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The Sloping Land Conversion Program in China:
Effect on Rural Households' Livelihood Diversification

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Abstract: By overcoming the barriers that limit access to financial liquidity and human resource, the Sloping Land Conversion Program (SLCP) can promote rural livelihood diversification. This paper examines this effect using a household survey data set spanning the 1999 implementation of the Sloping land conversion program. Our results show that SLCP works as a valid external policy intervention on rural livelihood diversification. In addition, the findings demonstrate that there exist heterogeneous effects of SLCP implementation on livelihood diversification across different rural income groups. The lower income group was more affected by the program in terms of income diversification.

Key Words: Sloping Land Conversion Program; China; Livelihood diversification; Income diversity index; Identification condition; Difference in differences

1. INTRODUCTION

The contradiction of rural poverty and the environment has been the subject of discussion since the end of the previous century (Leonard 1989, World Bank 1992). Environmental resources can be broadly utilised by rural populations in various ways, such as gathering, grazing and other managed planting. It would be advantageous if people could regulate the use of certain resources. However, this balance is fragile and can easily break down in rural areas in developing countries. Leonard (1989) points out that rural poverty is intimately connected with environmental degradation, and poverty is seen as both a cause and a result of natural resource depletion

A lack of an income source and land resource due to population growth drives rural populations to rely on the extraction of environmental resources to a greater extent, such as gathering (firewood, building materials and fodder for animals), overgrazing grasslands, and the overuse of marginal land (Brundtland 1987). Furthermore, environmental degradation such as soil erosion, the over-grazing of pastures and the loss of watershed protection further intensifies the degree of poverty experienced by rural households which precipitates a downward spiral in the poverty-environmental nexus. Important in these explanations is a purported 'survival calculus' amongst the rural who are on the brink of destitution, so that helplessness leads them to consume the resources that would otherwise sustain their future survival because no other choices are available to them. The study by Ellis (2000) indicates that rural livelihood diversification[1] is important with regards to the poverty-environment equation, because it can directly switch the time allocation of the household from gathering activities, to off-farm or non-farm income generating activities by providing alternative sources to relieve the pressure on the environment. With the exhaustion of environmental resources and diminishing returns to fragile land on steep hillsides, it is reasonable for rural households to shift their labor activities from low labor return from crop production on environmental sensitive sloping fields, to high labor return activities. However, rural households always face an uphill struggle to overcome entry barriers, which include both human capital constrains such as education, skill and good health, and financial capital constraints (Ellis 2000, Smith et al. 2001). These barriers could be overcome by intervention policy which aims to improve the asset holdings of the rural, either by endowing them with additional financial, fixed, human, natural or social assets, or by increasing the productivity of assets they already hold, or both (Barrett et al. 2001).

This paper introduces the Sloping Land Conversion Program (SLCP) as an example to illustrate the effects of policy intervention on livelihood diversification, which contributes to the sustainability of a rural livelihood. China has been suffering from environmental problems caused by the destruction of rural households since the end of the last century. In response to this, the central government initiated the SLCP in 1999 to induce structural economic change at the local level by means of financial incentives to reverse the adverse poverty-environmental connection, alleviate poverty and improve environmental conditions, which are the main objectives of this program (Grosjean and Kontoleon 2009). Hence, the success of the program is determined by providing the rural households with alternative income sources that reduce their reliance on gathering activities from the local environment and reducing their motivation to initiate cultivation in

[1] Rural livelihood diversification is defined as the process by which rural households construct an increasingly diverse portfolio of activities and assets in order to survive and improve their standard of living (Ellis 2000), and they are complementary measures in the study of diversification behaviors. However, the prevailing practice is to emphasize livelihood diversification measures, since income offers a measure of direct interest because of its clear interpretation as a welfare outcome (Barrett et al. 2001). In addition, the income data from rural household surveys are much more exact and easy to interpret than assets information.

environmentally sensitive locations. This is achieved by providing options that make time spent in exploiting natural resources (above examples, gathering activities in forests and farming on sloping land) less remunerative than time spent doing other things (Ellis 2000). The growth of non-farm income sources, if accessible in remote rural areas might reduce the need for landless dwellers to carry out extractive practices in local environments for their survival. This has been called the 'substitution of employment for the environment' and has received quite a lot of attention in the policy literature (Lipton 1991).

Obviously, the implementation of the SLCP brings some changes and effects on the livelihood strategy of farm households in the rural areas, which has inspired extensive empirical policy evaluation studies on, e.g. income growth, inequality and off-farm labor participation. Li et al. (2011), Liu et al. (2010), Uchida et al. (2009) and Yao et al. (2010) all find that the program has had a significant positive effect on the income growth of participating households, whereas Xu et al. (2004) found that the effect on the income of participants is statistically insignificant. Besides, Kelly and Huo (2013), Qu et al. (2011) and Uchida et al. (2009) argue that participating households are increasingly shifting their labor endowment from on-farm work to the off-farm labor market, which is also a kind of diversification reaction, while the program was not successful in shifting labor into off-farm sectors during the first few years of implementation (Xu et al. 2004) .

As described above, a large literature exists which discusses either the change in income, or the change in the distribution of income activities. Our particular focus is on the impact of the SLCP on rural households' livelihood diversification as this captures the changes in income activities and their distribution simultaneously, which we consider a neglected aspect of the existing literature. In addition, as shown previously, livelihood diversification is an effective way of solving the problem caused by poverty and environmental degradation. Therefore, livelihood diversification can be used as an efficient indicator to evaluate the success and sustainability of the SLCP in China.

We make three contributions to the existing literature. First, the paper sheds light on the internal and external factors that motivate rural households to diversify their livelihood or income sources. Particularly, we attempt to investigate whether SLCP works as a valid external policy intervention on livelihood diversification, which is considered an effective means of solving the problem caused by poverty and environmental degradation. To the best of our knowledge, our study is the first to shift focus from analyzing the impact of SLCP on income growth and off-farm labor participation to livelihood diversification. Second, this study attempts to examine the heterogeneity in policy impact among different income groups by analyzing whether the effect on livelihood diversification differs across different rural income groups. Our results show that the low-income group benefits more in terms of livelihood diversification from the policy intervention. Accordingly, poverty alleviation in rural areas can be achieved by implementation of the SLCP. The third contribution is that this study revealed that the period between 1999 and 2010 was characterized by overall implementation of SLCP as well as recent policy adjustment since 2007. Our study provides a comprehensive analysis of the policy impact of SLCP and may fill the gap in the literature by providing evidence from the collected rural household data after the policy adjustment.

The paper proceeds as follows: Section 2 provides some background on the SLCP in China; Section 3 outlines the conceptual framework; Section 4 presents the data and defines the livelihood diversification index used in our study; Section 5 describes the empirical strategy and empirical specification; Section 6 reports the empirical results and discussions, while Section 7 concludes.

2. BACKGROUND OF SLOPING LAND CONVERSION PROGRAM

In response to growing environmental pressure and public protection awareness, the Chinese government initiated several ecological restoration programs in the late 1990s. The SLCP, which is also known as Grain for Green (GFG), is distinct from the other programs since it is one of the first, and certainly the most ambitious, programs based on payments for environmental services (PES) in China (Bennett 2008).

(a) *The initial state of SLCP*

The main reasons for the implementation of this PES program was the drought of the Yellow River in 1997 and the massive floods along the Yangtze River in 1998 (Xu and Cao 2002). The Chinese government initiated the SLCP to limit water and soil erosion by afforestation in three provinces – Sichuan, Shaanxi and Gansu – in 1999 and formally launched the program nationwide in 2002, which was originally designed to convert 14.67 million hectares of farmland to forest or grassland (4.4 million of which is on land with slopes above 25 degrees), and an additional "soft" goal of afforesting a roughly equal area of denuded mountains and wasteland by 2010 (SFA 2003).

The program focuses mainly on cultivated land on steep slopes (greater than 15° in the northwest and 25° in the southwest), which is the kind of land which tends to experience serious erosion resulting from cultivation. The State Forestry Administration (SFA) charged by the State Council and provincial and sub-provincial forestry bureaus are primarily responsible for targeting general areas of land for enrollment in the program as well as in setting and distributing enrollment quotas to local government (Zuo 2002). Local governments were in charge of evaluating land plots. Households whose land plots fell into the planned project area were eligible to be involved in the program. The participant households were granted seedlings as well as technique guidance for planting, and they could receive subsidies on condition that the survival rate of the planted trees on the sloping land reached 70%, the inspection work for which is conducted by local governments. There were two subsidy levels between regions due to different yields in that the annual grain subsidy was 1500 kg / ha in the Yellow River Basin, while it was 2250 kg in the Yangtze River, reflecting inherent differences in regional average yields. However in 2004, grain subsidies were changed to cash payments (the conversion rate of grain to cash is 1 kg grain = 1.4 CNY, 1USD=6.31 CNY, in 2004) (Liu and Wu 2010). Besides, participant households are also given 300 CNY annually for managing and protecting the planted trees per hectare of converted sloping land. Obviously, the first and primary goal of the SLCP is to contribute to ecological restoration by increasing forest cover on sloped cultivated land in the upper reaches of the Yangtze and Yellow River basins to prevent soil erosion (SFA 2003). However, the program has another important objective, i.e. that the financial incentives or subsidies provided alleviate rural poverty in the areas with heavy ecological degradation (Grosjean and Kontoleon 2009, Xu et al. 2004). This was officially announced by the State Council of China in 2005.

(b) *The adjustment of SLCP*

In 2007, before the compensation contract expired, the Chinese government adjusted the policy in two ways. As a result of the sharp reduction in the grain output, which had been falling continuously, reaching its lowest point (430.70 million tons) in 2003, the Chinese government started to worry about food security, while the significant growth in government subsidies led to financial pressure. Therefore, afforestation on converted sloping farmland under this program was suspended in 2007, although afforestation on barren mountains and wasteland of SLCP program is still under way, while the planned

afforestation areas have to be completed in the next years. On the other hand, because a number or participants still had problems earning a living because of the unsuccessful or uncertain economic structural change after the first program stage, the government prolonged the contract in order to subsidize participating households for another eight years, while basic farmland construction will be developed by government investment, which could also help rural households improve their long-term livelihoods, something which is in line with our livelihood diversification analysis above.

By the end of 2012, the total afforestation areas of SLCP had reached 29.4 million hectares, of which 9.3 million hectares of sloping land had been converted to forest. In addition, the total investment amounted to 438.5 billion CNY including the grain subsidy, seed fund, maintenance fees and various special funds, of which 326.2 billion was paid directly to households, thereby benefitting a total of 32 million households in 25 provinces. However, the government has reduced the pace of implementation and the conversion of farmland under the SLCP stands at 63.1% of the original plan (14.7 million hectares) due to concerns over domestic food security and financial pressure. Nevertheless, the program has made a significant contribution to ecological recovery and poverty alleviation.

3. CONCEPTUAL FRAMEWORK

By reviewing the theoretical and empirical literature on livelihood diversification, this section establishes a framework for clarifying the mechanisms behind rural households' livelihood diversification activities as shown in Figure 1 and proposes our hypotheses.

(a) *The causal origins and determinants of diversification*

Households in some rural areas often have to cope with poverty and income variability. Diversification of income sources has been brought forward as one of the strategies to minimize substantial income fluctuations and to ensure a certain level of income. Multiple motives prompt rural households to diversify their income-generating activities. According to Barrett et al. (2001), there are two types of motivations; "push factors" and "pull factors".

With regards to push factors, rural households tend to select a portfolio of activities, through which they are able to stabilize their income, reduce the risk of seasonality, climatic uncertain and natural disasters, and relax their liquidity constraints. Diversification which is driven by push factors is highly dependent on the household's access to productive assets such as land, labor and livestock (Schwarze 2004). On the other hand, push factor induced diversification is greatly affected by the individual characteristics of the household (Abdulai and CroleRees 2001). Hence, in this study, we introduce internal determinants of diversification, household endowments and characteristic variables — the size of farmland and forest land, labor supply, age, and educational attainment of the household head — to investigate the relationship between household's income diversification and its internal determinants. It appears that rural households with a higher education level are more likely to be involved in nonfarm activities since non-farm employment often requires higher levels of education (Schwarze 2004). Hence, we assume that households with a higher education are associated with greater nonfarm employment opportunities and so tend to have more income sources to diversify. Following Woldenhanna and Oskam (2001), we expect a negative relationship between farmland size and income diversity. Because nonfarm wage employment is considered to be a residual employment that absorbs the surplus family labor, the farm households' participation in

nonfarm wage employment is driven by the availability of surplus family labor, greater farm size and greater farm and relatively less nonfarm income sources, resulting in less income diversity.

Regarding "pull factors", motivation is comprised of the following aspects: realization of strategic complementarities between activities, such as crop and livestock integration, through which the crop stalks can be feed to animals, while the animal manure can replace chemical fertilizer; specialization development, individuals or households will exhibit diverse assets, activities and income even if there is specialization according to comparative advantage at the level of individuals (Barrett et al. 2001, Barrett and Reardon 2000). The pattern of livelihood diversification induced by pull factors is conditioned by external determinants such as infrastructure and institutions (Schwarze 2004). In this study, we use 'distance to nearest county capital and 'road condition' as proxies to capture the external impact from local engines of growth on income diversification. We anticipate that diversification is negatively associated with the distance to nearest county capital but is positively associated with road condition, as the shorter the distance to county capital, the greater the opportunities for diversification of income-generating activities while better road conditions mean easier access to the non-farm work market. On the other hand, living in remote areas reflects higher transaction costs for engaging in nonfarm work (Abdulai and CroleRees 2001), leading to less opportunity for livelihood diversification.

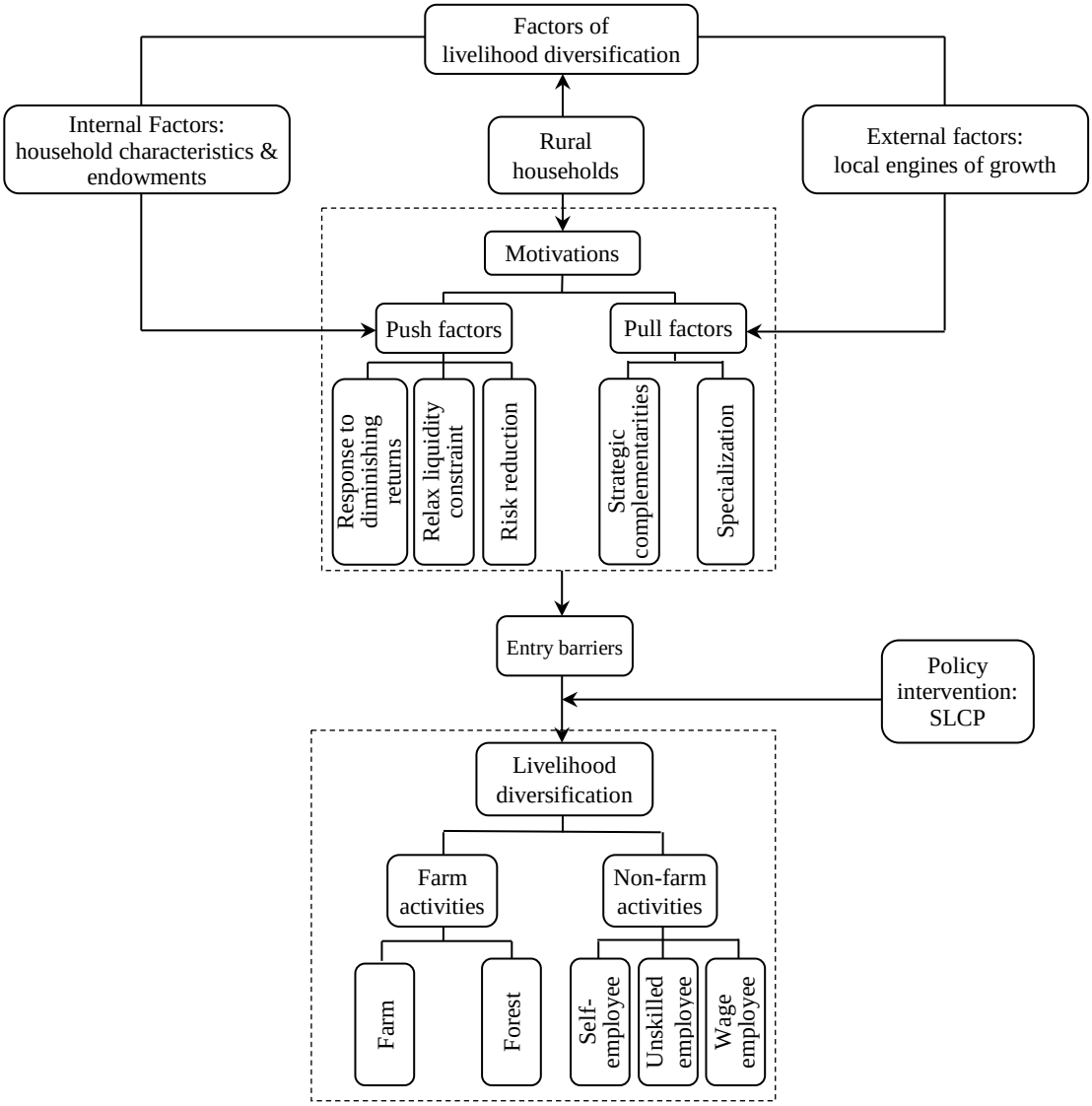
(b) *The SLCP effect on household diversification*

The above analysis addressed the internal and external determinants of rural households' income diversification. In practise, households always face an uphill struggle to overcome binding entry barriers such as limited land and capital endowments, educational attainment and liquidity constraints to take part in nonfarm activities with higher returns, which could lift them out of poverty (Abdulai and CroleRees 2001, Barrett et al. 2001, Woldenhanna and Oskam 2001). One of the most important barriers is financial capital, which includes liquidity constraints and restricted access to credit. As a policy intervention, SLCP aims to improve the asset holding of rural populations and is considered to be a strategy to overcome this barrier as it enables rural households to relax their liquidity constraints by endowing them with additional financial assets such as program subsidies (Kelly and Huo 2013, Uchida et al. 2009). Apart from this, farmers have been granted free seedlings for trees as well as free technical guidance after returning farmland to forests. The government also established some public employment service agencies to provide skill training to farmers, and guidance and help for those choosing to work and live in cities (Démurger and Wan 2012, Weyerhaeuser et al. 2005, Zuo 2002). Thus, SLCP, to some extent, overcomes the barrier caused by relatively low quality rural human resources, and so helps rural households diversify their on and off-farm income-generating activities.

In addition to examining the relationship between livelihood diversification and its internal and external determinants, this study mainly focuses on investigating the effect of the policy intervention on rural households' livelihood diversification. Specifically, we test the hypothesis that the SLCP acts as an effective intervention on households' participation in nonfarm activities and diversifying their livelihood. Moreover, compared to their richer counterparts, poorer households are considered to have less resources and endowments and so are associated with less income diversification, because they are more likely to face binding liquidity and credit constraints, while they have fewer opportunities to enter into non-farm activities (Abdulai and CroleRees 2001, Barrett et al. 2001, Woldenhanna and Oskam 2001). Therefore, we

attempt to compare the policy effect across different income groups based on our further hypothesis that the livelihood diversification of poor households is more inclined to be targeted by SLCP than the other groups.

Figure 1 *Scheme for conceptual framework*



4. DATA

(a) *Sampling and collection*

The analyses were based on data collected mainly from a rural household survey that was conducted by the SFA. The survey was designed in 2004 and implemented in the following five provinces (with erosion and desertification control and SLCP): Sichuan, Jiangxi, Guangxi, Hebei and Shaanxi which are respectively in the Yangtze River basin and Yellow River Baisn. Sichuan and Shaanxi provinces initiated the program as pilot in 1999, while the remainder started in 2002. As for the configuration of the sample (See Table 1), a stratified sampling technique was adopted. In our survey, 14 counties were

chosen from the above five provinces. First, the selected counties are all in the SLCP program and produce consistent geographic coverage as the overall counties across five provinces and two River Basins. Secondly, the selected counties should also cover diverse income groups of households based on their net revenue per capita. Both of these could thus claim a more representative sampling. Then, townships, villages, and households were randomly selected in each of the chosen counties. On average, three townships were randomly selected in each county, three villages were selected in each township, and around 13 households were randomly sampled to be interviewed in each village. To ensure survey quality, pre-tests, group discussions, and enumerator training were carefully conducted. A total of 1,458 rural households entered the dataset with a follow-up survey being conducted once in the subsequent 10 years from 126 administrative villages and 42 townships in 14 counties. The last year for which the data were entered, checked and made available was 2010.

Table 1 *Sample configuration of rural household survey statistics*

Province	Region	Counties	Townships	Villages	Households (Balanced)
Sichuan	Yangtze River Basin	4	12	36	486 (423)
Jiangxi	Yangtze River Basin	3	9	27	320 (271)
Hebei	Yellow River Basin	3	9	27	320 (241)
Shaanxi	Yellow River Basin	2	6	18	172 (154)
Guangxi	Yangtze River Basin	2	6	18	160 (137)
Total		14	42	126	1458 (1226)

A large amount of comprehensive, reliable and accurate data is necessary and paramount for a successful assessment. Normally, this kind of data is not easily available, accessible, or of high quality in China. However, our data may be considered to be the sole existing panel data of top quality from a rural household survey. These surveys were sponsored by the Asian Development Bank and China's Ministry of Finance, which provided compelling support to finish the longitudinal and large scale data collection. Plus, the cooperation of local governments is also a necessary condition for interviewing farmers, as it is much easier to access relatively reliable information from farmers after officials' mediation. The household is defined as the smallest decision-making unit which sets the strategy concerning the generation of income and the allocation of this income for consumption and reproduction (De Janvry et al. 1991, Sadoulet and de Janvry 1995). Information about peasant households is important for policy. Therefore, our survey contains information regarding demographic and location characteristics, the economic activities and program participation of households more thoroughly. This study mostly focuses on income source activities including various kinds of on-farm and off-farm income activities, which are described in detail in the next section.

In order to better understand the effect of the program, we asked interviewees to recall their livelihood information back to 1995, and then we conducted the same survey in each subsequent year. The only shortcoming of this data set is the question of veracity of the data in former years, as you cannot guarantee that farmers can recall their family situation in the first few years and few people keep excepted accounts. In order to minimize this recall bias in our data, we used local

government statistics to help respondents recollect. By the end of 2011, of the 1,458 households surveyed in 2004, we were still able to track 1,226 with 16 years balanced data (the missing samples are due to migration, death, failure to recall and some logic mistakes in the statistical process).

The number of annual household observations is 1226 in our balanced sample. Since the State council initiated the SLCP in 1999, households kept participating in the program year by year[2]. Hence, we can observe that the number of cumulative participants increases annually whilst the number of cumulative nonparticipants decreases as shown in Table 1. It can be found a sharp decrease in the number of new participants since 2003, which might be attributed to the adjustment of the SLCP implementation induced by the problems of food security (Liu and Wu 2010)[3]. However, we can still witness a few households joined in the program until 2008, afterwards, no more new participants are involved in the program.

Table 1 *Descriptive statistics of participation status*

Year	No. of new participants	No. of cumulative participants	No. of cumulative nonparticipants
1995	0	0	1226
1996	0	0	1226
1997	0	0	1226
1998	0	0	1226
1999	127	127	1099
2000	119	246	980
2001	42	288	938
2002	204	492	734
2003	187	679	547
2004	26	705	521
2005	31	736	490
2006	3	739	487
2007	42	781	445
2008	5	786	440
2009	0	786	440
2010	0	786	440

(b) *Measures of rural livelihood diversification*

Regarding the measurements on rural income diversification, two approaches can be distinguished by the measurable dimensions they account for. One contains one-dimensional indexes, which only counts the number of income-earning activities or evaluates changes in the volumes of different divisions, whereas the other is based on two or more dimensional measurements considering both the number of earning activities and their relative volumes of total income. Rural diversification reflects rural households' exchanges of assets and their allocations of assets across various activities in order to improve household income (Barrett et al. 2001). Thus, an increasing diversification level should cause a variation in both

[2] In terms of program timing, the batch of 3 pilot provinces includes Sichuan, Shaanxi and Gansu when the State council initiated the SLCP in 1999. After that, the SLCP was formally launched nationwide in 2002. Thus, the program timing is different for counties in different provinces.

[3] In view of food security, the Chinese government has clearly begun to slow the process of converting sloping land and reduce areas that need to undergo SLCP program since 2003. It has almost ceased converting sloping cropland conversion to forestland in 2007, when the price of grain dramatically soared.

the number of various activities and distribution across volumes from each income component. In China, to generate novel income sources, rural households income are usually involved in multiple income-earning activities, but poorer group mostly work on lower-pay and easy-entry activities because of more capital constraints and entry barriers (Abdulai and CroleRees 2001). However, for the richer rural households, they are more able to undertake multiple income generating activities with more profit. Therefore, counting number of income source cannot better represent rural diversification if the income shares are not evenly allocated, thus suggesting a one-dimensional income diversification index fails to provide an accurate reflection of households' income improvement. The volume of income sources should be also emphasised when measuring income diversification (Zhao and Barry 2013). To integrate diversification measures for different types of rural households, (Zhao and Barry 2013) empirically compared various dimensional diversification indexes and found that two-dimensional diversification measurement better fit the income diversification situation in rural China, which is also confirmed by Chang (1997) and Ellis (2000). Therefore, we decided to use the two-dimensional diversification measurement known as the inversed Herfindahl-Hirschman Index:

$$\mathrm{HDI} = \left[\sum_{\mathrm{h}=1}^{n} \mathrm{IP_h}^2\right]^{-1}$$

where HDI is household income diversity index, IP_h is the proportion for income activity h to total income and n is the number of income activities for a specific household. According to the characteristics of rural China, here we develop the income category based on the rural household income categories (Adams and He 1995, Brundtland 1987, Ellis 2000), which include forest income, farm income, consisting of both farm cash and subsistence (grain, meat and others) and non-farm income, which is subdivided into unskilled employee income, including labor payment in the harvest, agricultural infrastructure construction (building reservoirs, road repairing and ditching), wage employment, which includes relatively fixed and stable long-term employment (normally work in the service industry, city construction and manufacture), which requires good health, special skills or high education and self-employment where rural people do some non-farm business locally. Generally, the above category covers almost all the income activities of rural households in China. The maximum number of n in our study is 5, containing farm and non-farm activities as shown in Table 3. The index ranges from a minimum of 1 for a household that derives all its income from a single activity, to a maximum of 5 for a household that receives its income evenly across five farm and non-farm activities[4].

The use of a total income diversification index instead of a non-farm diversification index as in (Barrett et al. 2001, Escobal 2001) is based on the following considerations. Firstly, diversification into non-farm activities reflects more diversity in income sources, but this is not always the case. For instance, if a household raises the share of income from non-farm resources from 10% to 50%, this implies diversification into non-farm activities, but not income diversification in terms of the number of diversification activities and the balance of income sources. In addition, Minot et al. (2006) reviewed a branch of literature which examined the relationship between non-farm income and its share of total rural income, and highlighted the conflicting evidence regarding whether rich or poor rural households earn a higher share of

[4] According to Ellis (2000), the upper limit index value possible is equal to the number of income activities which can be obtained when each income source is shared equally among total income, while the lowest limit is one when a given household has only one source of income.

their income from non-farm activities. This may be inadequate to support our underlying fundamental hypothesis, which supposes a positive relationship between income and its diversification. Furthermore, concerning the situation in China, as quite a number of rural households only focused on farm activities before the implementation of SLCP, the application of a non-farm diversification index is likely to generate a large number of missing observations when calculating the diversification index.

Table 2 presents the descriptive statistics in terms of average per capita income and income diversity index for both (potential) participants and non-participants from 1995 to 2010. Figure 2 (based on Table 2) illustrates the evolution of average per capita income and the income diversity index in the period 1995-2010. As shown in Figure 2, the average per capita income exhibits a gradually increasing trend for both non-participants and participants, which increased from 1,293 and 1,247 in 1995 to 2,990 and 3,029 in 2010 respectively. The average per capita income of the two groups does not show significant difference before the SLCP implementation until it declined sharply for participants in 1999 (the year when the SLCP was initiated). This may be attributed to the loss in converted sloping lands that were used for farming. Although it was initially planned that households would be provided with a certain level of subsidies as a result of participating in the SLCP, distribution of the funds was often delayed and sometimes the payments were insufficient (Uchida et al. 2007, Xu et al. 2004), so the subsidies in the early stage of the SLCP could not make up for the loss of converting the sloping land to forest. The average income gap between participants and non-participants continued to decrease until 2009, when the average income of participants began to exceed that of nonparticipants.

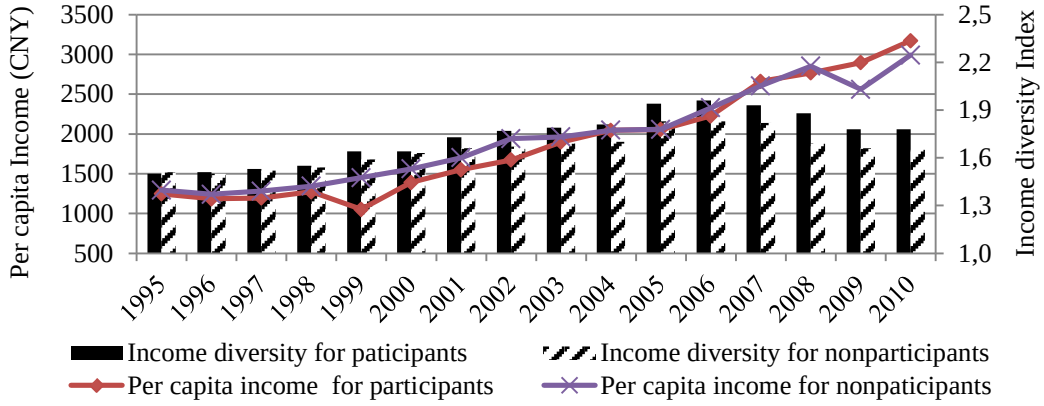
Table 3. *Descriptive statistics of income diversity index and per capita income for participants and nonparticipants*

Year	Total participants				Total nonparticipants			
	(1) Per capita income (CNY)		(2) Income diversity		(3) Per capita income (CNY)		(4) Income diversity	
	MEAN	SE	MEAN	SE	MEAN	SE	MEAN	SE
1995	1247.78	1014.91	1.50	0.47	1293.09	821.93	1.51	0.48
1996	1184.99	1027.87	1.51	0.47	1242.09	769.09	1.50	0.48
1997	1195.58	926.55	1.53	0.47	1280.89	818.95	1.52	0.49
1998	1274.21	1053.19	1.55	0.48	1343.23	824.74	1.54	0.50
1999	1052.15	629.84	1.64	0.48	1451.02	1020.10	1.59	0.49
2000	1390.30	909.96	1.64	0.44	1561.86	1106.43	1.63	0.51
2001	1550.44	984.94	1.73	0.49	1702.21	1224.46	1.66	0.50
2002	1673.13	955.83	1.77	0.46	1942.05	1412.12	1.67	0.50
2003	1899.78	1308.02	1.79	0.47	1962.84	1361.81	1.69	0.54
2004	2046.24	1476.09	1.81	0.47	2048.26	1310.02	1.70	0.52
2005	2056.35	1268.47	1.94	0.51	2057.69	1085.71	1.83	0.56
2006	2227.55	1323.71	1.96	0.53	2328.75	1226.42	1.83	0.57
2007	2661.81	2039.12	1.93	0.60	2605.20	1782.22	1.82	0.60
2008	2768.47	2250.99	1.88	0.66	2850.98	2203.34	1.69	0.53
2009	2895.29	2930.27	1.78	0.56	2560.03	2371.61	1.66	0.50
2010	3171.47	2882.55	1.78	0.54	2990.45	3028.76	1.65	0.51

a. The participants between 1995 and 1998 are potential participants and the number is 786, which is the number of the cumulative participants in 2010. Participants in other years are the actual households who are involved in the program and the annual number of participants equals to the value of corresponding year listed in the third column (No. of cumulative participants) of table 1.

b. Values of income are converted to real terms using Consumer Price Index (CPI) of 1994 for each province.

Figure 2 *Average per capita income vs. average income diversity for participants and non-participants (1995-2010)*



With regard to income diversification, there was no difference between participants and non-participants before the implementation of the SLCP in terms of absolute value of diversity index. After a steady increase throughout 1999 and 2006, both of them reached their highest point in 2006. Then they dropped slightly until 2009 and then remained stable afterwards. Though the income diversity index appeared to exhibit a similar trend for both participants and non-participants,

the absolute value of the diversity index of participants was always higher than that of nonparticipants after the implementation of SLCP.

Table 3 provides more details about the changes in income sources of households during the periods. To facilitate the comparison between participants and nonparticipants, we create Figure 3 and Figure 4 based on Table 3. We can see that, for both participants and nonparticipants, the share of farm income displayed a downward trend from 1995 to 2010 indicated by farm cash, whereas the share of non-farm income showed a general upward trend. In detail, the share of forest income showed an increasing trend from 1995 to 2000 and fluctuated afterwards for participants, while it stagnated for nonparticipants during the period. Turning to average wage income proportion, this increased from 7% and 8% in 1995 to 23% and 20% in 2010 for participants and nonparticipants respectively, and the absolute value is higher for participants than non-participants. The absolute value in terms of share of unskilled employment is also found to be higher for participants than non-participants. Regarding the share of self-employment wage for participants and nonparticipants, we cannot distinguish them in terms of their average shares.

Table 4 *Sources of income and their shares for participants and non-participants (%)*

Year	Forest income		Farm income		Self-employed income		Unskilled employee income		Wage employee income	
	Par	Non	Par	Non	Par	Non	Par	Non	Par	Non
1995	8.16	11.38	75.11	70.98	2.38	2.86	7.29	6.15	7.05	8.63
1996	8.19	11.12	74.44	71.19	2.40	2.77	7.55	6.01	7.43	8.90
1997	8.41	10.94	73.19	69.87	2.52	2.74	7.85	6.19	8.04	10.26
1998	8.53	10.90	72.02	68.71	2.64	2.89	8.39	7.04	8.42	10.45
1999	13.47	8.87	68.90	65.32	2.32	2.94	10.19	12.07	5.12	10.80
2000	14.01	8.82	67.21	62.78	1.77	3.40	9.36	12.54	7.65	12.45
2001	13.00	8.42	61.37	60.03	2.11	3.91	14.48	13.64	9.05	14.00
2002	11.46	9.45	57.96	59.52	3.38	4.25	19.28	9.82	7.93	16.96
2003	10.58	10.39	56.69	58.66	3.82	4.38	17.91	9.85	11.00	16.71
2004	11.61	9.88	54.29	57.68	4.59	3.97	17.92	10.54	11.60	17.93
2005	13.74	10.80	46.85	48.11	4.62	5.52	18.47	12.28	16.33	23.29
2006	13.76	10.42	45.74	47.80	4.68	5.43	18.92	13.39	16.91	22.96
2007	11.98	10.05	45.02	45.04	7.85	9.05	16.50	14.47	18.65	21.39
2008	12.20	7.65	42.26	46.43	8.00	8.44	17.40	14.57	20.14	22.90
2009	11.87	8.03	36.83	43.42	11.27	12.75	17.36	16.01	22.67	19.78
2010	11.56	8.90	36.38	42.03	11.86	13.21	17.26	15.64	22.94	20.22

a. "Par" is short for non-participants and "Non" is short for participants;

b. The value of each variable from participants in the first four years before the SLCP is calculated from the potential participants group as defined in Table 2.

Figure 3 *Sources of income and their shares for participants*

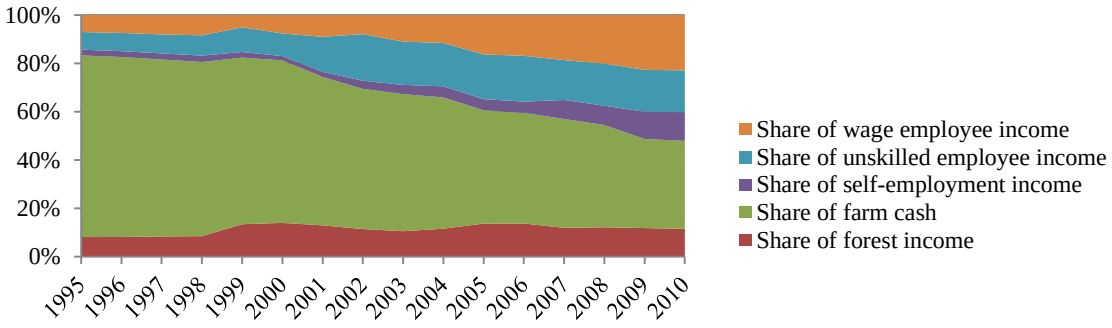
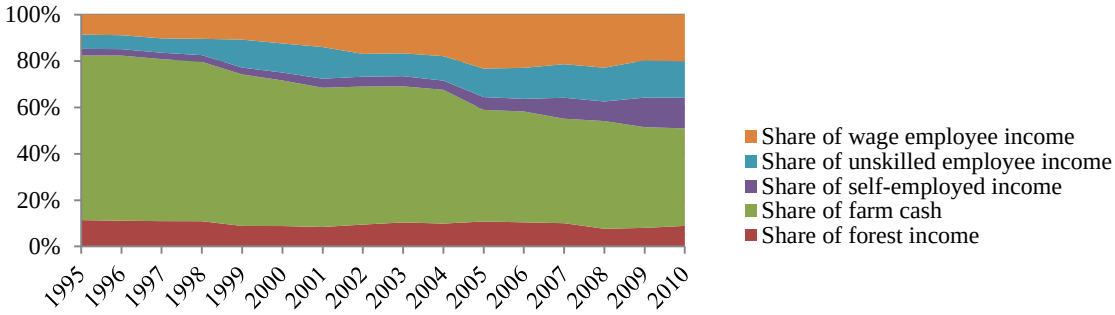


Figure 4 *Sources of income and their shares for non-participants*



The descriptive statistics of the main variables used in our empirical analysis are presented in Table 4. To see the difference between participants and nonparticipants, we divide our sample observations into two groups: participants and non-participants. As shown in Table 4, the characteristics in average values for most households do not show significant difference between households who participated in the SLCP and those who did not, indicating that the participants and non-participants are theoretically comparable. For example, households in two groups have similar characteristics in terms of the education level of the head of the household, the condition of road, labor force and distance to the nearest county capital. However, we can still witness some difference between two groups of participants which may be caused by the implementation of the SLCP. For instance, non-participants have more farmland (5.8 mu) compared to participants (5.5 mu), which is mainly a result of the enrollment of part sloping land. Besides, the participant households may reduce working time after converting some sloping land to forest, because the labor force of non-participants works 30 days more than participants.

Table 5 *The descriptive statistics of the variables*

Variables	Description	Participant		Nonparticipant	
		MEAN	SE	MEAN	SE
Age	Age of household head in years	48.35	11.00	46.34	11.33
Education	Schooling years of household head	6.53	3.01	6.46	2.85
Road	Type of road to the household (0=soft surface, 1=hard surface)	0.43	0.50	0.43	0.49
Cadre	Any household member working for the government (0=no, 1=yes)	0.09	0.29	0.09	0.29
Farmland	Size of household farmland (mu=0.067 hectare)	5.52	6.53	5.77	5.70
Forestland	Size of forest land owned by the household (mu=0.067 hectare)	1.15	2.06	1.05	2.27
Labor	Annual total household working days (per 100days)	4.43	2.75	4.73	2.94
Distance	Distance to the nearest county capital (per 100km)	0.44	0.27	0.44	0.27
No. of observation		7151		7561	

Note: The observations only consist of the sample after 1999 when the SLCP was implemented.

5. ECONOMETRIC SPECIFICATION

Since the 1990s, econometricians have paid treatment effect analysis more attention (Abadie 2002, Hahn 1998, Lee 2000). The approach of treatment effect analysis is to compare two groups, one of which has received a treatment, while the other has not; named the treated and control group respectively. One of the most popular treatment effect analysis methods is difference in differences (DID) (Lee 2005), which involves comparing the before-after change of the treated group with the before-after change of the control group.

(a) *The empirical models*

We apply the DID approach to measure the impact of the SLCP on rural households' income diversification. The basic empirical regression specification is:

$$Y_{it} = \alpha + \beta D_{it} + \theta T_t + \delta_i T_t D_{it} + \gamma X_{it} + \varepsilon_{it} \quad (1)$$

where subscript *i* and *t* represent household *i* and time period *t* respectively, *Y* represents households' outcome which is livelihood diversity in our context. *T* is the time dummy, which is equal to 1 for all years when the outcome *Y* is observed after program implementation and equal to 0 otherwise. *D* is the dummy for being treated, which equals 1 if the household participated in the program. T^*D is the interaction term. The coefficient β is the counterfactual difference in livelihood diversity between the treatment group and control group, while θ represents the common time trend of this and δ captures the treatment effects. X is a vector including a variety of household and village characteristic variables that may be correlated to the livelihood diversity and $\gamma$is a vector of coefficients on X.

Considering the fact that households received the treatment in different years in the expansion process of the SLCP (see Table 1), our estimating equation originating from equation (1) can be described by:

$$Y_{it} = \alpha + \sum_{t=1999}^{2010} \theta_t T_t + \sum_{t=1999}^{2010} \delta_t T_t * D_{it} + \gamma_1 age_{it} + \gamma_2 edu_{it} + \gamma_3 road_{it} + \gamma_4 cadre_{it} + \gamma_5 farmland_{it} + \gamma_6 forestland_{it} + \gamma_7 labor_{it} + \gamma_8 distance_{it} + \varepsilon_{it} \quad (2)$$

Let D_{it} =1 indicate all households participating in the SLCP in a specific year t, and D_t =0 otherwise, and T_t =1 means the observations are observed in year t. T_t is the time dummy, which is equal to 1 if the outcome Y is observed in year t and equal to 0 otherwise. θ_t indicates the different year time effect of the program, and δ_t is the main parameter of interest as it is the treatment effect from the different treatment groups. The control variables of household and village characteristics (X_{it}) include age, education, labor, leadership, road condition, distance to county capital, household farmland and forestland size.

(b) *Unbiased Identification*

In order to attain consistent estimation of the impacts of the SLCP, the identification condition (same time-effect condition) of the DID estimate in the above setting has to hold as follows:

$$\mathrm{E}(\mathrm{Y}_{1\mathrm{t}} - \mathrm{Y}_{1\mathrm{t}-1} | \mathrm{D} = 0) = \mathrm{E}(\mathrm{Y}_{0\mathrm{t}} - \mathrm{Y}_{0\mathrm{t}-1} | \mathrm{D} = 0) \quad (3)$$

In other words, the change in outcomes between the treatment and control groups would have been identical in the absence of the intervention. In our case, the same time-effect condition is that the other changes will have an equal influence on the participant group and nonparticipant group in the absence of the SLCP. However, in reality, the same time-effect condition as equation (3) is impossible to test as the counterfactual cannot be observed.

We can nonetheless test whether average outcome pre-treatment trends were similar between the proposed treatment and comparison groups instead (Gertler, P., Patrinos, H. and Codina, M.R. 2007). If pre-treatment trends (at *t'*<*t*) were not significantly different between treatment and comparison households, there is reason to believe that changes would have been similar in the post-intervention periods (*t*) when the treatment was not in place. Then, the identifying assumption can be rewritten:

$$\mathrm{E}(\mathrm{Y}_{1\mathrm{t}'} - \mathrm{Y}_{1\mathrm{t}-1'} | \mathrm{D} = 0) = \mathrm{E}(\mathrm{Y}_{0\mathrm{t}'} - \mathrm{Y}_{0\mathrm{t}-1'} | \mathrm{D} = 0) \quad (4)$$

We can test the validity of the identification or same time-effect condition in our data by running the following equation for all pre-intervention years:

$$\mathrm{Y}_{\mathrm{it}} = \alpha + \sum_{\mathrm{t}=1996}^{1999} \beta_{\mathrm{t}} \mathrm{T}_{\mathrm{t}} + \sum_{\mathrm{t}=1996}^{1999} \delta_{\mathrm{t}} \mathrm{T}_{\mathrm{t}} * \mathrm{PD}_{\mathrm{it}} + \mathrm{u}_{\mathrm{it}} \quad (5)$$

where PD_{it} is a dichotomous variable which equals 1 if the household is a potential treatment household from year 1996 to 1998. *T* is a year dummy variable for all pre-intervention years. In this test, we chose the period 1995 to 1998, because the SLCP started in 1999. Then we have three year dummy variables T_{1996}, T_{1997}, T_{1998} and three interaction terms with year dummy, while year 1995 works as the baseline year. If the δ_t is not significantly different from zero, then the pre-intervention trends for households that will eventually participate in the SLCP are not significantly different from those in the comparison group at each time.

Table 5 *Difference in pre-intervention trends of the livelihood diversity between treatment and comparison groups*

Variables	Observations (from 1995 to 1998)				Observations (from 1995 to 2001) excluding households participated in SLCP from 1999-2001[5]			
	(1)		(2)		(3)		(4)	
	Fixed effect		Random effect		Fixed effect		Random effect	
	COEF	SE	COEF	SE	COEF	SE	COEF	SE
T_{1996}	-0.002	0.009	-0.001	0.009	0.006	0.020	0.003	0.020
T_{1997}	0.015	0.009	0.015	0.009	0.030	0.020	0.027	0.020
T_{1998}	0.036***	0.009	0.037***	0.009	0.054***	0.020	0.051**	0.020
T_{1999}					0.074***	0.020	0.071***	0.020
T_{2000}					0.127***	0.020	0.124***	0.020
T_{2001}					0.160***	0.020	0.157***	0.020
$PD_{1996}{}^{*}T_{1996}$	0.015	0.012	0.015	0.011	0.002	0.027	0.008	0.026
$PD_{1997}{}^{*}T_{1997}$	0.016	0.012	0.015	0.011	0.010	0.027	0.016	0.026
$PD_{1998}{}^{*}T_{1998}$	0.016	0.012	0.013	0.011	0.009	0.027	0.014	0.026
$PD_{1999}{}^{*}T_{1999}$					0.040	0.027	0.043	0.026
$PD_{2000}{}^{*}T_{2000}$					0.013	0.027	0.019	0.026
$PD_{2001}{}^{*}T_{2001}$					-0.003	0.027	0.003	0.026
R^2	0.022		0.022		0.078		0.078	
N	4904				6566			

a. * Significant at 10%; ** Significant at 5%; *** Significant at 1%

b. The tested observations include participants and non-participants from sample from 1995 to 1998 in model (1) and (2), while the observations exclude households that took part in the SLCP in the period from 1999 to 2001 in model (3) and (4).

Table 5 above reports results for averaged livelihood diversification index in the pre-intervention period[6]. Regressions assess the equality in all aspects other than their treatment status in each pre-intervention year across heterogeneous subjects. The results present no significance differences in the pre-intervention period. This indicates that the livelihood diversification in comparison groups and in treatment groups followed rather similar patterns during the pre-intervention years. Therefore, our same time-effect condition holds in our case.

(c) *Self-selection of participation*

To obtain consistent estimators of the SLCP effects with our regression models, it is necessary to assume that there is no selection bias. Otherwise, the participation of the household becomes endogenous, which is likely to cause biased estimates. Participation in the SLCP is commonly believed to be "quasi-voluntary", with households being "strongly encouraged" by local governments to participate.

In practice, if households' land plots are included in the planned project areas, they were willing to participate since the compensation in most cases exceeded foregone income from cultivation (Liu et al. 2010, Uchida et al. 2009). On the other hand, if households' plots were excluded in the planned project areas, they were not eligible to be participants. The study

[5] The tested observations exclude households that took part in the SLCP in the period 1999 to 2001 and the identification equation is $Y_{it} = \alpha + \sum_{t=1995}^{2001} \beta_t T_t + \sum_{t=1995}^{2001} \delta_t T_t * PD_{it} + u_{it}$. In this test, we chose the period 1995 to 2001, because the SLCP started in 2002 for some provinces in our sample. Then we have six year dummy variables T_{1996}, T_{1997}, T_{1998}, T_{1999}, T_{2000}, T_{2001} and six interaction terms with year dummy, while year 1995 works as the baseline year.

[6] The pre-intervention period is the period between 1995-1998 based on model (1) and (2), and the period of 1995-2001 is the pre-intervention period for model (3) and (4).

from Xu et al. (2004) finds that only 15 per cent of the participating households in the sample were consulted before program implementation. Therefore, there is less potential for self-selection, and the related previous research (Kelly and Huo 2013, Liu and Wu 2010, Uchida et al. 2007) about the SLCP is based on the assumption that enrolment is mandatory or exogenous from the perspective of the household[7].

6. RESULTS AND DISCUSSION

As we use household level panel data, our empirical analysis shall pay attention to the dynamic panel data characteristics of our dataset. We carry out both fixed effects and random effects regressions in the cases of full sample and low, medium and high-income groups.

(a) *Case of full sample*

The regression results of the average effects on the full sample are presented in Table 6, which focuses on the aggregative treatment effects in the different treatment years. The results of Hausman tests on full sample regression suggest that fixed effects estimates are consistent as the χ^2 values are 44.12 for the above estimation at the 10% significant level. Therefore, we place great emphasis on fixed effect results in the case of full sample analysis.

The results reveal that households with older heads are more likely to diversify their income sources than those with a younger head. This confirms the argument in Abdulai and CroleRees (2001) that older decision makers in the households tend to have richer experiences and so have more sources to diversify their livelihood.

With regard to the education level of the household head (Education), the insignificant coefficient is found, which is consistent with the finding of Woldenhanna and Oskam (2001). But Abdulai and CroleRees (2001) and Barrett et al. (2001) suggest more educated households are more likely to diversify into non-farm work than the less educated counterparts. These different findings imply that the existence of entry barriers (such as liquidity or capital constraints) to access to the non-farm labor market may influence the function of education on seeking non-farm employment opportunities (Abdulai and CroleRees 2001), which can be examined in the next estimation results.

The coefficient on total household working days (labor) shows that labor force has a significantly positive effect on rural income diversification. This result is consistent with the theory. According to Abdulai and CroleRees (2001), the participation of non-farm activities is driven by the availability of surplus household labor. The greater the household labor force, the greater the surplus labor available to take up a variety of non-farm activities.

The results in Table 6 show that forestland size is significantly positive, suggesting that households with more forestland are provided with additional and stable income from forest resources and forest-related activities and so are more likely to have a greater income diversity index. Regarding the farmland size of household (farmland), the results show that rural income diversification is significantly and negatively associated with household farmland size. A similar finding was reported in Corral and Reardon (2001), who argue that the greater the farmland size, the greater the opportunity costs of participation in non-farm activities. Thus, households with more farmland are less likely to become involved in non-farm employment, leading to a lower income diversification index.

[7] Liu et al. (2010) ruled out the possibility of self-selection bias in their study. Since the data of this study is from the same source with theirs, we believe that self-selection bias is not serious concern in this paper.

The result shows that cadre status has a significantly negative effect on rural income diversification, which is inconsistent with our expectations. A cadre, by taking advantage of his position, may gain more support or assistance from locals and so a household with a cadre family member is more likely to focus on farm and farm related activities in the village. Hence, the significantly negative correlation between cadre status and rural income diversification emerges in the result.

The development of infrastructure plays an important role in encouraging diversification. This is reflected in the positive and significant coefficient of road condition. The diversity index of households with an asphalt surface road is 0.046 higher than households with other hard surface roads. A better road network actually induces diversification in farm and non-farm income sources as it implies lower transport costs and the quick and easy disposal of commodities. The coefficient for distance to the nearest county capital (Distance) is significant with an expected negative sign. The state of the roads used to travel to work may therefore be an important factor governing the decision to work off-farm. The result indicates that the closer the place a household locates in to the nearest county, the higher the income diversification index it has.

The estimation results from the time dummy indicate that the livelihood diversification increased from 1999 to 2007 for both participants and nonparticipants, which is consistent with our previous analysis that both participants and nonparticipants have a strong motivation to diversify their livelihood (Uchida et al. 2009) due to diminishing returns to labor or land, market failure and coping with risk (Barrett et al. 2001). Most coefficients of time trends are significantly positive regarding the diversification level except for 2003 and 2004, while the last three years witness a negative effect which is not statistically significantly different from zero. This may imply that the livelihood diversification level of rural households has been somewhat hindered after it increased in the first few years, which according to some rural livelihood diversity studies (Ellis 2000, Smith et al. 2001) is because rural households are limited by both human and financial capital barriers to develop other activities, even though they are intrinsically motivated to diversify livelihoods. In addition, this decline or stagnation may be caused by the economic crisis which reduced employment opportunities and the monthly earnings of rural labor force between 2008 and 2009 (Huang et al. 2011).

The coefficients of interaction terms in the first three years do not show any significant difference between participants and nonparticipants, but they become significantly positive with diversification for the remainder of the treatment years. These results are consistent with some previous findings, where the SLCP was not successful in shifting labor into off-farm sectors during the first few years of implementation (Uchida et al. 2007, Xu et al. 2004), but participation in off-farm activities increased more for participants than nonparticipants after the first five years of the program (Uchida et al. 2009). This result, to some extent, may be due to the fact that it takes some time for participants to adopt their livelihood strategy after policy intervention and also the actual compensation received by households sometimes falls short of the compensation standards for some reason (one is logistic delay in that local government responsible for program supervision does not have sufficient manpower to check whether the converted land satisfies government-stipulated requirements, while the other is that local governments keep some compensation to make up for expenditure on plant seedlings and tax arrears or other costs) (Xu et al. 2010).

Table 6 *Estimation results of average treatment effects on livelihood diversification of the full sample*

Variables	COEF	SE
Age	0.014**	0.005
Education	-0.001	0.002
Road	0.046***	0.013
Cadre	-0.047**	0.022
Farmland	-0.002**	0.001
Forestland	0.024***	0.002
Labor	0.022***	0.002
Distance	-0.138***	0.050
T_{1999}	0.034*	0.014
T_{2000}	0.060**	0.015
T_{2001}	0.067**	0.015
T_{2002}	0.065*	0.017
T_{2003}	0.059	0.020
T_{2004}	0.066	0.021
T_{2005}	0.172***	0.021
T_{2006}	0.160***	0.022
T_{2007}	0.134**	0.023
T_{2008}	-0.005	0.023
T_{2009}	-0.049	0.024
T_{2010}	-0.075	0.024
$T_{1999}D_{1999}$	-0.036	0.040
$T_{2000}D_{2000}$	-0.040	0.031
$T_{2001}D_{2001}$	0.019	0.029
$T_{2002}D_{2002}$	0.058**	0.025
$T_{2003}D_{2003}$	0.078***	0.025
$T_{2004}D_{2004}$	0.073***	0.025
$T_{2005}D_{2005}$	0.081***	0.025
$T_{2006}D_{2006}$	0.095***	0.025
$T_{2007}D_{2007}$	0.073***	0.026
$T_{2008}D_{2008}$	0.152***	0.026
$T_{2009}D_{2009}$	0.073***	0.026
$T_{2010}D_{2010}$	0.082***	0.026
R-squared	0.120	
Hausman (FE vs.RE)	44.12	{0.060}
N	19616	19616

a.* Significant at 10%; ** Significant at 5%; *** Significant at 1%;
b. the regression includes a constant (not reported);
c. p-values of Hausman tests are shown in braces. According to hausman tests, the estimation results of full sample analysis are based on fixed effect model.

From 2002, the results reveal that participants' livelihood diversification level increased more than non-participants and the differences are statistically significant through the remainder of the treatment years. One explanation for this is that participation in the program relaxes a household's liquidity constraint so that it becomes much easier for participants to shift their surplus labor force from farming to non-farming activities with the financial support of the program, while non-participants in the same condition may have more liquidity constraints (Groom et al. 2010, Uchida et al. 2009). Especially, the difference increased rapidly from 2002 to 2006 when most participant households joined the program, while the effect

of the SLCP on livelihood diversification strengthened with the participation of more rural households. Then, a slowdown is observed in the diversification trend of participants in the following year when the first contract was due to expire, which may be attributed to the uncertainty regarding the longevity of the program[8]. In addition, the study by Cao et al. (2009) found that a large proportion (37.2%) planned to return to cultivating on sloping land once the contract was over, which highlights the importance of program longevity for the decision making of rural households. In 2008, the diversification level of participants rose sharply after the new policy about renewable subsidies was announced in 2007 and then continues to be higher than the diversification level of nonparticipants for the last two years as well.

(b) *Case of low, medium and high-income groups*

To gauge the relationship between the affluence of a household and its income diversification, we divide the sample observations into three sub-groups according to the households' average monetary income in the previous four years before program implementation[9]. They are low-income group, medium-income group and high-income group. The income is defined as disposable cash income, which includes annual income from off-farm employment and on-farm production, but excludes irregular receipts such as government transfer payments or personal remittance. In the case of low, medium and high-income groups, Hausman test results indicate that random effects regression is efficient in the low-income and medium-income groups, while high-income group prefer consistent estimation from fixed effects model.

Table 7 reports the results in the case of low, medium and high-income groups. In terms of forestland size (forestland) and household working days (labor), the results are consistent with that of our full sample analysis for three income groups. Besides, it is also interesting to see that the coefficients of other characteristic variables differ across different income groups in terms of the signs and the magnitudes.

With regard to education levels (Education), the estimated result shows the significantly negative coefficient for the poor income group and the significantly positive coefficient for the high-income group, although the model of the medium-income group shows an insignificant coefficient. The different coefficients in each income group mean different effects on income diversification within income groups facing different liquidity or capital constraints. The negative relationship between education level and income diversification for the low-income group may be explained by the study from Barrett et al. (2001) that the existence of entry barriers (such as liquidity and credit constraints) to access to the non-farm labor market weakens the function of education on seeking non-farm employment opportunities. In this sense, the high-income group with less liquidity constraints is expected to have significantly positive relationship between education level and rural income diversity. For the low-income and medium-income groups, participation in farm and non-farm activities may not depend on their education levels. Moreover, due to more entry-constraints, poor farmers with higher education may concentrate on specialization in agricultural of production.

[8] Government-financed programmes often start as pilot programmes, followed by an expansion. Thereafter, the size of these programmes tends to change with annual budget allocations, which cause policy inconsistency and payment uncertainty. See details in Zheng et al. (2011) that identify the impact on programme participation of uncertainty regarding the likely longevity of the programme.

[9] In practice, we rank the households on the basis of their average annual incomes from 1995 to 1998 before the implementation of the SLCP and divide the observations into three equal groups containing equal numbers of households. Then we divide the first 1/3 of observations with highest incomes into the high-income group, the following 1/3 of observations into the medium-income group, while the remainder are included in the low-income group.

The coefficients on road condition (Road) show that road condition has an insignificant effect on income diversification for medium and high-income groups, but a significantly positive effect for the low-income group. This result reflects the fact that the livelihood diversification activities of low-income farmers are more reliant on rural infrastructure compared with their counterparts. The results imply that policy makers should make greater investments to improve the rural infrastructure in order to encourage rural income diversification.

Turning to the variable of distance to nearest county capital (Distance), which is another proxy for accessibility to the non-farm labor market, the coefficient associated with high-income group is significantly negative. However, the coefficients are found to be insignificant for the low and medium-income groups. One possible explanation for the insignificant coefficients is the existence of entry barriers to participating in non-farm activities for relatively poor households. Barrett et al. (2001) suggest poorer households do not have the resources to overcome the skill and capital entry barriers that prevent them from engaging in non-farm activities even though they live close to the labor market.

The results consistently show that income diversification is significantly and negatively associated with farmland size for medium and high-income group. However, the insignificant coefficient is found in the regression result for the low-income group. This confirms the argument that the income diversification decisions of poor farmers are driven by household endowments rather than household characteristics.

The estimation results from the time dummies indicate that the low-income group experiences a greater increase in terms of diversification than the other two groups in the period. Also, the regression result from the medium-income group shows that the time effect is significantly positive in most time of the period, though it appears to be insignificant after 2009. However, for the high-income group, the time effect is insignificant for most of time, but somewhat surprisingly, it becomes significantly negative in the later period of the SLCP. Therefore, the positive time effect for the full sample is mainly derived from that of the low and medium-income groups. This finding confirms the discussion in (Reardon et al. 2007) who find that the relatively poorer households are strongly motivated to diversify their livelihood strategy (mainly by taking up low-return nonfarm rural activities), even though they probably have more barriers to accessing non-farm alternatives. The significant negative time effect on the high-income group in the later years can be interpreted by the argument of Reardon et al. (2007), which suggest that greater diversification at the household level actually involves specialization among individuals, and households from the high-income group are more likely to specialize in either purely farm or purely nonfarm pursuits.

The results of the interaction term in three regressions indicate that implementation of the SLCP has heterogeneous effects on livelihood diversification across the various income groups. The average treatment effects from three groups are found to be positive in most scenarios, although most of the significant cases are from the regression results of the low-income group. This suggests that the positive and significant treatment effect of the full sample is mainly ascribed to the low-income group. The results from the sub-samples reveal that households with lower income are more likely to be affected by the program than the others. This is in agreement with the findings of Uchida et al. (2009) who showed that the subsidies for setting aside cultivated land are more important to relax the liquidity constraints for the households with less liquid assets prior to the program than the other groups (Uchida et al. 2009). Thus, the more constrained the household, the larger the effect of the program on off-farm participation and diversification levels. Furthermore, this result complies with

poverty reduction quite well, which is another aim of the program. In addition, the insignificant treatment effects on high-income households indicate that the constraints on participation in non-farm activities are not only due to liquidity, but also physical and human capital or even the external economic environment and system. In the first few years, the treatment effect on the livelihood diversification of low-income households is also insignificant. A possible explanation for this may be that the compensation is delayed or insufficient, which makes it much more difficult for the low-income group to develop or explore other income activities in the initial phase. By contrast, the coefficients of treatment effect from medium and high-income groups are significantly correlated with the livelihood diversification in the beginning of the period. This result may be explained by the fact that it is easier for relatively rich participant households to access other resources to diversify their income sources, which can be immediately promoted by extra subsidies.

Table 7 *Estimation results of average treatment effects on livelihood diversification with respect to different income groups*

Variables	(1) Low-income group		(2) Medium-income group		(3) High-income group	
	COEF	SE	COEF	SE	COEF	SE
Age	-0.002	0.001	0.001	0.001	0.012	0.009
Education	-0.010***	0.003	0.000	0.003	0.010***	0.004
Road	0.066***	0.020	0.021	0.019	-0.026	0.021
Cadre	0.011	0.029	-0.128***	0.032	0.010	0.038
Farmland	0.001	0.001	-0.002*	0.001	-0.002*	0.001
Forestland	0.009***	0.004	0.025***	0.004	0.031***	0.004
Labor	0.017***	0.003	0.019***	0.003	0.013***	0.003
Distance	0.036	0.045	-0.001	0.001	-0.388***	0.105
T_{1999}	0.097***	0.025	0.066***	0.024	0.001	0.031
T_{2000}	0.156***	0.027	0.098***	0.025	0.017	0.038
T_{2001}	0.197***	0.028	0.118***	0.026	0.012	0.046
T_{2002}	0.235***	0.031	0.146***	0.030	-0.023	0.055
T_{2003}	0.255***	0.036	0.153***	0.033	-0.028	0.064
T_{2004}	0.273***	0.037	0.158***	0.035	-0.003	0.073
T_{2005}	0.532***	0.039	0.274***	0.036	-0.012	0.081
T_{2006}	0.549***	0.040	0.278***	0.036	-0.035	0.089
T_{2007}	0.529***	0.042	0.246***	0.039	-0.036	0.098
T_{2008}	0.403***	0.043	0.146***	0.040	-0.192*	0.106
T_{2009}	0.366***	0.043	0.053	0.040	-0.173	0.114
T_{2010}	0.358***	0.044	0.053	0.041	-0.207*	0.123
$T_{1999}D_{1999}$	0.0003	0.057	0.034	0.066	0.075	0.108
$T_{2000}D_{2000}$	-0.023	0.047	0.017	0.051	-0.005	0.064
$T_{2001}D_{2001}$	0.040	0.045	0.096*	0.049	-0.012	0.058
$T_{2002}D_{2002}$	0.062	0.042	0.035	0.042	0.134***	0.045
$T_{2003}D_{2003}$	0.098**	0.044	0.059	0.042	0.092**	0.042
$T_{2004}D_{2004}$	0.120***	0.044	0.073*	0.043	0.042	0.042
$T_{2005}D_{2005}$	0.125***	0.045	0.069	0.043	0.020	0.042
$T_{2006}D_{2006}$	0.127***	0.045	0.101**	0.043	0.026	0.042
$T_{2007}D_{2007}$	0.074	0.046	0.082*	0.044	0.031	0.043
$T_{2008}D_{2008}$	0.264***	0.046	0.079*	0.044	0.066	0.043
$T_{2009}D_{2009}$	0.111**	0.046	0.074*	0.044	0.013	0.043
$T_{2010}D_{2010}$	0.122***	0.046	0.051	0.044	0.051	0.043
R-squared	0.275		0.119		0.043	
Hausman (FE vs. RE)	40.96	{0.109}	32.41	{0.397}	48.49	{0.024}
N	6544		6544		6528	

a.* Significant at 10%; ** Significant at 5%; *** Significant at 1%;

b. All regressions include a constant (not reported);

c. p-values of Hausman tests are shown in braces. According to hausman tests, the estimation results of Low- and medium-income groups are based on random effect model and the results of high-income group are based on fixed effect model.

7. CONCLUSION

In this paper we use a household level panel data set from 1995-2010 consisting of 19616 observations to examine the internal and external determinants of rural income diversification. We focus on examining the effects of the SLCP implementation on livelihood diversification, which is thought to be the solution to poverty and environmental dilemmas and the key to success regarding sustainable development by providing alternative non-farm employment. The results clearly show that both participant and nonparticipant households experienced an increase in livelihood diversification, which mainly derived from an increase in participation in non-farm activities and non-farm income share. More importantly, a significant average treatment effect suggests that households significantly broaden their income sources and balance the proportion of each income component through participating in SLCP.

This study has benefited from the extensive data on the implementation of program to test the volatility around the time when the first contract expired and the new policy was introduced. The results suggest that the second round of contracts improved the confidence of participants in shifting labor endowment from on-farm to off-farm activities, while the reduction in subsidies did not significantly change the treatment effect, all of which suggests that policymakers made the prospect of policy clear including the duration and the level of the financial incentive targeting the success and sustainability of SLCP at the lower possible opportunity cost.

The results also demonstrate that SLCP implementation does indeed have heterogeneous effects on livelihood diversification across the income groups. The households with greater liquidity constraints are more likely to be affected by the program, which seems to be consistent with policy aimed at alleviating poverty. The insignificant effects on the households with high incomes indicate that the policy challenge lies in relaxing additional constraints such as institutional and market failures apart from liquidity constraints. More positive effects may be achieved if institutional constraints on the land exchange market, tenure security or the credit market are alleviated (Groom et al. 2010). Besides, the analysis of the characteristics and endowment of households suggests that the policymakers should increase investments in the physical infrastructure such as road conditions and public transportation, which would make it easier for households to access alternative off-farm employment opportunities.

Finally, we expect that our findings will provide guidance to improve the implementation and performance of the SLCP and will contribute to the on-going debate of how to improve the effectiveness of the program regarding poverty reduction. We also hope that our work will make a difference to other similar treatment effect studies of ecological restoration programs.

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