consultant of the China Ministry of Health (MoH) in reproductive health, and health services in rural China since 1996.

Teaching: Medical sociology, health policy and management, evaluation of the health projects and services.

Prof. Zhang served as a member of the Advisory Panel of the UNDP/ UNFPA / WHO / World Bank Special Program of Research, Development and Research Training in Human Reproductive (HRP) 1998 to 2005. He was a Visiting Professor at the Faculty of Social Sciences and Humanities, Mahidol University, Thailand 1996-1997, and has been a Trustee member of the Regional Center for Social Science and Sustainable Development (RCSD), Faculty of Social Sciences, Chiang Mai University, Thailand since 2000.

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