How much have agricultural projects contributed to economic mobility and food security in China?

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PRELIMINARY AND INCOMPLETE, PLEASE DO NOT CITE

Abstract: To what extent agricultural development projects are associated with greater economic mobility and food security of their beneficiaries? Our study measures the impact of seven rural agricultural development projects supported by the International Fund for Agricultural Development (IFAD), and implemented in rural China. We adopt a non-experimental design approach to estimate the ex-post cumulative impact of these projects. These seven projects cover the whole portfolio of projects closing between 2010 and 2015 in China, and therefore give a representative estimate of the aggregate impact within IFAD's Chinese portfolio. Using a primary household survey with a sample of 1,356 households from seven provinces, our empirical results illustrate aggregate significant and positive impacts on economic mobility (as measured by asset accumulation), and on food security (as measured by dietary diversity indicators). Further, given that these projects are representative of the Chinese project portfolio, we provide a projection of the number of people who experienced significant changes in economic mobility as a result of the projects. Finally, we discuss relevant implications to rural development policy in China based on the findings from this study.

Keywords: impact evaluation, agriculture, agricultural development, economic mobility, China, Asia

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1. Introduction

Alleviating hunger and poverty, and foster economic growth are paramount objectives for the realization of equitable and sustainable development of the world. Since the beginning of China's reform and open-up policy in 1978, the Chinese government has been implementing poverty alleviation strategies and fostering rural economic development. In this study, we examine the cumulative impact of seven agricultural development projects specifically designed to reduce rural poverty and foster economic growth in poverty-stricken areas of rural China. While the main focus of our study is to measure the impacts on economic mobility and food security outcomes, we also extend our analysis to other relevant outcome indicators including agricultural revenues, access to financial activities, and access to rural infrastructure.

China provides a special setting to investigate the impacts of agricultural development projects with poverty reduction and growth-driven objectives. During the past few decades, various development projects focusing on agriculture such as agricultural extension, technology adoption, microfinance initiatives, rural environmental improvements, have been implemented in rural areas to foster rural economic growth (Laufer and Schäfer, 2011; Degert et al., 2016). Despite various development initiatives aimed at improving the living conditions of rural citizens, rural poverty is still widely prevalent. A number previous of studies have investigated the impacts of the agricultural projects in China on various agricultural and welfare outcomes including income, saving, and consumption (Ravallion and Chen, 2005; Li et al., 2011), farm revenues and market participation (Ito et al., 2012), management skills (Yang et al., 2008), and migration (Li

et al., 2004). As these projects previously evaluated usually cover a small geographical area, the extent to which their findings can be generalized to other areas of rural China is limited. Our study contributes to this literature strand by evaluating a series of seven agricultural projects in rural China, which covers a vast landscape exhibiting substantial geographical heterogeneity.

In this study, we conduct an ex-post impact evaluation of multiple agricultural projects in China supported by IFAD to examine the impact on beneficiaries' economic mobility and welfare outcomes. To the best of our knowledge, this is the first rigorous effort that measures the impact of multiple agricultural projects retrospectively in China. These seven projects in China mainly consist of three focal components: rural finance, rural infrastructure and social development interventions. Rural finance includes rural financial services, microfinance for women, and village-level mutual development funds. Rural infrastructure interventions span from improvements of elementary schools conditions such as maintenance, as well as curriculum development for teachers, to improving sanitary conditions, providing drinking water supplies and roads construction and rehabilitation. Also on the environmental side, ecological environment restoration with afforestation and meadow conservation, biogas digesters equipped with planting and breeding facilities, are also provided as part of supported interventions. Social development programs aim at providing female literacy and skills training, improving women's capacity building on practical techniques and management, skill training on breeding and planting, technical supervision from special agricultural commissioners, and agro-technical extension trainings.

A common feature in all seven projects is to improve the income-generating capacity of the poor by providing them with greater access to production means and improved living conditions. This study also builds on previous work conducted by Shuai et al. (2011) who assessed the aggregate impacts of 12 agricultural projects in China between 1981 and 2006 on outcomes including farm income, food security, capacity building, and project sustainability. Results indicate that the projects in China have had positive and significant impacts across different economic mobility and welfare indicators.

Using a primary household survey consisting of 1,356 households, we employ the matching estimator to reconstruct the counterfactual from households sampled in the villages that do not receive the projects. We estimate the ex-post impacts of the seven projects in China on five categories of outcomes: economic mobility, agriculture, food security, access to rural finance services, and access to rural infrastructure. Our results indicate that households in the treatment group have higher levels of durable asset accumulation. Treated households also receive higher revenues from sales of forest products, grow more types of crops (both for overall crops grown and only for cash crops), are more likely to consume non-staple food items, and have greater access to financial savings. Finally, treatment households have greater access to rural infrastructure namely health clinics and schools.

This study contributes to the literature on rural development initiatives in at least three aspects. First, this work responds to the call for rigorous counterfactual-based impact evaluations of agricultural projects by international funding agencies including the

Inter-American Development Bank (IDB) and the World Bank (IDB, 2010; World Bank, 2010; Winters et al. 2011). While most of the existing impact evaluations of agricultural-related projects are evaluations of one project in a particular setting, our study adds to the literature by evaluating several agricultural projects in China. Although the settings of project locations share several common features including high poverty prevalence, lack of access to markets, the geographical attributes of the areas where several projects in China took place vary greatly, which allows us to capture the impacts of the project across a broad geographical scope.

Second, we complement the existing studies on rural development policies in rural China, a setting which has seen constant and rapid economic growth during the past few decades (Lin, 1992; Kanbur and Zhang, 2005; Ravallion and Chen, 2007; Shuai et al., 2011). While Lin (1992), Kanbur and Zhang (2005), and Ravallion and Chen (2007) analyze broad changes in agricultural trends of rural China, our study focuses specifically on evaluating agricultural development projects. Our study undertakes a portfolio-level impact evaluation of all projects supported by the same financial institution in China during a certain period of time along the line of Shuai et al. (2011), which allows us to assess the overall impact of several agricultural development projects supported by an international organization in a given country during a given period of time. Building on the work by Shuai et al. (2011), we improve the methodology to evaluate impacts of multiple agricultural projects in China by using a rigorous counterfactual-based methodology, which would allow us to generate more precise estimates of impacts on economic mobility, and other relevant welfare outcomes.

Third, our work relates to the strand of studies which use non-monetary indicators to measure economic mobility. Previous studies have used asset indices to measure poverty or economic mobility (Carter and Barrett, 2006; Shanks et al., 2010). We extend the analyses in this area by using asset indices to investigate the impacts of agricultural projects on economic mobility with a rigorous counterfactual-based approach. Our work does not limit the measurement of economic mobility to only a single indicator, which is also suggested by previous studies (Alkire, 2007; Garbero 2016). Finally, we supplement the economic mobility results with nutritional outcomes. In particular, our work complements the growing body of literature related to the relationships between agricultural projects and dietary diversity outcomes, specially on the consumption of non-starchy staple food items including meat, dairy products, and fruits and vegetables (Rawlins et al., 2014; de Brauw et al., 2015; Darrouzet-Nardi et al., 2016; Jodlowski et al., 2016).

The remaining sections of this paper are organized as follows. In Section 2, we describe our approach to define and measure economic mobility using asset-based indicators. In Section 3, we present the descriptive statistics of our dataset, and describes the setting of our study takes place. Section 4 outlines our methodology to estimate the impacts of the agricultural projects in our setting. We present our results of the impact estimates in Section 5, and concludes the paper along with discusses some policy implications related to rural development policies in China in Section 6.

2. Defining and measuring economic mobility

Rural economic growth is a topic of research which has gained widespread interest in

sociology, economics, and management science. Specifically, researchers have been continuously develop the empirical approaches to address two research questions: (1) how to define and measure economic mobility, and (2) how to evaluate the extent to which interventions through agricultural development projects may contribute to fostering rural economic mobility. There exists substantial research on the choice of proxies for economic mobility. However, in terms of data availability for impact evaluation using empirical methods, obtaining accurate data from households before the project had taken place is usually difficult, causing great challenges for obtaining unbiased estimates for project impacts.

Obtaining reliable household income data is challenging due to the fact that a considerable portion of the labor force in developing countries is concentrates in agricultural production and private businesses. As a result, self-reported household income data may be subject to measurement error or misreporting. One common alternative is to use household consumption data as proxies for poverty or economic mobility indicators (Khanna et al, 2015; Garbero 2016). Researchers also use an asset index to measure poverty or economic mobility instead of income (Shanks et al., 2010). Carter and Barrett (2006) propose a new approach to measure household economic mobility indices based on the theory of assets in the poverty trap literature, by using household assets to measure chronic poverty and transient poverty prevalence. Thus, the asset index approach is widely used to measure middle and long term poverty prevalence as an alternative approach to using only money-metric indicators (Booysen et al., 2008; Dang and Lanjouw, 2013; Dang et al., 2014; Garbero, 2014; Sweeney et al., 2016). The

combination of two conceptually-distinct poverty indicators to evaluate the targeting performance of agricultural development projects can be useful, and thus can improve the validity of impact estimates of projects in an impact evaluation setting using a counterfactual-based approach (Notten, 2015).

To provide a better understanding of the prevalence of economic mobility, a careful attention should be given to welfare indicators beyond household income (Drèze & Sen, 2006). Multi-dimensional indicators may provide more accurate information of household welfare, as the concept of poverty or economic mobility cannot be measured using one single indicator (Alkire, 2007; Garbero 2016). Thus, multi-dimensional indicators index is widely used in the impact evaluation of projects related to economic mobility (Islam, 2014). In this study, we address the data and technical challenges discussed in the literature by overcoming the challenges of obtaining reliable money-metric indicators by using asset indices to measure economic mobility, and by providing multi-dimensional measures of economic mobility by constructing several asset indices including durable asset index, productive asset index, and the overall asset index including both types of asset in one single asset index.

3. Data and Setting

Our study estimates the aggregate impacts of seven agricultural projects supported by IFAD in China. These seven projects represent the entire portfolio of IFAD's operations at the time of their implementation. These seven projects are estimated to have benefited more than 5.4 million beneficiaries in more than 1.1 million households. These projects covered a total of nine provinces across the Northwest (Xinjiang, Inner Mongolia, Gansu,

Ningxia, Shaanxi), the Southwest (Sichuan, Chongqing) and the Central (Henan) regions in China, as illustrated in Figure 1. In Table 1, we provide a list of the projects considered in this study, along with short summaries describing the interventions in the project. Counties to receive the projects were identified through the vulnerability assessment mapping (VAM) approach according to the poverty ranking categories classified by the Poverty Alleviation Office (PAO) of the Chinese federal government..[7] The villages participated in the projects were selected through a participatory approach according to the local demand. Within the villages, each household was classified into one of four categories based on their per capital household income levels according to the nationally-defined thresholds: A, B1, B2, and C.[8]

[Table 1 around here]

In terms of selecting the optimal sample size for this study, we use secondary data of 18 counties on per capita net income of households three provinces covered by the projects (Gansu, Henan and Sichuan). Before the projects in our setting were implemented, the annual average per capita household income of the population in project counties was 3,197 RMB , with a standard deviation of 1,120 RMB, and an intra-cluster correlation coefficient (ICC) of 0.17.[9] Then, we simulate the sample sizes under seven scenarios given the minimum power of 90%, assuming that the project will increase per capita household income for the treatment group by different increments ranging from 5% to 50%, as illustrated in Table 2.

[7] China's PAO publishes a list of poverty-stricken villages in rural areas all around China. The ranking categories are determined by the annual per capita of household income as a proxy for household wealth.

[8] The four categories representing household wealth status are as follows: A – poor, B1 – normal, B2 – poor, and C – very poor. Unfortunately, we do not have this information available in our dataset, and thus cannot control directly for the weather status of the household in our estimation.

[9] 1 Chinese Yuan (RMB) = 0.15 US$ (in 2014) approximately.

[Table 2 around here]

Considering the fast pace of economic growth witnessed in China during the past few decades, we assume that the increase in household income during the project life (approximately 5 - 6 years in our setting) should be at least 20%. Therefore, among the above seven scenarios, Scenario 4 with at least 900 household in our sample should be sufficient for us to detect any statistically significant changes in the variables of interest. As our estimation strategy involves a propensity score matching approach, a number of observations would be excluded from the analysis. Therefore, we increase the calculated sample size by at least 50%, resulting in a total of 1,354 households in seven provinces.

The research team conducted a primary data collection in 49 villages in seven provinces between November 2014 and February 2015. The survey collected data from households in the villages that received the projects (treatment), and in the villages without projects (control). The treatment and control villages from the same county were selected from village-level characteristics considered to be similar across both groups of villages. We consulted the local project implementation officers at the provincial and at the regional levels to help us select the most appropriate villages to become part of the control group.

Our dataset consists cross-sectional data with recall information to the time period five years preceding the time of survey, which was before the start of the projects. Of all 1,354 households surveyed, 796 households received the project activities (treatment), and 556 which did not (control). The dataset denotes the type of project component(s) of which a household is a beneficiary, from a list of three categories: rural finance, infrastructure, and social protection. IFAD classifies projects depending upon their main

budgetary allocation. In our setting, the budgetary allocation determines that five of the seven projects are classified as "agriculture," one is classified as "rural development," and the last one is classified as "credit." A particular project may deliver more than one type interventions beyond its classified type, but still have a singular classification.

We adopted a multi-stage stratified sampling approach to construct our dataset. Since there are a total of seven projects in nine provinces (two projects covered two provinces and the other five projects covered one province each), only one province was randomly chosen to be included in the sample for the two projects which took place in more than one province. The survey design randomly selected one county in each province containing project beneficiaries.[10] Then within each county selected, four villages within each province was randomly selected from all the villages in the province which received the project. Then, they were paired with three other villages from the same county in the same province which did not receive the project. The village characteristics used as the criteria to pair the beneficiary and the non-beneficiary villages in each province were baseline income, farmland area, distance to road, and elevation from the mean sea level. Finally, approximately 27 households randomly are selected from seven villages in each province (four beneficiary and three non-beneficiary villages).

4. Methodology

The projects analyzed in this study generally involve three main focuses: rural finance, rural infrastructure development, and social development. Each component is carried out through various activities, all aimed at helping the poor to improve their welfare

[10] The surveyed county was selected randomly from the list of counties with villages receiving the project within a province.

outcomes by providing them with means of production and fostering their viability. We hypothesize that the implementation of these seven projects in China have positive impacts on households living the project villages. As the project interventions vary across different villages, and also across different households in project villages, our average treatment estimates on the treated (ATT) obtained are considered the intention-to-treat (ITT) estimates of the projects. The estimated impacts may at least reflect in the changes of farmers' asset ownership, household income, and living conditions. A number of research hypotheses can be advanced from the details about the interventions carried out by the projects in China according to five sets of outcomes: economic mobility, agriculture, food security, financial activities, and access to rural infrastructures.

4.1 Construction of economic mobility indicators

Our study uses information about household-level asset ownership to construct asset indices as proxies for measuring economic mobility. Existing studies have used asset-based indicators or asset indices to measure household wealth and poverty outcomes (Booysen et al. 2008; Wall and Johnston, 2008; Ezzrari and Verme, 2012; Garbero, 2016). Principal components analysis (PCA), and multiple correspondence analysis (MCA) methods are among the most common approaches to construct asset indices (Blasius and Greenacre, 2006; Booysen et al., 2008; Michelson et al., 2013). Rather than relying on a single asset index, we follow the methodology in Garbero (2016) to construct the asset indices for durable, productive, and overall assets. We use the MCA approach to construct the asset index for durable assets, which consists of categorical

variables.[11] For productive asset variable, which are continuous, we use the PCA method to construct the asset indices. Further, we combine all asset indices into one single indicator consisting of overall household assets by using the polychoric factor analysis method (Kolenikov and Angeles, 2004). This approach allows one to combine categorical and continuous variables to construct a single asset index in the form of a continuous variable.

4.2 Impact estimates from the five matching estimators

We construct the comparison group by using the propensity score matching (PSM) approach to match households in the treatment and in the control groups based on a number of observed characteristics. The PSM approach allows us to control directly for the selection into project participation based on observable characteristics. The PSM results show considerable common support between households in treatment and control groups, which helps confirm that the conterfactual group was constructed appropriately, as shown in Figure 1. We present the descriptive of the households in the unmatched sample and the matched sample for comparison purposes in Table 3.

[Table 3 around here]

While it is true the descriptive statistics for the matched sample presented in Table 3 still show some evidence of systematic differences between households in both groups, Figure 2 illustrates that PSM reduces the standardized percentage of bias across all the covariates substantially. Specifically, PSM reduces the level of bias across all covariates

[11] In our dataset, durable asset items include motorcycle, car/truck, washing machine, refrigerator, television, computer, mobile phone, jewelry, number of rooms per capita (quintiles), source of cooking fuel, type of floor, and main source of drinking water.

from 45% to 11%, which is lower than Rubin's suggested threshold of 25% (Rubin, 2001). Therefore, propensity score matching improves the quality of the counterfactual group for the project beneficiaries. We impose common support by excluding observations in the treatment group whose propensity scores are higher than the maximum or lower than the minimum of the observations in the control group. We also trim the sample at the 2nd and the 98th percentiles of the propensity score to improve the common support between the treatment and the control groups (Smith and Todd, 2005). The total number of households remaining in our analysis after imposing common support and trimming the dataset is 1,274 (745 treatment and 529 control households). We can presentation the mathematical expression of the estimated impacts of the projects on the outcomes of households as follows:

$$\Delta_i = Y_{1i} - Y_{0i}$$

where Δ_i denotes the impact of the project, Y_{i1} refers to the outcome of household i when receiving the project, Y_{i0} and is the outcome of household i in the absence of the project. Further, we can express the average treatment effects among those that receive the treatment (ATT) estimates as follows:

$$ATT = E(\delta_i|T = 1) = E(Y_{i1} - Y_{i0}|T = 1).$$

The five impact estimators used in this study include (1) regression adjustment (RA), (2) nearest neighbor matching with five nearest neighbors (PSM), (3) covariate matching with five nearest neighbors (NN), (4) inverse probability weighting (IPW), and (5) inverse probability weighting combined with regression adjustment (IPWRA). It is important to note that the IPWRA estimator is a "doubly-robust" estimator (Wooldridge, 2007). The doubly-robust estimator contains two models: the propensity to receive

treatment model, and the potential outcome model. The doubly-robust property of this estimator allows for the flexibility that only one of the two models needs to be specified correctly to provide consistent treatment effects estimates (Wooldridge, 2010).

While attempting to create a counterfactual group to estimate the treatment effects of the projects by including a number of observable characteristics, there may be a number of factors that potentially confounded our results. First, there is no real baseline information, which limits us to control directly for any time-varying characteristics of the households before the interventions started, or any pre-existing conditions facing the households in our sample. Thus, there may still be unobservable differences (such as access to markets or agro-climatic conditions) across the households that may drive the results. Such effects may also be correlated with the capacity of the households to capitalize the benefits received from the projects into the improvements in the outcomes of interest. Second, there is insufficient documentation about the exact implementation criteria with which households were selected into receiving the project. If the households were selected into receiving the project based on the characteristics unobservable by the researcher, the results may be driven by unobserved characteristics, and may still contain bias due to such selection into treatment.

4.2 Extrapolation of impact estimates

(UNDER CONSTRUCTION)

5. Results

5.1 Impact estimates from the five treatment effects estimators

The results from the five different estimators are presented in Tables 4 and 5. Columns (1) to (5) of both tables presents the overall treatment effects estimates using RA, PSM, NN, IPW, and IPWRA estimators, respectively. For all estimates, the control variables included in the estimation models are age (in years), sex, and educational attainment (highest level of education achieved) of the household, ethnicity, religion, demographic information (household composition of adults and children), asset ownership, and land ownership.

In Column (6), we report the average levels of the outcomes for the households in the control group, which allow us to calculate the magnitude of increases in the outcomes of interest using the point estimates of the treatment effects. Overall results illustrate that our five estimators provide consistent estimates of the impacts of seven IFAD-supported projects in China (both in terms of direction and magnitude) on economic mobility, agricultural production, food security, access to rural financial services, and access to rural infrastructures. As the IPWRA estimator is a doubly-robust estimator, our discussions of the magnitude of the results will focus on the point estimates of the treatment effects using the IPWRA estimator.

[Table 4 around here]

Panel A of Table 4 reports the treatment effects estimates of the projects on economic mobility indicators, as proxied by asset indices. On average, households in the treatment group have 10% higher asset index for durable assets than that of households in the control group. However, we do not find significant changes in productive assets. Further, we also do not find a significant impact of the project on the overall asset indices among

the households in the treatment and the control groups.

In Panel B, we present the estimates of the projects on agricultural production outcomes. We observe a positive and significant increase in the levels of agricultural revenues among the households in the treatment group. We also find that the increase in agricultural revenues is mostly driven by the revenues from forest products (a 8% increase relative to the control group on average). Households in the treatment group grow more types of crops on average, both for any type of crops, and for specifically cash crops. The magnitudes of the increases are approximately 18% and 16% higher than those of the mean of the control group. Households in the treatment group also have greater areas of arable land for agricultural production. However, the difference is not significant between households in the treatment and the control groups.

[Table 5 around here]

In Table 5, treatment effects estimates on food security outcomes are reported in Panel A. Based on a seven-day recalled information, we ask whether household members consumed food items that are fruit and vegetables, dairy or meat products, all of which are non-starchy staple food items. Overall, results show that households in the beneficiary villages (treatment group) are more likely to have consumed non-staple food items than households living in the non-beneficiary villages (control group). In terms of magnitude, households in the treatment group are more likely to have consumed fruits and vegetables by 3%, dairy products by 11%, and meat products by 9% relative to the mean of the control group. This set of results provide evidence that households in the treatment group are likely to have higher food security levels than households in the

control group as they are more likely to have consumed non-starchy food items according to the survey.

In Panel B, we report the treatment effects estimates on two types of rural financial services: savings and formal insurance. We do not find that households in the treatment group have significantly greater amount of savings than households in the control group. However, we find that households in the treatment group invest 3% higher amount of insurance premium on average, indicating that they have greater access to formal insurance mechanisms.

As a test for the sensitivity of results, Rosenbaum bounds were calculated on the estimates (Rosenbaum, 2002). That is, by increasing the magnitude of hidden bias at various increments (10%, 20%, and so on), the Rosenbaum bounds report at which level the estimated effect of the project will no longer be statistically significant due to the increase the level of bias due to unobservables. We calculate the Rosenbaum bounds at the 10% significance level. Our calculations indicate that the robustness of the estimates to hidden bias varies for the outcome variables considered in this assessment report. The results from the Rosenbaum bounds indicates that it would require a substantial increase in the magnitude of hidden bias to eliminate the significant effects of the estimates projects in our setting.[12]

The results in Table 4 and Table 5 illustrate the overall estimates of the impact of the seven projects. We supplement the analysis of the overall estimates by providing a stratified analysis by project type. In our setting, there are five projects classified as

[12] The results from the Rosenbaum bounds estimates are not reported in this paper, but are available upon request.

agriculture, one as a credit project, and one as a rural development project. We separate our stratified analysis into two sets of results. The first set of results investigates of the projects classified as agriculture, as reported in Tables 6 and 7. As described in Table 1, projects classified as agriculture focus on delivering activities specifically targeted to improve agricultural production outcomes. Specifically, these projects delivered interventions related to agricultural extension services, technology adoption, market linkages, and marketing support to their beneficiaries.

[Tables 6 and 7 around here]

In Table 6 Panel A, our results indicate that beneficiaries of the projects classified as "Agriculture" see increases in their durable asset accumulation, as indicated the values of their durable asset indices. The results are positive, and are consistently significant across all estimators in Columns (1) to (5). In Panel B, our results show that treated households have higher agricultural revenues, in particular from forest products. They cultivate higher number of crops overall, and also cultivate higher number of cash crops specifically. In Table 7 Panel A, results show that treated households are more likely to consume non-starchy food items including meat, fruits and vegetables, and dairy products when compared to control households. And finally, they are more likely to invest in insurance premium, as shown in Panel B of Table 7.

[Tables 8 and 9 around here]

Turning to the analysis for only the two projects classified as "Credit" and "Rural development" in Tables 8 and 9. Similar to the results from the projects classified as "Agriculture," in Table 8 Panel A we also find that treated households greater durable

asset accumulation. However, the impact is not consistently significant across all estimators. In Panel B, we find that beneficiaries of "Credit" and "Rural development" projects have significantly lower revenues from forest products. This finding is not surprising as the project activities may have encouraged them to divert their livelihood activities to other income-generating activities apart from agricultural production. In Table 9, Panel A reports the consumption of non-starchy food items is only positive and significant for meat products, but not for dairy items, or vegetables and fruits. In Panel B, we find that treated households have lower amount of savings, and lower investments in insurance premium. While the estimates are not consistently lower across all estimators, this finding might be due to the fact that the investments in the income-generating activities promoted by the projects necessitated the households to liquidate their savings and divert the budget otherwise dedicate to insurance purchases to be allocated to the investments in the inputs of the income-generating activities.

Overall, our stratified analysis by project type reveals that the beneficiaries of the projects classified as "Agriculture" witness improvements in their durable asset accumulation, agricultural revenues, and nutrition. Specifically for the significant impacts of the projects on dietary diversity outcomes, our findings correspond to the positive and significant impacts found in previous studies investigating the impacts of agricultural projects on dietary diversity (Rawlins et al., 2014; de Brauw et al., 2015; Darrouzet-Nardi et al., 2016; Jodlowski et al., 2016). For the two projects classified as "Credit" and "Rural development," we find significant but more limited impacts on durable asset accumulation, and only on the consumption of meat products (and not on

the consumption of dairy products or of vegetables and fruits). These findings are not surprising, as the nature of the project interventions may not have focused directly on improving the productive capacity of agricultural production among the beneficiaries. Further, the magnitude of the credit or rural development interventions may not be sufficient to generate drastically significant changes in the outcomes of the beneficiaries.

5.2 Extrapolation of impact estimates

(UNDER CONSTRUCTION)

6. Conclusion

During the past decade, there has been a growing interest from international financial organizations in the extent to which investments in rural agricultural projects may generate significant results. This study responds to this recent call made by funding agencies like the World Bank and the IDB for greater amount counterfactual-based rigorous impact evaluations of agricultural development projects. The setting of our study is in rural China, where the economy has witnessed rapid growth during the past few decades both in urban and rural areas. Therefore, our setting provides an interesting scenario to study the impact of agricultural interventions in the context where the economy is growing rapidly. Further, it contributes to the literature on the rural development policies in China, which has documented notable changes in the socio-economic performance of the rural sector during the past few decades.

We present an example of rural agricultural interventions by analyzing seven agricultural projects related to agriculture supported by IFAD. Our results illustrate positive and

significant impacts on economic mobility of treated households, as measured by asset indices. We observe a significant change in the economic mobility indicator in the durable asset index. Households in the treatment group see an improvement in their revenues from agricultural production, which is largely driven by the revenues from forest products. They also cultivate more types of crops, both for overall crops cultivated and specifically for cash crops, a possible evidence that households who receive the project are able to greater diversify their crop choice.

In terms of food security outcomes, our findings show that households in the treatment have increases in the consumption of fruits and vegetables, dairy, and meat products. While they invest a greater amount on insurance premium relative to the control group, they do not have significantly higher amount of savings. Finally, the results indicate that households in the treatment group have access to higher numbers of health clinics and schools.

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Figure 1: Distribution of the IFAD project areas and sampling areas

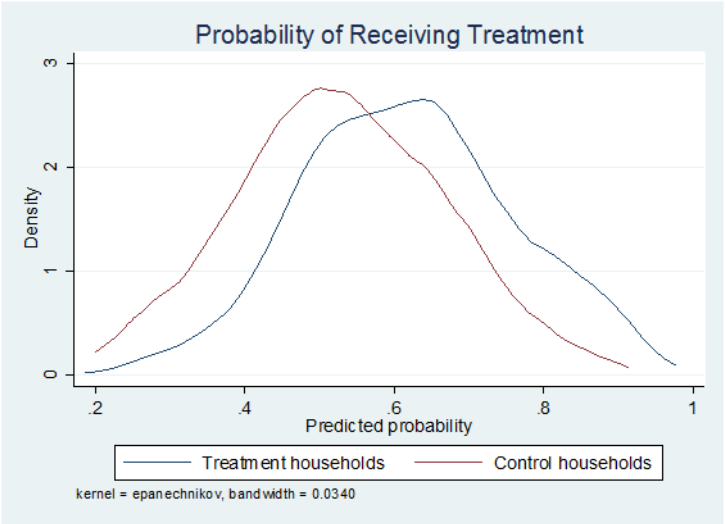

Figure 2: Common support

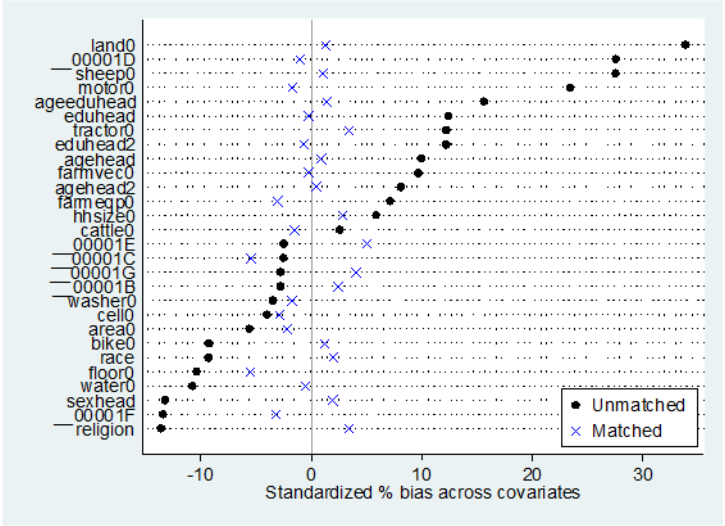

Figure 3: Bias reduction after propensity score matching

Table 1 Summary of IFAD-supported projects in China

Project	Type	Summary
Environment Conservation and Poverty-Reduction Programme (ECPRP, 1223), Ningxia & Shanxi	Agriculture	Aims to achieve increased agricultural output and social service access, mainly through improving the development of human capital, access to rural finance, and provision of improved irrigation.
Rural Finance Sector Programme (RFSP, 1227), Shaanxi & Chongqing	Credit	Aims to ensure that rural financial services contribute effectively and sustainably to reducing poverty through improving access to such services. It should help reduce the transactions cost in obtaining credit. As a result, beneficiaries are excepted to benefit from greater amount of expenditures, higher revenues from agriculture, and higher rates of input investments and technology adoption.
South Gansu Poverty-Reduction Programme (SGPRP, 1271), Gansu	Agriculture	Broad rural poverty reduction project comprising of various infrastructure, microfinance and social development services. Therefore, beneficiaries are expected to have greater access to markets, lower transactions cost of borrowing, and greater revenues from crops and livestock.
Xinjiang Uygur Autonomous Region Modular Rural Development Programme (MRDP-XUAR, 1323), Xinjiang	Agriculture	Aims to contribute to sustainable poverty reduction and gender equality through various social and economic development services including improving rural infrastructure and access to rural finance. Expected outcomes from the project include greater market access, technology adoption, farm investments, and higher revenues from agriculture.
Inner Mongolia Autonomous Region Rural Advancement Programme (IMARRAP, 1400), Inner Mongolia	Agriculture	Works to reduce rural poverty through social development and infrastructure support and improving access to information, technology, rural financial services and markets. It is expected that the project to help beneficiaries improve their market access, farm investments, technology use, and farm revenues.
Dabieshan Area Poverty Reduction Programme (DAPRP, 1454), Henan	Agriculture	Aims to achieve sustainable poverty reduction though a range of agricultural development services, including market access support and microfinance, with strategic support being offered to very poor groups. Beneficiaries of the project should expect to see improvements in poverty status, agricultural production, and household income.
Sichuan Post-Earthquake Agriculture Rehabilitation Project (SPEAR, 1478), Sichuan	Rural development	Aims for rapid, balanced recovery of the agricultural sector and living standards through various infrastructure and technology development services, such as improving access to environmentally friendly rural energy. The project aims to foster investments in farm inputs, expand agricultural production, and increase rural income.

Table 2 Results of Sample Size Simulation with seven scenarios

Power	Minimum 90%						
Scenario	1	2	3	4	5	6	7
Assumed effect size	5%	10%	15%	20%	30%	40%	50%
Standardized MDE	0.14	0.28	0.43	0.57	0.86	1.14	1.43
No. of observations per cluster	30	30	30	30	30	30	30
No. of clusters (approx.)	430	102	48	30	16	12	8
Sample size	12900	3060	1440	900	480	360	240

Note: MDE stands for the Maximum Deviation Error.
Source: Household survey conducted by CUG (2014).

Table 3: Comparison of descriptive statistics: Unmatched and matched samples

Descriptive characteristics	Unmatched			Matched		
	Treatment	Control	p-value of difference	Treatment	Control	p-value of difference
Sex of HH head (=1 if male)	0.90	0.93	0.02	0.90	0.93	0.05
Age of HH head (years)	50.96	49.77	0.07	50.84	50.33	0.45
HH size (count)	4.16	4.08	0.29	4.15	4.10	0.47
No. of adults (count)	3.41	3.40	0.91	3.42	3.39	0.63
No. of children (count)	0.77	0.87	0.05	0.77	0.84	0.13
Education of HH head (level)	1.24	1.14	0.03	1.26	1.18	0.06
Ethnicity (=1 if Han)	2.32	2.47	0.09	2.35	2.49	0.14
Floor materials (=2 if improved)	1.60	1.68	0.06	1.63	1.70	0.09
Source of water (=2 if well/pipe)	1.80	1.84	0.05	1.78	1.83	0.04
N	796	558	1,354	745	529	1,274

Source: Household survey conducted by CUG (2014)

Table 4: Estimates of the average treatment on the treated (ATT) effects of the seven projects

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Economic mobility							
Overall asset index	1,274	0.001	0.018	0.042	0.019	0.019	0.456
		(0.029)	(0.038)	(0.029)	(0.033)	(0.028)	
Durable asset index	1,274	0.047***	0.050***	0.044***	0.048***	0.049***	0.460
		(0.009)	(0.007)	(0.011)	(0.009)	(0.009)	
Productive asset index	1,274	-0.0280	0.149*	0.0541	0.0676	0.0150	1.002
		(0.099)	(0.088)	(0.088)	(0.089)	(0.093)	
B. Agricultural production							
Agricultural revenue (yuan)	1,274	0.198	0.333*	0.178	0.342*	0.393**	7.325
		(0.209)	(0.179)	(0.187)	(0.188)	(0.184)	
Crop revenue (yuan)	1,274	0.0795	0.220	0.0846	0.244	0.278	1.012
		(0.219)	(0.185)	(0.196)	(0.192)	(0.190)	
Forest product revenue (yuan)	1,274	0.524***	0.611***	0.564***	0.537***	0.564***	7.066
		(0.156)	(0.154)	(0.138)	(0.152)	(0.149)	
No. of crops grown	1,274	0.298***	0.348***	0.275***	0.356***	0.360***	1.977
		(0.081)	(0.072)	(0.080)	(0.074)	(0.073)	
No. of cash crops grown	1,274	0.123***	0.097**	0.060	0.123***	0.130***	0.781
		(0.041)	(0.043)	(0.043)	(0.046)	(0.039)	
Total arable land (hectare)	1,274	1.530***	1.044	0.755	1.230	1.377**	0.604
		(0.587)	(0.741)	(0.559)	(1.143)	(0.540)	

Source: Household survey conducted by CUG (2014).

Note: All revenue variables are in the logarithmic scale. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.

Table 5: Estimates of the average treatment on the treated (ATT) effects of the seven projects

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Food security (consumption)							
Fruit and vegetables (7 days)	1,274	0.113***	0.169***	0.173***	0.161***	0.120***	4.562
		(0.038)	(0.039)	(0.041)	(0.045)	(0.038)	
Dairy products (7 days)	1,274	0.354***	0.360***	0.379***	0.383***	0.367***	3.215
		(0.061)	(0.062)	(0.064)	(0.065)	(0.062)	
Meat products (7 days)	1,274	0.327***	0.358***	0.319***	0.355***	0.329***	3.853
		(0.058)	(0.064)	(0.063)	(0.058)	(0.058)	
B. Financial services and income							
Total savings (yuan)	1,274	-0.265	-0.130	-0.0325	-0.270	-0.285	5.583
		(0.298)	(0.221)	(0.313)	(0.309)	(0.302)	
Insurance premium (yuan)	1,274	0.138***	0.160***	0.135**	0.135**	0.157***	6.136
		(0.053)	(0.054)	(0.058)	(0.058)	(0.053)	

Source: Household survey conducted by CUG (2014).

Note: Food security (consumption) variables represent the number of days (during the past seven days preceding the date of survey) members of the households consumed the given food items. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.

Table 6: Estimates of the average treatment on the treated (ATT) effects of the projects classified as "Agriculture"

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Economic mobility							
Overall asset index	1,068	0.007	0.003	0.034	-0.001	0.025	0.456
		(0.037)	(0.048)	(0.038)	(0.045)	(0.033)	
Durable asset index	1,068	0.057***	0.072***	0.050***	0.061***	0.054***	0.460
		(0.012)	(0.012)	(0.012)	(0.014)	(0.012)	
Productive asset index	1,068	0.167	-0.009	0.058	-0.065	0.026	1.002
		(0.201)	(0.118)	(0.121)	(0.143)	(0.106)	
B. Agricultural production							
Agricultural revenue (yuan)	1,068	0.437*	0.665**	0.291	0.441	0.602**	7.325
		(0.235)	(0.266)	(0.187)	(0.271)	(0.178)	
Crop revenue (yuan)	1,068	0.143	0.380	0.025	0.148	0.308	1.012
		(0.243)	(0.267)	(0.199)	(0.269)	(0.183)	
Forest product revenue (yuan)	1,068	1.171***	1.080***	1.136***	1.301***	1.220***	7.066
		(0.209)	(0.208)	(0.208)	(0.187)	(0.197)	
No. of crops grown	1,068	0.357***	0.428***	0.280***	0.335***	0.365***	1.977
		(0.092)	(0.093)	(0.097)	(0.088)	(0.078)	
No. of cash crops grown	1,068	0.265***	0.356***	0.221***	0.249***	0.274***	0.781
		(0.054)	(0.045)	(0.058)	(0.065)	(0.048)	
Total arable land (hectare)	1,068	0.103*	0.254***	0.078	-0.047	0.092*	0.604
		(0.056)	(0.076)	(0.057)	(0.095)	(0.049)	

Source: Household survey conducted by CUG (2014).

Note: All revenue variables are in the logarithmic scale. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.

Table 7: Estimates of the average treatment on the treated (ATT) effects of the projects classified as "Agriculture"

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Food security (consumption)							
Fruit and vegetables (7 days)	1,068	0.168***	0.164***	0.171***	0.233***	0.175***	4.562
		(0.054)	(0.054)	(0.055)	(0.062)	(0.049)	
Dairy products (7 days)	1,068	0.572***	0.587***	0.565***	0.675***	0.617***	3.215
		(0.076)	(0.075)	(0.079)	(0.083)	(0.077)	
Meat products (7 days)	1,068	0.364***	0.433***	0.400***	0.423***	0.348***	3.853
		(0.070)	(0.067)	(0.068)	(0.074)	(0.066)	
B. Financial services and income							
Total savings (yuan)	1,068	0.342	0.578	-0.040	0.392	0.374	5.583
		(0.377)	(0.384)	(0.379)	(0.441)	(0.365)	
Insurance premium (yuan)	1,068	0.255***	0.292***	0.217**	0.289***	0.249***	6.136
		(0.057)	(0.056)	(0.055)	(0.059)	(0.055)	

Source: Household survey conducted by CUG (2014).

Note: Food security (consumption) variables represent the number of days (during the past seven days preceding the date of survey) members of the households consumed the given food items. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.

Table 8: Estimates of the average treatment on the treated (ATT) effects of the projects classified as "Credit" and "Rural development"

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Economic mobility							
Overall asset index	735	0.016	0.006	0.015	0.018	0.006	0.456
		(0.035)	(0.034)	(0.038)	(0.043)	(0.034)	
Durable asset index	735	0.025***	0.026***	0.023	0.011	0.025***	0.460
		(0.014)	(0.010)	(0.015)	(0.016)	(0.143)	
Productive asset index	735	0.027	0.076	0.024	0.047	-0.005	1.002
		(0.110)	(0.103)	(0.121)	(0.132)	(0.108)	
B. Agricultural production							
Agricultural revenue (yuan)	735	-0.389	-0.355	-0.458	0.009	-0.231	7.325
		(0.342)	(0.345)	(0.361)	(0.432)	(0.358)	
Crop revenue (yuan)	735	-0.179	-0.226	-0.325	0.108	-0.101	1.012
		(0.345)	(0.346)	(0.366)	(0.431)	(0.360)	
Forest product revenue (yuan)	735	-0.823***	-0.611***	-0.537***	-0.556***	-0.642***	7.066
		(0.155)	(0.150)	(0.164)	(0.117)	(0.122)	
No. of crops grown	735	0.196	0.162	0.057	0.283*	0.245*	1.977
		(0.137)	(0.131)	(0.148)	(0.158)	(0.136)	
No. of cash crops grown	735	-0.198***	-0.163***	-0.217***	-0.158**	-0.148**	0.781
		(0.062)	(0.061)	(0.068)	(0.074)	(0.063)	
Total arable land (hectare)	735	0.029***	0.042***	0.044***	0.057***	0.042**	0.604
		(0.014)	(0.007)	(0.016)	(0.012)	(0.011)	

Source: Household survey conducted by CUG (2014).

Note: All revenue variables are in the logarithmic scale. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.

Table 9: Estimates of the average treatment on the treated (ATT) effects of the projects classified as "Credit" and "Rural development"

Variable	*N*	(1) RA	(2) NN	(3) CM	(4) IPW	(5) IPWRA	(6) Control mean
A. Food security (consumption)							
Fruit and vegetables (7 days)	735	0.055	0.055	0.107*	0.108	0.095*	4.562
		(0.056)	(0.057)	(0.058)	(0.071)	(0.058)	
Dairy products (7 days)	735	-0.044	0.053	0.132	0.093	0.073	3.215
		(0.076)	(0.073)	(0.083)	(0.082)	(0.074)	
Meat products (7 days)	735	0.268***	0.313***	0.333***	0.246**	0.318***	3.853
		(0.095)	(0.102)	(0.101)	(0.102)	(0.094)	
B. Financial services and income							
Total savings (yuan)	735	-1.357***	-0.661	-0.766	-0.846	-1.137**	5.583
		(0.047)	(0.477)	(0.516)	(0.551)	(0.501)	
Insurance premium (yuan)	735	-0.179	-0.174*	-0.233**	-0.275**	-0.221**	6.136
		(0.109)	(0.105)	(0.1)	(0.118)	(0.110)	

Source: Household survey conducted by CUG (2014).

Note: Food security (consumption) variables represent the number of days (during the past seven days preceding the date of survey) members of the households consumed the given food items. Robust standard errors are in parentheses. Statistical significance at * < 0.1; ** < 0.5; *** < 0.01. Control variables include age, gender, and education level of the household head (including the interaction and squared terms of these variables), ethnicity, religion, household demographic information, recalled information about durable, livestock, farm assets, land ownership, and a dummy indicating the province in which households are located.