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# How Sustainable are Sustainable Development Programs? The Case of the Sloping Land Conversion Program in China

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**Summary.** — This paper undertakes a comprehensive assessment of the long-run sustainability of one of the world's largest sustainable development programs, the Slopping Land Conversion Program (SLCP) in China under different plausible post-SLCP scenarios. The analysis is based on farmer contingent behavior post-program land and labor decisions as well as choice experiment data. Our econometric results highlight the main obstacles to the program's sustainability, which include specific shortfalls in program implementation and certain institutional constraints, namely tenure insecurity and poor land renting rights. The use of a choice experiment also reveals unique evidence on rural households' preferences over tenure reform in China.


*Key words* — sustainable development programs, sustainability, recursive bivariate probit, choice modeling, Asia, China

## 1. INTRODUCTION

There is a well-established literature on household behavior in developing countries that describes how market and institutional imperfections drive inefficient allocation choices, which in turn contribute to both poverty and environmental degradation (De Janvry & Sadoulet, 2005, Key, Sadoulet, & De Janvry, 8; Key *et al.*, 2000). For example, failures in the off-farm labor market prevent households to access income-enhancing off-farm activities and constrain them to oversupply labor on farm. Such constrained, excess on-farm labor has been shown to be associated with high levels of forest-land conversion, which lead to both economic hardship and to negative environmental externalities (Bowlus & Sicular, 2003; Feng, Yang, Zhang, Zhang, & Li, 2004; Groom, Grosjean, Kontoleon, Swanson, & Zhang, 2006). Similarly, land right imperfections have been shown to undermine land quality investment incentives and provoke land degradation (Carter & Olinto, 2003; Deininger, Jin, Adenew, Gebre-Selassie, & Negra, 2003; Li, Rozelle, & Brandt, 1998). This "diagnosis"

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has motivated various policy responses that aim at killing two birds with one stone: by addressing the common roots of poverty and environmental degradation, it is anticipated that households will be lifted out of inefficiency traps and steered toward a more sustainable development path. The idea is to provide direct or indirect financial incentives (usually in the forms of subsidies or royalty payments) to local communities in order to induce changes in their land and labor allocation choices. These policies measured include land set aside and agri-environment programs, community-based conservation schemes and the so-called Integrated Conservation and Development Programs (Abbot, Thomas, Gardner, Neba, & Khen, 2001; Cernea & Schmidt-Soltau, 2006). Though such sustainable development programs come in various guises they have one common feature: the duration of the financial incentives or subsidies provided is finite as the aim is to induce a structural economic change at the local level such that this "win–win" objective of poverty alleviation and environmental improvement becomes self-sustainable.

The immediate silver bullet attraction of such programs led to their proliferation since the mid-1990s. Given the significant funds and attention that these programs have received, there has been evident interest in investigating to what extent they have been meeting their dual objective of addressing environmental externalities and economic development. This has sprung an extensive empirical policy evaluation literature. Some of this work has focused on examining the impact of these programs on household income, on household land and labor allocation decisions as well as on the environmental externalities the programs sought to address (Duflo & Kremer, 2003). The data used in these analyses mostly come from surveys that collect information over household behavior before and during the program. Though these studies provide useful information over the implementation of these programs, they are not particularly useful for assessing their *long-term viability or sustainability*, [1] that is, how participating households will be affected *after* the specific program ends. Such an analysis can be undertaken by using household surveys that include direct contingent behavior questions over household post-program decisions (e.g., Johnson, Misra, & Ervin, 1997). Further, most evaluation studies provide an assessment of the *gross* policy impact and thus do not adequately discern which particular attributes of a given policy are relatively more effective in generating the desired changes in allocative behavior. They are, thus, not very informative over any auxiliary improving measures that policy makers can adopt *during* the program nor over the optimal design features of a viable and cost-effective potential follow-up program *after* the current one expires. Addressing this issue requires a detailed analysis of the impact of specific attributes of a program, which represents an empirical challenge in the absence of sufficient randomization of program attributes among households. In the absence of such data, analysts may use stated preferences choice modeling techniques which are suitable for assessing the relative importance of different program attributes (Louviere, Hensher, & Swait, 2000; Mercer & Snook, 2004, chap. 6). [2]

This paper attempts to address this limitation in the current policy appraisal literature by providing a comprehensive direct assessment of the sustainability of the largest sustainable development programs currently under implementation in the developing world, the Sloping Land Conversion Program (SLCP) in China—a program that simultaneously attempts to address rural poverty and externalities from deforestation. Our analysis uses both contingent behavior and choice modeling data obtained from household and village leader surveys undertaken in two provinces in China. The data allow us to assess the program's sustainability under three plausible mutually exclusive post-program scenarios: the case when the current program is renewed in its current form, when the program is terminated altogether, and when a new program is introduced. By adopting such a direct *ex ante* assessment of the SLCP, the analysis is able to identify which policy characteristics warrant more attention in the post-SLCP period as well as which households should be targeted so that the dual objective of the program can be attained in a long lasting and cost-effective manner. Further, the use of a choice modeling approach reveals unique evidence on farmers' preferences over land tenure reform currently underway in China.

The paper is organized as follows. Section 2 briefly describes the SLCP and discusses the framework adopted for directly assessing its sustainability using contingent behavior post-program land and labor allocation data as well

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as choice modeling data. Sections 3 and 4 present the econometric framework adopted for analyzing these two types of data and the results of the empirical analysis. Section 5 concludes.

## 2. A FRAMEWORK FOR A DIRECT ASSESSMENT OF THE SUSTAINABILITY OF THE SLCP

The common lineage of rural poverty and environmental degradation has been particularly well documented in the case of China. Institutional and market failures inherited from central planning policies biased toward industrialization have constrained farmers into inefficient production choices, characterized in particular by high labor–land ratios and a low level of agricultural and land savings investments (Jacoby, Li, & Rozelle, 2002). More specifically, the oversupply of on-farm labor and the inaccessibility to off-farm labor market opportunities have been pointed out as major driving factors for both rural poverty and the cultivation of marginal, low yield, and highly sloped lands (Feng *et al.*, 2004; Xu & Cao, 2002). In fact, extensive cultivation of previously forested sloping lands in the upper reaches of the Yangtze, Yellow, Chao, and Bai Rivers has induced severe environmental degradation in the corresponding river-basin in recent years, which culminated in serious flooding and loss of life along the Yangtze River in the summer of 1998 (Uchida, Xu, & Rozelle, 2005; Wang *et al.*, 2004). In 2000, the Chinese government formally introduced the Sloping Land Conversion Program (SLCP), an ambitious 10-year program that aims at converting 32 million hectares of sloped land into forest land. The SLCP has a budgetary outlay of over US$30 billion and will affect 60 million households making it one of the largest land-set aside programs in the world (Xu *et al.*, 2006a).

The program has the dual objective of curtailing environmental degradation as well as reducing the extent of rural poverty. To this end, it provides participating households a combination of grain, cash, and seedlings as compensation for reforesting and maintaining cultivated sloped land in the upper reaches of the major river basins (Xu, Bennett, Tao, & Xu, 2004). There are two compensation levels, which are defined at the regional level and which reflect differences in the opportunity costs of reforested land. The total value of compensation to be received in each of these two regions is ¥200 and ¥300/mu/year, respectively (Uchida *et al.*, 2005; Zuo, 2002). The duration of the compensation depends on whether the specific sloped plot of land is converted to "ecological" or to "commercial" forest, or to grassland. In the first case, land is replanted with trees that serve mainly an ecological function (namely soil retention) while farmers have no rights to the forest products that could be derived from such trees. In this case, compensation can be obtained for up to eight years. In the second case, participants are granted the rights to collect nontimber forest products, so that there is potential for the farmer to replace income lost from the reduced cultivation of crops once the trees become productive. Compensation under this case lasts for a shorter period of up to 5 years. A minimum of 80% of the reforested area in any given region must nonetheless consist of ecological forest, reflecting concerns that commercial trees may have sufficiently inferior soil retention characteristics. [3]

Groom *et al.* (2006) present a household production model which shows how, under certain conditions, the provision of the SLCP subsidies may enable participants to reallocate labor toward more lucrative off-farm activities, and thereby break out of an inefficient equilibrium characterized by on-farm surplus labor and excess forest land conversion. Whether the program is in fact achieving its long-term goals is nevertheless not clear. Though there are a few empirical studies that have gained some understanding over the track record of the SLCP during its implementation, there is very little appreciation over the long-term viability of the program's ecological and developmental aims after the program expires. Given the limited duration of the program, it is important to gain an appreciation of whether the huge budgetary outlay spent will in fact lead to long-lasting and self-sustaining benefits.

Some preliminary evidence from the work by Bennett *et al.* (2004), Uchida *et al.* (2005) and Uchida *et al.* (2007), Uchida, Xu, Xu, and Rozelle (2005), and Xu and Cao (2002) suggests that the SLCP impact on participating household income levels and on shifts to noncrop related income generating activities (such as off-farm labor or livestock activities) is not sufficient to make a substantial and long lasting change to pre-program production decisions.

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Further, various program implementation issues that have been observed such as the often involuntary nature of the program, the poor quality and frequent irregularity of the compensation payments, the inadequate training and support to local farmers in replanting and maintaining trees, and the inappropriateness of some of the plots targeted for inclusion in the program have undermined the long-term viability of the program (Xu & Cao, 2002). Moreover, the work by Groom *et al.* (2006) indicates that half-way through the current SLCP, market and institutional constraints (primarily incomplete property rights and high transactions costs) still constitute serious impediments to the reallocation of labor toward off-farm activities, and thus remain important contributors to the vicious circle of inefficient production processes, poverty, and environmental degradation. However, though the results from the aforementioned studies provide useful information over the implementation of the current SLCP and to some extent some *indirect* evidence over its viability, they provide insufficient direct insights over its long term sustainability. We therefore turn instead to a more *direct* assessment of household behavior, intentions, and preferences under the three plausible and mutually exclusive alternative post-SLCP scenarios: where the program will be renewed in its current form, where the program will be terminated, and where a different and new program will be introduced. [4]

Our analysis is based on the data obtained from a purposefully designed survey that was implemented in two provinces: Ningxia, situated in northwest China into the middle reaches of the Yellow river, and Guizhou, located in the southwest, on the reaches of the Yangtze River. Selection of these provinces was motivated by the fact that they were among the first where the SLCP was implemented and by the fact that their particularly poor economic and ecological conditions relative to the rest of China were envisaged to provide particularly important information for the sustainability of the SLCP. Our sample thus somewhat leans toward poor and ecologically degraded regions. Both household and village level data were collected *via* in person interviews with the head or spouse of randomly selected households (without replacement) and with village leaders. Household data were collected for both SLCP participants and nonparticipants. In total, 286 households in 44 villages were surveyed. [5]

In order to assess the viability of the program in its current form, we analyze the determinants of responses to contingent behavior questions over household land and labor allocation intentions after the program expires, in two polar scenarios where subsidies are renewed and where they are terminated. This analysis was naturally confined to SLCP participants alone and was focused on *both* labor and land allocation intentions of participating households as this is essential for investigating the sustainability of the SLCP's double ecological and economic objective. Reforested land allocation intentions are the core of the ecological success of the program, while labor allocation choices and in particular the ability to reallocate surplus labor away from farming are essential determinants of rural poverty alleviation. Indeed, the remarkable reduction of poverty (less than $1 per day or RMB900 in PPP terms) over the last two decades, falling from 76% to 13% (Chen & Ravallion, 2005), has been largely achieved through increases in rural incomes, which are mainly due to the reallocation of rural labor away from farming toward off-farm activities (De Janvry, Sadoulet, & Zhu, 2005; Park, Wang, & Wu, 2002).

We then turned to the assessment of the sustainability of the objectives of the under the third plausible post-program scenario, namely that of a new program being introduced. In this case, we use a choice experiment (CE), which broadens the policy implications of our analysis to which attributes contribute most to the sustainability of a hypothetical new program as well as to the cost efficiency of such a program. In this case, both participants and nonparticipants were requested to select their preferred policy option from a range of potential hypothetical land set aside policies that differed with respect to the levels assigned to different policy attributes. After a detailed literature review as well as a series of consultations and pilot tests, five policy attributes were selected for the design of the CE. These include two attributes reflecting direct pecuniary benefits accruing from the subsidies received and from the revenues obtainable from the commercial exploitation of replanted trees. The former of these attributes (''subsidy amount'') was expressed in ¥/year/Mu while the latter (''commercial forest'') as the percentage of land that each household would be allowed to plant with commercial trees. We also included in the CE design whether a new program would en-

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tail enhanced land tenure and exchange rights, as these have been widely shown to be essential determinants of agricultural and labor allocation choices in China (Carter & Yao, 1999; Jacoby *et al.*, 2002; Li *et al.*, 1998; Deininger & Jin, 2002). In particular, insecure land rights may discourage households from committing to land quality investments (such as the maintenance of reforested trees) while they may also constrain household members from seeking more profitable off-farm employment opportunities due to the fear of losing unused land. [6] Therefore, it is expected that land tenure and exchange rights should impact upon the likelihood of enrolling into a new SLCP. The former of these rights is proxied by whether land *redistribution* would be permissible (''land tenure'') while the latter by whether or not land *renting* would be allowed or restricted (''land renting''). A fifth and final program characteristic reflects the level of household confidence in the implementation of the program. The specific proxy attribute chosen was the degree of assurance offered to households of receiving the program subsidies in a timely and consistent manner (''subsidy assurance''). During our focus group sessions and consultations, many households expressed distrust in the capacity of authorities to provide the promised amount of subsidies. Xu *et al.* (2004) also report that in many regions compensation payments have not been (either completely or partially) delivered to their rightful recipients, due to delays and shortfalls in the payment of compensation. Hence, ''subsidy assurance'' was considered to be a major determinant of whether households would be willing to sign up and to comply with a new program. The description of the CE attributes and levels as well as their expected impact on household utility is presented in Table 1. An orthogonal fractional factorial design was used to allow the estimation of all the main effects of the attributes (Louviere *et al.*, 2000). The resulting subsets of 32 choice sets were (randomly) blocked into four sets, and each household was presented with eight sets. Each choice set presented respondents with two policy options, each having a 30 year duration, and a third option which corresponded to having no land set aside policy.

## 3. ANALYSIS OF POST-SCLP INTENTIONS OF LABOR AND LAND ALLOCATION CHOICES

We first analyze the responses to post-SLCP contingent behavior land and labor decisions under the two polar scenarios where the program is either renewed in its current form or it is altogether abandoned.

### (a) *Econometric framework for analyzing land and labor decisions*

The dependant variables modeled here are binary. Respondents were asked whether the household intended to increase/maintain or decrease on-farm labor and reforested land in the two polar post-SLCP scenarios. In the case where subsidies are renewed, 63% of farmers stated that they would sign up to the program and maintain/increase reforested land, while 42% stated that they would decrease their on-farm labor activities. In the other polar case where subsidies were terminated, only 38% of farmers stated that they would continue to maintain their reforested lands, while 67% stated that they would increase their on-farm labor activities.

Econometrically, the interdependence of on-farm labor and land allocation decisions can be accounted for in two ways. Firstly, economic theory supports a simultaneous relationship between household labor and land allocation decisions. [7] Secondly, under market and institutional imperfections that are not always observable, factors not accounted for in the nonrandom (observed) part of the econometric

Table 1. *Choice experiment attribute description*

| Attribute description | Attribute levels | Expected impact on utility |
|---|---|---|
| Land renting rights | =1 if land rights permitted/no obstacles | + |
| Subsidy Assurance | =1 if assured | + |
| Land Redistribution | =1 if prohibited | + |
| Percentage of commercial forest | 100%, 80%, 50%, 20%, 0% | + |
| Subsidy amount (¥/mu/year) | 800, 500, 400, 300, 200, 100 | + |

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model may be influencing both decisions. This implies that the error terms in the equations of each of these two decisions may also be correlated. Failure to account for possible simultaneity as well as for correlation in unobserved heterogeneity may lead to biased and inconsistent parameter estimates (Greene, 1998). To account for these likely complementarities, we employed the bivariate (recursive) simultaneous equation model initially suggested in Maddala (1983). In its more general form, the model can be presented using the latent variable approach whereby latent labor and land post-SLCP decisions are each a function of exogenous explanatory variables as well as of each other, producing a system of equations of the generic form

$$\begin{aligned} y_1^* &= \gamma_2 y_2^* + \beta_1' \mathbf{x}_1 + \varepsilon_1 \\ y_2^* &= \gamma_2 y_1^* + \beta_2' \mathbf{x}_2 + \varepsilon_2 \end{aligned} \quad (1)$$

where latent post-SLCP labor ($y_1^*$) and land ($y_2^*$) decisions are determined by each other, and $\mathbf{x}_1$ and $\mathbf{x}_2$ are vectors of explanatory variables while $\beta_1'$, $\beta_1'$, $\gamma_1$, and $\gamma_2$ are the corresponding parameter vectors, and $\varepsilon_1$ and $\varepsilon_2$ are the errors terms that may or may not be correlated. There are various formulations of this model based on various censoring mechanisms, on whether and in what manner the latent continuous variable $y_j^*$ or its nonlatent censored or discrete counterpart, $y_j$, is observed and on whether the error terms are correlated (Lewbel, 2007). Based on the data-generating process in our study, the formulation most relevant in this paper is one where the continuous latent variables are observed in binary form. Further, the simultaneity relationship adopted is based on the work by Groom *et al.* (2006), who use a standard household production model under binding constraints related to land use and production requirements, and show how, for the case of Chinese rural communities affected by the SLCP, household labor allocation decisions are residual upon land allocation decisions, when both the enrollment into the SLCP and the amount of land enrolled are exogenous to each household (a situation that mostly characterizes our study sites). [8] Hence, the nature of the model (in reduced form) that is most relevant for our data is

$$\begin{aligned} y_1 &= \delta_1 y_2 + \pi_1' \mathbf{x}_1 + \upsilon_1 = 1 \quad \text{if } y_1^* > 0 \\ y_2 &= \pi_2' \mathbf{x}_2 + \upsilon_2 = 1 \quad \text{if } y_2^* > 0 \end{aligned} \quad (2)$$

where $\delta_1$ is the parameter of the reported binary land allocation decision, $y_2$, which enters the specification of the labor allocation decision, $y_1$. The parameters $\pi_1$ and $\pi_2$ correspond to the vector of explanatory variables $\mathbf{x}_1$ and $\mathbf{x}_2$ of each decision, and $\upsilon_1$ and $\upsilon_2$ are the error terms of each equation that accounts for all unobserved heterogeneity that may influence the observance of $y_1$ and $y_2$. If factors determining unobserved heterogeneity are correlated then the random variables $\upsilon_1$ and $\upsilon_2$ follow a bivariate probit distribution such that $\upsilon_1$, $\upsilon_2 \sim \text{BVN}[(0,0), \sigma_1^2, \sigma_2^2, \rho]$, where $\sigma_1^2$ and $\sigma_2^2$ are the standard deviations and $\rho$ is the correlation coefficient. The above recursive model involving binary dependent variables is estimated *via* FIML as suggested in Greene (1998).

### (b) *Specification of bivariate probit simultaneous equation model*

The dependent variables consist of binary responses to questions ascertaining household intentions of the use of forested land ($LAND_j$) and of on-farm labor allocation ($LABOR_j$) under the two polar post-SLCP scenarios ($j = 1, 2$), where subsidies are simply renewed in their current form and duration ($j = 1$) or they are terminated all together ($j = 2$). In both scenarios, $LABOR_j = 1$ if the respondent stated that the household intended to reduce on-farm activity while $LAND_j = 1$ when the household intended not to reconvert forest back to crop land. [9] Hence, the binary dependent variables have been specified in such a way where equality to one implies household behavior that would promote the sustainability of the impacts of the SLCP.

Explanatory variables (see Table 2) that were included in $\mathbf{x}_1$ and $\mathbf{x}_2$ in (2) were determined on the basis of the theoretical framework in Groom *et al.* (2006) as well as on the past applied econometric research on farmer land and labor decision in China (e.g., Jacoby *et al.*, 2002; Li *et al.*, 1998; Uchida *et al.*, 2005).

Firstly, post-SLCP *labor* allocation decisions ($\text{LABOR}_j$) are likely to be constrained by the presence of institutional and market imperfections that characterize rural China, and in particular by imperfect tenure security and high labor market access transaction costs. Following Li *et al.* (1998) and Deininger and Jin (2002), tenure security (TENSEC) was proxied through village level rating (obtained from the village leader survey) of the likelihood of land reallocations on farmers' land endowments

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Table 2. *Description of variables*

| Abbreviation | Description | Survey source | Pooled | Ningxia | Guizhou |
|---|---|---|---|---|---|
| | | | Mean (Std. Dev.) | Mean (Std. Dev.) | Mean (Std. Dev.) |
| $LAND_1$ | =1 when not reconvert forest back to crop land (and =0 otherwise) in scenario where subsidies renewed | Household | 0.63 (.49) | 0.58 (0.58) | 0.55 (0.48) |
| $LAND_2$ | =1 when not reconvert forest back to crop land (and =0 otherwise) in scenario where subsidies are not renewed | Household | 0.38 (0.49) | 0.35 (0.48) | 0.43 (0.50) |
| $LABOR_1$ | =1 when reduce on-farm labor (and =0 otherwise) in scenario where subsidies renewed | Household | 0.42 (0.50) | 0.38 (0.51) | 0.44 (0.47) |
| $LABOR_2$ | =1 when reduce on-farm labor (and =0 otherwise) in scenario where subsidies are not renewed | Household | 0.33 (0.48) | 0.31 (0.44) | 0.37 (0.38) |
| SLCPINC | Average direct monetary SLCP (actual annual cash subsidy, annual value of the grain subsidy, value of SLLCP forest product income (figures summed then averaged over 2000–04) | Household | 3314 (2502) | 3663 (2398) | 2902 (2537) |
| COMMVALUE | Expected future commercial value of trees planted under the SLCP (ranging from 1 to 4 with 1 low expected value and 4 high expect value) | Household | 2.63 (.94) | 2.88 (1.53) | 3.05 (1.56) |
| SGQUALITY | =1 if quality assessed by village leader to be good and =0 if assessed to be poor | Village | 0.43 (0.49) | 0.38 (0.50) | 0.48 (0.48) |
| PLTMNG | =1 if household plated and managed trees itself (=0 if planting) | Household | 0.51 (0.5) | 0.43 (0.49) | 0.62 (0.48) |
| FLDVAL | Expected protection against flooding from the SLCP (ranging from 1 to 4 with 1 low expected protection and 4 high expected protection) | Household | 1.73 (1.03) | 1.48 (0.88) | 1.9 (1.10) |

(*continued on next page*)

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Table 2—*continued*

| Abbreviation | Description | Survey sourcePooled | Ningxia | Guizhou | |
|---|---|---|---|---|---|
| | | | Mean (Std. Dev.) | Mean (Std. Dev.) | Mean (Std. Dev.) |
| HHYIELD | Household average grain yield (kg/mu) of all arable land prior to SLCP | Household | 215 (164) | 148 (63) | 293 (231) |
| LIVSTCK | Number of farm cattle livestock (pig, sheep, cows, poultry) in previous period | Household | 4.46 (7.24) | 2.35 (3.45) | 6.96 (9.45) |
| VYIELD | Village level average grain yield of sloped (kg) prior to SLCP | Village | 141 (131) | 62 (45) | 205 (71) |
| AGE | Average household age (years) in previous period | Household | 37.36 (10.16) | 36.89 (7.43) | 37.96 (12.81) |
| EDUSPOUSE | =1 if spouse has acquired at least primary school level education (=0 otherwise) | Household | 0.51 (0.5) | 0.50 (0.5) | 0.51 (0.5) |
| PRCOFFL | Percentage of village population supplying off-farm labor in previous period | Village | 0.33 (0.18) | 0.29 (0.17) | 0.38 (0.15) |
| EMPLC | =1 if village has local employment guidance officer or center (=0 otherwise) | Village | 0.57 (0.49) | 0.45 (0.49) | 0.685 (0.46) |
| CREDIT | =1 if credit in or within easy access to the village (=0 otherwise) | Village | 0.42 (0.49) | 0.39 (0.49) | 0.53 (0.50) |
| TENSEC | =1 if VL states that land redistributions would be highly unlikely to occur again (=0 otherwise) | Village | 0.35 (0.47) | 0.36 (0.47) | 0.35 (0.478) |

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|---|---|---|---|---|---|
| FORRIGHT | =1 if the perceived redistribution risk of SLCP land is higher than nonSLCP land (=0 otherwise) | Household | 0.53 (0.46) | 0.47 (0.50) | 0.59 (0.49) |
| RENTEASE | =1 if land rental unrestricted and =0 if land rental subject to the authorization from the village leader, or prohibited | Village | 0.72 (0.63) | 0.73 (0.58) | .68 (0.59) |
| PROVINCE | =1 if Guizhou and =0 if Ningxia | Household | 0.44 (0.5) | – | – |
| SLCP | =1 if household participated in SLCP | Household | 0.75 (.43) | 0.77 (0.41) | 0.73 (0.44) |
| DISTANCE | Distance of village from nearest large town in (km) | Village | 6.20 (4.78) | 7.09 (4.73) | 4.99 (4.6) |
| ELDERS | =1 if household has nonproductive elderly members in previous period | Household | 0.28 (0.33) | 0.28 (0.33) | 0.28 (0.35) |
| HHSIZE | Household size | Household | 5.28 (1.37) | 5.5 (1.69) | 4.9 (1.59) |
| FARMLAND | Total amount of household arable land (in mu) in pre-SLCP period | Household | 15.24 (6.45) | 18.76 (5.17) | 10.7 (4.99) |
| AVOFFWAGE | Average off-farm wage (in RMB) in previous period | Village | 3630 (1487) | 2981 (1133) | 4229 (1527) |
| OFFLABOR | Total household days worked off-farm in previous period. | Household | 284 (300) | 276 (284) | 292 (318) |

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(see Table 2). We also include specific tenure security of the land reforested under SLCP, using farmers' assessment of the likelihood of redistribution of SLCP land compared to other types of land (FORIGHT). The introduction of this variable is justified by the concern raised by farmers during our interviews about the future allocation of land rights over reforested land. [10] The degree of freedom in land transfers (RENTEASE) is assessed through a dummy variable, which takes the value 1 if renting land is not submitted to administrative procedures or prohibited. This information was obtained from the village head, who was asked whether land rental exchanges were free (RENTEASE = 1), subject to the authorization from the village leader, or prohibited (in these two cases, RENTEASE = 0). Indicators for transaction costs included the distance to nearest large town or off-farm labor market (DISTANCE), the presence of a local employment center (EMPLC), and the presence of a credit institution in or within easy access to the village (CREDIT). We also included the percentage of villagers from each village supplying off-farm labor (PRCOFFL) in order to capture likely network effects as well as overall village-specific off-farm labor constraints. All this information on transaction cost and institutional constraints was obtained in the village questionnaire in order to avoid endogeneity issues relating to particular household situations, except for the FORRIGHT variable, since the village questionnaire did not contain a specific question about the tenure security on reforested land. However, the problem of endogeneity that arises from using perceived tenure security at the household level is less acute in what concerns specifically reforested land because, in our sample, more than 90% of the land enrolled in the SLCP in our sample has been converted to ecological forest, which does not mobilize labor, once the initial phase of tree planting has been completed. [11]

In addition, more standard variables found in labor supply functions were included in the analysis such as the degree to which a household has diversified its labor into other income generating activities such as livestock production (LIVSTCK), household and village level proxies for the productivity of land (see below), household education (which proxies for off-farm wage), [12] and household average age. Lastly, in accordance with Eqn. (2), the stated post-SLCP land decision ($LAND_j$) was also included as a regressor to account for this particular form of simultaneity between land and labor choices.

Turning to post-SLCP *land* allocation decisions ($LAND_j$), these will depend first on conventional farm activity variables that are related to the productivity of land such as household yield data on all arable land prior to the SLCP as well as village level estimates of yield of sloped land (HHYIELD and VYIELD, respectively) [13] as well as the number of livestock (LIVSTCK). Further, the direct and indirect benefits associated with reforested land will also impact on the land allocation decision. Direct benefits include the direct monetized-SLCP income received (SLCPINC [14] (more relevant in the scenario where the program is renewed), and the estimated future commercial value of products derived from reforested land under the program (COMVALUE). Indirect benefits refer to positive environmental benefits accruing from improved land quality (such as perceived protection against floods—FLDVAL, see Weyerhaeuser *et al.*, 2005, p. 243). Moreover, the way in which the program is implemented will also impact post-program land decisions. For example, the quality of program targeting, measured by the opportunity cost of converted land (proxied by the household and village measures of land yield mentioned above), the quality of the seedlings and grain subsidy received, as assessed by the village head [15] (SGQUALITY), or whether the program provided households with training for planting and managing trees (PLTMNG) may impact the likelihood of a household being willing to maintain its reforested land.

Moreover, as trees are interpreted as an investment in land quality (Deininger & Jin, 2002; Li *et al.*, 1998), traditional determinants of land investment must be included in the specification of (2). Such variables include household characteristics (such as human capital) and land rights, in particular land tenure and exchange rights. Human capital was proxied by several household variables, including average household age (AGE) and different household educational variables, including the education level of the spouse of each household (EDUSPOUSE), which has proven to be a relatively more telling variable for the level of diffusion of social and human capital within a household (Ahituv & Kimhi, 2006). Land rights indicators were proxied using the variables discussed above (i.e., TENSEC, FORIGHT, and RENTEASE). Lastly, geographical differences are also likely to

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impact both labor and land decisions, and we included a provincial dummy variable (such that PROVINCE = 1 if the household came from Guizhou and "0" if from Ningxia) as well as county fixed effects (for the six county areas surveyed between the two provinces).

### (c) *Results of the bivariate probit simultaneous equation model*

Table 3 presents the results of the recursive bivariate probit model under the two polar post-SLCP scenarios, namely the business as usual scenario where subsidies are continued and the scenario where subsidies are terminated. These results were derived using a top-to-bottom approach coupled with sequential LR-tests to obtain the most appropriate specification. [16] Models 1 and 3 in Table 3 refer to specifications that include the same set of explanatory variables across scenarios. [17] Yet, multicolinearity problems masked the true significance of several variables. Using standard LR-testing, we derive the best-fit regressions (Models 2 and 4) in that they entail the more parsimonious specifications which were found to outperform the larger models. [18] Moreover, as these latter models do not have the same set of explanatory variables across scenarios they can more clearly highlight the differences between the two polar post-SLCP scenarios. [19]

All models in Table 3 display a satisfactory fit to the data. In the case of the best-fit specifications (Models 2 and 4), we observe 72% of $y_1$ and 78% of $y_2$ responses correctly predicted in the first scenario and correspondingly 75% and 73% in the second scenario. The McKelvey-Zavoina $R^2$ goodness-to-fit measure is 38% and 51%, respectively, which is satisfactory for the particular discrete choice model. Also, the correlation coefficient of the error terms of the two decisions (in all four specifications) is large and highly significant in the scenario where subsidies are renewed but insignificant when subsidies are terminated. [20]

Further, due to the nonlinear nature of the estimated models, the raw coefficients cannot provide accurate measures of the determinants of the dependent variables. This requires the estimation of the *marginal effects* of each explanatory variable. Using the terms of Eqn. (2), this translates in assessing the impact on the conditional expectation of $y_1$ and $y_2$ from a change in an explanatory variable in $\mathbf{x}_1$ and $\mathbf{x}_2$. Note that, as we are using a recursive model where $y_2$ enters as a regressor of $y_1$, we must calculate the *total* marginal effect of a change in each of the explanatory variables in $\mathbf{x}_1$ and $\mathbf{x}_2$ on the expectation of $y_1$ which comprises of a *direct* and *indirect* effect. [21] Marginal effects (MEs) for both post-SLCP scenarios were calculated as specified in Greene (1996) and are presented in Table 4 for all four specifications. Asymptotic standard errors of the marginal effects were estimated using the Delta Method. Significant MEs are highlighted in bold (up to the 10% level of significance), while exact significance levels are highlighted with superscripts. [22] As discussed below the marginal effects across all four specifications are comparable and allude to the same policy implications—a finding that further underlines the robustness of the estimated coefficients.

By examining Table 4, our results first confirm the unidirectional simultaneity relationship between land and labor allocation decisions discussed above. In fact in both scenarios the LAND variable appears to be associated with among the strongest marginal effects. This finding corroborates that the ecological and economic goals of the SLCP are strongly intertwined and jointly affect the sustainability of the SLCP. The remaining marginal effects illustrate the precise factors which contribute to such sustainability.

With respect to the determinants of post-SLCP *labor* allocation decisions, we see that household education (as a proxy for the wage rate) plays a prominent role in inducing lower on-farm labor in the post-SLCP period under both scenarios. Further, we see that in both scenarios transactions costs that may act as constraints to off-farm mobility are influential, with more short term variables such as EMPLC and DISTANCE being more influential in the first scenario, while more long-term constraints such as PRCOFFL and CREDIT appearing as more influential in the second. These findings are in line with the literature that stresses sources of labor mobility friction as leading to inefficient production decisions (Groom *et al.*, 2006), while the significance of these variables highlights the importance in helping local communities overcome sources of transaction costs in seeking more profitable off-farm employment opportunities. Moving from similarities to differences with respect to the marginal effects between the two scenarios, we can discern three main patterns. Firstly, agricultural productivity variables influence intended labor decisions (directly through

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Table 3. *Simultaneous equation probit model of post-SLCP land and labor allocation choices: coefficient estimates*

| | Subsidies renewed scenario | | | | Subsidies not renewed scenario | | | |
|---|---|---|---|---|---|---|---|---|
| | Model 1 | | Model 2 | | Model 3 | | Model 4 | |
| | Coef. | SE | Coef. | SE | Coef. | SE | Coef. | SE |
| *Labor equation: $LABOR_j$ = 1 when reduce on-farm labor* | | | | | | | | |
| Constant | **−1.233** | **0.894** | **−0.878** | **0.576**[c] | **−1.635** | **1.067**[b] | **−1.475** | **0.289**[a] |
| LAND | **0.452** | **0.296**[c] | **0.970** | **0.541**[a] | **0.946** | **0.586**[c] | **1.251** | **0.405**[a] |
| SLCPINC | – | – | – | – | | | – | – |
| COMMVALUE | – | – | – | – | | | – | – |
| SGQUALITY | – | – | – | – | | | – | – |
| PLTMNG | – | – | – | – | | | – | – |
| FLDVAL | – | – | – | – | | | – | – |
| HHYIELD | −0.0009 | 0.00063[d] | – | – | −0.00006 | 0.0013 | – | – |
| LIVSTCK | **0.067** | **0.046**[c] | **0.075** | **0.032**[a] | −0.00022 | 0.0089 | – | – |
| VYIELD | **−0.0008** | **−0.0005**[c] | **−0.0005** | **0.0003**[c] | 0.0249 | 0.0401 | – | – |
| AGE | −0.026 | 0.020 | **−0.025** | **0.018**[c] | −0.002 | 0.022 | – | – |
| EDUSPOUSE | **1.396** | **0.405**[a] | **0.954** | **0.340**[a] | **0.602** | **0.376**[c] | **0.672** | **0.362**[b] |
| PRCOFFL | 1.665 | 0.4002 | – | – | **1.665** | **0.400a** | **0.489** | **0.138**[a] |
| EMPLC | **1.165** | **0.381**[a] | **0.650** | **0.235**[a] | 0.520 | 0.447 | – | – |
| DISTANCE | **−0.001** | **0.001**[b] | **−0.100** | **0.057**[b] | **−0.594** | **0.417**[c] | **−0.200** | **0.107**[b] |
| CREDIT | **1.663** | **0.399**[a] | **1.180** | **0.421**[a] | **0.382** | **0.221**[c] | **0.097** | **0.064**[c] |
| TENSEC | 0.051 | 0.480 | – | – | **1.856** | **0.441**[a] | **0.89** | **0.26**[a] |
| FORRIGHT | −0.474 | 0.448 | – | – | 0.643 | 0.98 | – | – |
| RENTEASE | 0.485 | 0.511 | – | – | **−0.030** | **0.014**[b] | **0.48** | **0.30**[b] |
| PROVINCE | −0.154 | 0.603 | – | – | 0.306 | 0.603 | – | – |
| *Land equation: $LAND_j$ = 1 when not reconvert forest back to crop land* | | | | | | | | |
| Constant | −1.258 | 1.081 | −3.220 | 0.823[c] | −2.353 | 1.646[d] | −5.010 | 1.39[a] |
| SLCPINC | **0.0005** | **0.0002**[a] | **0.0005** | **0.0002**[a] | 0.0001 | 0.0016 | – | – |
| COMMVALUE | 0.00004 | 0.128 | – | – | **0.8734** | **0.532**[c] | **1.122** | **0.576**[a] |
| SGQUALITY | **1.473** | **0.375**[a] | **1.635** | **0.462**[a] | −0.010 | 0.854 | – | – |
| PLTMNG | **1.693** | **1.186**[d] | **1.405** | **0.832**[b] | 0.811 | 0.552[d] | 0.932 | 0.625[d] |
| FLDVAL | 0.438 | 0.408 | – | – | **0.753** | **0.453**[c] | **1.422** | **0.832**[c] |
| HHYIELD | **−0.0012** | **0.0004**[a] | **−0.00014** | **0.000078**[b] | **−0.00156** | **0.0010**[c] | **−0.0038** | **0.0017**[a] |
| LIVSTCK | **0.0678** | **0.03**[a] | **0.0282** | **0.009**[a] | −0.0011 | 0.0013 | – | – |
| VYIELD | −0.0002 | 0.00051 | – | – | **−0.0856** | **0.048**[b]& **−0.0013** | **0.00082**[c] | |
| AGE | **−0.030** | **0.023d** | **−0.033** | **0.021**[c] | **−0.041** | **0.0247**[c] | **−0.0652** | **0.0402**[c] |
| EDUSPOUSE | **0.901** | **0.403**[a] | **1.105** | **0.287**[a] | 0.624 | 0.900 | – | – |
| TENSEC | −0.205 | 0.458 | | | −0.00011 | 0.954 | – | – |
| FORRIGHT | 0.00011 | 0.0033 | – | – | **1.669** | **0.981**[b] | **1.21415** | **0.548**[a] |
| RENTEASE | −0.266 | 0.372 | – | – | **2.788** | **0.997**[a] | **2.95777** | **0.636**[a] |
| PROVINCE | 0.517 | 0.610 | – | – | **1.733** | **0.909**[b] | **1.899** | **0.806**[a] |
| $N = 216$ | *Model 1: $\rho_{1,2}$ = 0.61[a]; LL = −113.4199; McKelvey-Zavoina $R^2$ = 41%* | | | | *Model 3: $\rho_{1,2}$ = 0.06; LL = −82.04580; McKelvey-Zavoina $R^2$ = 53%* | | | |
| | *Model 2: $\rho_{1,2}$ = 0.67[a]; LL = −118.5872; McKelvey-Zavoina $R^2$ = 38%* | | | | *Model 4: $\rho_{1,2}$ = 0.05; LL = −90.56670; McKelvey-Zavoina $R^2$ = 51%* | | | |

*Notes*: Superscripts a, b, c, and d denote 1%, 5%, 10%, and 15% levels of significance, respectively.

VYIELD and indirectly through HHYIELD and LIVSTCK) in the scenario where subsidies are renewed. A tentative explanation is that the land use restrictions imposed by the SLCP may induce a land use constraint to bind, entailing nonseparability between household consumption and production decisions (De Janvry & Sadoulet, 2005, chap. 8). Secondly, program implementation variables only affect the labor decisions in the case where

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Table 4. *Simultaneous equation probit model of post-SLCP land and labor allocation choices: marginal effects*

| | Subsidies renewed scenario | | | | | | | | Subsidies not renewed scenario | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Model 1—marginal effects | | | | Model 2—marginal effects | | | | Model 3—marginal effects | | | | Model 4—marginal effects | | | |
| | Direct | Indirect | Total | SE | Direct | Indirect | Total | SE | Direct | Indirect | Total | SE | Direct | Indirect | Total | SE |
| *Labor equation: $LABOR_i$ = 1 when reduce on-farm labor* | | | | | | | | | | | | | | | | |
| LAND[D] | **0.321** | – | **0.321** | **0.184**[c] | **0.427** | – | **0.427** | **0.1221**[a] | **0.567** | – | **0.567** | **0.343**[c] | **0.532** | – | **0.532** | **0.175**[a] |
| SLCPINC | – | **0.115** | **0.115** | **0.069**[c] | – | 0.737 | 0.737 | 0.644 | – | 0.00034 | 0.00034 | 0.0019 | – | – | – | – |
| COMMVALUE[C] | – | 0.001 | 0.001 | 0.482 | – | – | – | – | – | −0.384 | −0.384 | 0.682 | – | −0.652 | −0.652 | 0.984 |
| SGQUALITY[D] | – | **0.145** | **0.145** | **0.092**[c] | – | **0.215** | **0.215** | **0.151**[c] | – | 0.11 | 0.11 | 0.852 | – | – | – | – |
| PLTMNG[D] | – | **0.226** | **0.226** | **0.142**[c] | – | **0.183** | **0.183** | **0.112**[c] | – | 0.023 | 0.023 | 0.056 | – | 0.00001 | 0.00001 | 0.00001 |
| FLDVAL[C] | – | 0.003 | 0.003 | 0.011 | – | – | – | – | – | 0.004 | 0.004 | 0.020 | – | 0.015 | 0.015 | 0.147 |
| HHYIELD[C] | −0.01591 | −0.009 | −0.0249 | 0.01625[d] | – | **−0.266** | **−0.266** | **0.168**[c] | −0.0420 | −0.0176 | −0.0596 | −0.0372[d] | | −0.412 | −0.412 | 0.283[d] |
| LIVSTCK[C] | **0.031** | **0.011** | **0.042** | **0.0241**[c] | **0.020** | **0.003** | **0.023** | **0.013**[b] | −0.0210 | −0.072 | −0.093 | 0.589 | – | – | – | – |
| VYIELD[C] | −0.0021 | −0.0013 | −0.0034 | 0.00212[d] | **−0.0012** | | **−0.0012** | **0.00075**[c] | 0.0002 | 0.0001 | 0.0003 | 0.00025 | – | – | – | – |
| AGE[C] | **−0.015** | **−0.007** | **−0.022** | **0.013**[c] | **−0.004** | **−0.005** | **−0.009** | **0.0054**[c] | −0.08 | −0.0127 | −0.0927 | 0.375 | | −0.253 | −0.253 | 0.197 |
| EDUSPOUSE[D] | **0.252** | **0.003** | **0.255** | **0.084**[a] | **0.18** | **0.070** | **0.250** | **0.105**[b] | **0.175** | **0.111** | **0.286** | **0.174**[c] | **0.176** | – | **0.176** | **0.018**[a] |
| PRCOFFL[C] | 0.001 | – | 0.001 | 0.03 | – | – | – | – | **0.00059** | – | **0.00059** | **0.0003**[a] | **0.00087** | – | **0.00087** | **0.00052**[b] |
| EMPLC[D] | **0.172** | – | **0.172** | **0.0832**[a] | **0.263** | – | **0.263** | **0.109**[a] | 0.137 | – | 0.137 | 0.756 | – | – | – | – |
| DISTANCE[C] | **−0.011** | – | **−0.011** | **0.0065**[b] | **−0.055** | – | **−0.055** | **0.017**[a] | **−0.005** | – | **−0.005** | **0.0332**[d] | **−0.009** | – | **−0.009** | **0.0055**[c] |
| CREDIT[D] | 0.010 | – | 0.010 | 0.0087[d] | **0.0276** | – | **0.0276** | **0.017**[c] | **0.107** | – | **0.107** | **0.0603**[b] | **0.084** | **0.013** | **0.097** | **0.06**[c] |
| TENSEC[D] | 0.115 | −0.102 | 0.13 | 0.186 | – | – | – | - | **0.378** | **−0.0023** | **0.3757** | **0.201**[b] | **0.197** | – | **0.197** | **0.09**[a] |
| FORRIGHT[D] | −0.0036 | 0.00145. | −0.00215 | 0.008 | – | – | – | – | 0.050 | 0.001 | 0.051 | 0.0435 | – | 0.044 | 0.044 | 0.62 |
| RENTEASE[D] | 0.0704 | −0.0322 | 0.0382 | 0.319 | – | – | – | – | −0.0161 | 0.021 | 0.0049 | 0.0182 | **0.351** | **0.015** | **0.366** | **0.215**[c] |
| PROVINCE[D] | −0.15 | 0.03 | −0.12 | 0.78 | – | – | – | – | 0.131 | 0.017 | 0.148 | 0.217 | – | **0.450** | **0.450** | **0.311**[c] |
| *Land equation: $LAND_i$ = 1 when not reconvert forest back to crop land* | | | | | | | | | | | | | | | | |
| SLCPINC[C] | **0.00044** | – | **0.00044** | **0.00026**[b] | **0.00018** | – | **0.00018** | **0.0001**[b] | 0.00032 | – | 0.00032 | 0.0017 | – | – | – | – |
| COMMVALUE[C] | 0.09 | – | 0.09 | 0.153 | – | – | – | – | **0.292** | – | **0.292** | **0.171**[b] | **0.310** | – | **0.310** | **0.0868**[a] |
| SGQUALITY[C] | **0.240** | – | **0.240** | **0.0788**[a] | **0.595** | – | **0.595** | **0.125**[a] | −0.0724 | – | −0.0724 | 0.112 | – | – | – | – |
| PLTMNG[D] | **0.135** | – | **0.135** | **0.0821**[d] | **0.370** | – | **0.370** | **0.215**[b] | **0.0225** | – | **0.0225** | **0.0143**[d] | **0.180** | – | **0.180** | **0.095** |
| FLDVAL[C] | 0.130 | – | 0.130 | 0.565 | – | – | – | – | **0.105** | – | **0.105** | **0.0571**[b] | **0.176** | – | **0.176** | **0.105**[c] |
| HHYIELD[C] | **−0.0025** | – | **−0.0025** | **0.00084**[a] | **−0.0018** | – | **−0.0018** | **0.001**[b] | **−0.001** | – | **−0.001** | **0.0058**[b] | **−0.0009** | – | **−0.0009** | **0.00054**[c] |
| LIVSTCK[C] | **0.017** | – | **0.017** | **0.01**[b] | **0.034** | – | **0.034** | **0.022**[c] | −0.062 | – | −0.062 | 0.314 | – | – | – | – |
| VYIELD[C] | −0.0008 | – | −0.0008 | 0.032 | – | – | – | – | **−0.007** | – | **−0.007** | **0.0042**[c] | **−0.003** | – | **−0.003** | **0.0018**[c] |
| AGE[C] | **−0.021** | – | **−0.021** | **0.013**[d] | **−0.018** | – | **−0.018** | **0.00111**[c] | **−0.033** | – | **−0.033** | **0.019**[c] | **−0.025** | – | **−0.025** | **0.013**[b] |
| EDUSPOUSE[D] | **0.224** | – | **0.224** | **0.140**[b] | **0.385** | – | **0.385** | **0.178**[a] | −0.141 | – | −0.141 | 0.781 | – | – | – | – |
| TENSEC[D] | −0.187 | – | −0.187 | 0.752 | – | – | – | – | 0.137 | – | 0.137 | 0.621 | – | – | – | – |
| FORRIGHT[D] | 0.048 | – | 0.048 | 0.135 | – | – | – | – | **0.330** | – | **0.330** | **0.192**[c] | **0.420** | – | **0.420** | **0.260**[b] |
| RENTEASE[D] | −0.090 | – | 0.090 | 0.371 | – | – | – | – | **0.281** | – | **0.281** | **0.092a** | **0.530** | – | **0.530** | **0.292**[a] |
| PROVINCE[D] | 0.105 | – | 0.105 | 0.23 | – | – | – | – | 0.171 | – | 0.171 | 0.139 | **0.312** | – | **0.312** | **0.214**[b] |

*Notes*: Superscripts a, b, c, and d denote 1%, 5%, 10%, and 15% levels of significance, respectively. Superscripts C and D denote continuous and dummy variable, respectively.

subsidies are renewed. This result (albeit only indirect) further underlines the importance of proper policy implementation in order to generate wider community confidence in pursuing and committing to alternative production choices. Thirdly, labor allocation decisions in the scenario where subsidies are terminated are (uniquely) influenced by tenure security over a household's land (TENSEC) and renting rights (RENTEASE). These findings provide evidence that more secure tenure induces households to decrease farming activity, which in turn may free labor toward off-farm activities. One explanation for this is that insecure tenure induces households to inefficiently over-supply labor on farm as their incentives to engage in off-farm activities are dampened by the increased risk of losing (uncultivated) land in subsequent land reallocations. Similarly, the impossibility to sell, mortgage, or rent land imposes a further obstacle to off-farm labor supply.

The prominence of property rights in the scenario where subsidies are terminated could be attributed to the fact that households associate this scenario with a longer term period. Hence, land rights reform is seen as vital in the long term while policy implementation is more vital in the short term. As the subsidy termination scenario is ultimately the long-term scenario that people do expect at some point the need for land right reform becomes a pressing condition for ensuring that the impacts of the SLCP are long lasting.

Turning to the determinants of *land* use decisions, we can first discern that variables associated with SLCP implementation are important in both polar scenarios though we observe different effects in each case. In particular, in the case where subsidies are renewed the probability that households will maintain reforested land is mainly determined by the quality of the grain and seedlings (SGQUALITY) received under the current SLCP. This confirms previous observations that shortfalls in the quality of compensation may jeopardize future confidence in any renewed program (Weyerhaeuser *et al.*, 2005; Xu *et al.*, 2004). Also, whether households were involved and trained in the planting of trees (PLTMNG) also play a vital role in maintaining reforested lands in the business as usual scenario. The appointment of external teams to plant trees was often used by implementing local authorities in order to divert subsidies away from the participating households, a practice that has been received with resentments by local communities (Weyerhaeuser *et al.*, 2005; Xu *et al.*, 2004). The marginal effect of SLCPINC on the likelihood that a household will show commitment to maintain reforested lands is also significant but we find that gaining household support and confidence in the quality of the implementation of the program as well as granting a greater degree of autonomy and ability in managing reforested lands has a relatively larger impact on enhancing adhesion to the SLCP's ecological goals. In contrast, in the case where subsidies are terminated and no replacement program is instated, the expected commercial value of the planted trees (COMVALUE) together with perception over the importance of protection against flooding from maintaining reforested lands (FLDVAL) now becomes influential program implementation variables on a household's land decision.

Turning to agricultural activity variables, we find that yield (HHYIELD) significantly increases the probability of land re-conversion in both scenarios. As this variable also captures the opportunity cost of enrolled land, its negative and significant marginal effect provides further support that the quality of program targeting is important for long-term program sustainability. We also see that moving into livestock activities also promotes the sustainability of the program. As far as household demographic variables are concerned, household age appears to be the most influential and consistent determinant of maintaining reforested land in both polar post-SLCP scenarios with the effect being higher among younger households and stronger in the case where the subsidies are not renewed.

Examining next the property right variables, we see that these have an influential impact only in the second polar scenario. In particular enhanced tenure security over reforested lands (FORRIGHT) and restrictions on renting land (RENTEASE) are the most significant variables. The policy implications of our findings are clear: the type and quality of trees that are selected for reforestation have to be reassessed, while the rights for using these trees must be enhanced in order to increase the likelihood that reforested lands are maintained in the post-SLCP period. Also, these results suggest that ensuring that households make land decisions that internalize environmental externalities in a long lasting

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manner requires broader property right reform, which includes enhanced rental rights and more secure tenure.

Lastly, we more directly explored the impacts of spatial effects on post-SLCP land and labor decisions by including location-specific dummy variables that would capture any relevant spatial heterogeneity not already accounted for (indirectly) by the village level variables included in the specification. We considered both a provincial level dummy variable (=1 for Guizhou) and separate fixed effects for the six counties surveyed (three from each province). We found firstly that such direct spatial effects were not particularly significant (with only the provincial dummy being significant in the scenario where subsidies are terminated), implying that most of the spatial heterogeneity was accounted for by the village level proxy variables discussed above. Secondly, the expected sign of the provincial dummy could not be easily determined *a priori* as there are various counterbalancing effects. In the case where subsidies are renewed, we would expect the coefficient to be negative indicating that respondents from Ningxia would be more likely to sign up to continue with the program. This would be in line with the view that SLPC participants in Ningxia have been overcompensated (Uchida *et al.*, 2007). Yet, we observe that the coefficient is insignificant. This suggests that this may have been counterbalanced by another effect that has been observed for the case of Ningxia, namely that the subsidies have been delayed and turned out to be lower than pledged and thought by initial policy evaluation studies (see Tu *et al.*, 2007). In the scenario where subsidies are not renewed, the positive and significant coefficients of the province dummy variable suggest that SLCP participants in Ningxia, one of the poorest regions in western China that has relatively fewer off-farm labor opportunities, are more likely to reconvert their land back to cropping land.

## 4. ANALYSIS OF STATED PREFERENCES OVER ALTERNATIVE POST-SLCP PROGRAMS

We now turn to the assessment of the sustainability of the objectives of the SLCP under the scenario where a new hypothetical program is introduced by presenting the results from the analysis of the choice experiment data.

### (a) *Econometric framework for analyzing choice experiment data*

The econometric model employed was the random parameter logit (RPL) model which allows us to account for preference heterogeneity across households within a random utility modeling framework (McFadden & Train, 2000). The random utility function with random parameters is given by

$$U_{jtn} = V_{jtn} + \varepsilon_{jtn} \equiv \beta'_{jtn}\mathbf{x}_{jtn} + \delta'_k\mathbf{x}_{jtnk} + \varepsilon_{jtn} \qquad (3)$$

where household $n$ ($n = 1, \ldots, N$) obtains utility $U$ from choosing alternative $j$ ($j = A, B, C$) in each of the choice sets $t$ ($t = 1,\ldots,8$) presented to them. The utility is decomposed into a nonrandom component ($V$) and a stochastic term ($\varepsilon$). In its most simple form, the nonrandom component is assumed to be a function of the vector of $k$ choice-specific attributes $\mathbf{x}_{jtnk}$ with corresponding parameters $\beta_{nk}$ which, due to preference heterogeneity, may vary (randomly) across respondents in accordance with some joint density function with mean $\beta_k$ and standard deviation $\sigma_k$. [23] The household will choose the policy option, *j,* which yields a higher utility compared to any other option in each choice set. [24] In our case, as discussed in Section 2, the vector $\mathbf{x}_{jtnk}$ includes five attributes (renting, subsidy assurance, land tenure, percentage of commercial forest, and subsidy amount) as well as an alternative specific constant (ASC), which takes on the value of 1 when the individual chooses a program over the status quo option (no program). The ASC captures all other attributes erroneously omitted from $\mathbf{x}_{jtnk}$ and also reflects the utility derived from choosing to participate into the SLCP keeping all other attributes at their status quo levels.

The *sources* of preference heterogeneity can be explored by introducing household-specific characteristics, $z_n$. As these variables do not vary across choices, they would drop out of the probability so that their inclusion into the model can be made possible by interacting them with the choice varying attributes $\mathbf{x}_{jtnk}$. In our case we interact $z_n$ with the ASC of the model. By including such interaction terms, we can examine the household characteristics that affect the likelihood of participation in the new program. [25] Hence, the RPL model specified in (3) will be able to pick up two types of variation in preferences: A systematic *conditional* type of preference heterogeneity, the

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source of which can be identified in household characteristics, $z_n$, and a random, unconditional, and unobservable type of taste heterogeneity as captured by $\sigma_k$ of the distribution of each random parameter $\beta_{nk}$.

Ultimately, the estimation of CE data using the RPL approach provides various unique estimates that are directly relevant to assessing the sustainability of different post-SLCP programs. First, the model allows us to assess the determinants (program, village, and household specific) of choosing alternative programs. Next, we can assess the change in the probability of choosing to enroll into the program as a function of household, village and program-specific characteristics (i.e., the marginal effects). [26] We can also estimate the entire probability density function for participation into a new program for different subsidy levels. Lastly, we can estimate the marginal consumer surplus (i.e., marginal willingness to accept or implicit price) associated with specific changes in policy characteristics as well as the total consumer surplus (i.e., total willingness to accept) from changes in program profiles from the *status quo* of having no program. In cases where the parameter of a specific attribute has been found to be random and if we assume that $\beta_{\text{subsidy}}$ proxies for the marginal utility of income and is fixed (i.e., nonrandom), then we can incorporate the information contained in the distribution of that random parameter in the calculation of consumer surplus by following the approach detailed in Hensher *et al.* (2005) to estimate (*via* simulations) the expression $\text{MWTA} = -(\beta_k + \sigma_{nk} \cdot \Phi/\beta_{\text{subsidy}})$, where $\beta_k$ is the estimate of each random parameter $k$, $\sigma_{nk}$ its corresponding standard error, and $\Phi$ the *pdf* of the distribution assumed for each $\beta_k$. [27] In the present application, the marginal willingness to accept (MWTA) is hypothesized to be negative for each of the policy attributes as it represents a measure of the marginal compensating surplus that a household would be willing to forego in order to sign up to a reforestation program that is characterized by an improvement in a particular attribute. On the contrary, the implicit price for the ASC parameter is hypothesized to be positive as it would reflect the minimum amount that would need to be provided to each household in order to induce them to sign up to a program that sets all other attributes to their "less desirable" levels as specified in (3). Lastly, total net WTA or compensating surplus for signing up to different program profiles is given by $\text{TWTA} = -((V^0 - V^1)/\beta_{\text{price}})$ and provides an estimate of the minimum bid that a farmer would be willing to accept in order to sign up to a particular program that yields utility $V^1$ as opposed to that obtained from the status quo $V^0$.

### (b) *Specification of the random parameter logit model*

The parameters of the distribution of the random parameter vector $\beta'_{nk}$ as well as the fixed (nonrandom) parameter vector of the interaction terms, $\delta'_k$, were recovered *via* the simulation maximum likelihood routine in LIMDEP based on 1000 Halton draws. [28] Running the full RPL model with large number of draws is particularly time intensive, what hinders sufficient and comprehensive exploration of the data. We thus undertook the estimation process in two stages following the recommendation of Hensher *et al.* (2005). In the first stage, we undertook extensive initial exploratory estimation using just 20 draws. This initial stage was used to reveal which attributes were likely to be random, their likely distributional form, as well as which household-specific variables to include in $z_n$ in order to produce the best fit specification.

The variables that were explored to be included in $z_n$ were selected on the basis of a review of the literature on determinants of farmer participation in agri-environment and land-set aside programs (e.g., Birol *et al.*, 2005; Cooper, 2003; Johnson *et al.*, 1997; Langpap, 2004; Mullan & Kontoleon, 2008; Parks & Schorr, 1997; Pattanayak, Mercer, Sills, & Yang, 2003; Scherr, 1995; Vanslembrouck, Van Huylenbroeck, & Verbeke, 2002). These include previous participation in the program (SLCP = 1), off-farm labor supply in previous period (OFFLABOR), education level of spouse (EDUSPOUSE), and agricultural activity variables such as agricultural yield (HHYIELD), number of livestock (LIVSTCK), amount of arable land (FARMLAND) as well as average household age (AGE). In addition, the specification of $z_n$ was further guided by the insights derived from the behavioral model presented in Groom *et al.* (2006), which specifically explores the determinants of the allocation decisions of farmers exposed to the SLCP. These variables are common to those used in the analysis of the contingent behavior responses in Eqn. (2) and include institutional village level variables such as land

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tenure security (TENSEC), ease of renting rights (RENTEASE) access to credit (CREDIT), and existence of a center or program providing help for pursuing off-farm employment opportunities (EMPLC) as well as individual household level variables that affect off-farm labor opportunities such as distance to nearest large town (DISTANCE) and presence of nonproductive elders in the household (ELDERS).

In the second stage of the estimation process, we re-ran the RPL with the specifications that were "short-listed" from the first stage using 100, 300, 500, and 1000 Halton draws. This allowed us to test for the stability of the estimated parameters and then subsequently to choose the most robust best-fit specification. The final results of this estimation procedure are discussed in the following section.

(c) *Results from the choice experiment*

Table 5 presents the coefficient estimates for the specifications of the RPL model ran for the pooled sample as well for each of the two sampled provinces. Model 1 is an augmented specification based that uses the pooled sample. Models 2 and 4 use the same augmented specification as in Model 1 but are run for the each province separately. Models 3 and 5 are more parsimonious specifications derived using sequential likelihood ratio tests and eliminating variables that did not add additional information. The restricted models (3 and 5) were compared with their unrestricted counterparts (Models 2 and 4) using standard likelihood ratio tests, and in each case the null hypothesis that the restricted model is the correct one could not be rejected. [29]

From the adjusted $R^2$ and the $\chi^2$ statistics we see that the overall fit of the models is satisfactory. The coefficients on the parameters of the choice attributes are significant and have the hypothesized signs. Further, we see that the data exhibit considerable unconditional taste heterogeneity as signified by the significant standard deviations of the parameters found to be random in each of the three models. This provides indirect support for the use of the RPL approach as opposed to other approaches for accounting for preference heterogeneity (Hensher *et al.*, 2005). The table also displays the distributional assumptions made for each of the random parameters, with the triangular and normal distributions providing the best fit to the data.

Turning next to exploring the *sources* of preference heterogeneity, we see that the pooled model displays a considerably larger number of significant interacted individual characteristic which can partly be explained due to its larger sample size (see lower panel of Table 5). [30] The coefficient associated with "PROVINCE" is highly significant, justifying the use of the other two region-specific models. Also, its negative sign suggests that respondents in Ningxia province which have a considerably lower standard of living and fewer off-farm labor opportunities than those in Guizhou (Uchida *et al.*, 2005, 2007) would be more likely to participate in some form of program. Moreover, the determinant factors for participation in a new program are shown to vary across provinces. For example, production variables such as farm size and livestock are more significant in Ningxia, where farm sizes are larger and households more specialized in agriculture than in Guizhou. In contrast, institutional reforms such as tenure security, renting rights, and access to credit are more important in Guizhou, where off-farm opportunities are more diverse and more lucrative.

The raw coefficients, however, do not provide a clear measure over the relative importance of each of the variables affecting choice. For this, we can turn to the post-estimation results such as marginal effects, part-worth's and marginal probabilities described in Section 4a (see Table 6), which can provide valuable policy insights for designing cost-effective and sustainable land set aside policies. [31] In interpreting firstly the marginal effects (MEs) of each covariate in $\mathbf{x}$ and $\mathbf{z}$ caution must be exercised making comparisons between MEs of discrete (dummy) and continuous variables (Hensher *et al.*, 2005). Examining first the ME associated with the continuous choice attributes, we see that the subsidy amount emerges as an important factor affecting participation in both regions (though it has a somewhat higher impact in Guizhou which is consistent with a higher opportunity costs of enrollment in that province). In the pooled model, increasing the subsidy level by one Yuan would increase the likelihood of participating into the SLCP by 14%. Utilizing this estimate, policy makers can explore the likely impacts of plausible discrete changes in the subsidy amount on participation rates (e.g., an increase of ¥200 would, *ceteris paribus*, entail a 24% increase in the likelihood of participation). Examining next the ME of granting the full rights to plant

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Table 5. *Coefficient estimates of random parameters logit model with conditional heterogeneity*

| | Pooled Model 1 | | | Ningxia Model 2 | | | Ningxia Model 3 | | | Guizhou Model 4 | | | Guizhou Model 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Choice parameters | Coef. | Std. Dev.† | Dist. | Coef. | Std. Dev.† | Dist. | Coef. | Std. Dev.† | Dist. | Coef. | Std. Dev.† | Dist. | Coef. | Std. Dev.† | Dist. |
| ASC | **−2.5788**[a] | **1.6846**[a] | N | **−7.3620**[a] | **3.6910**[a] | N | **−2.146**[a] | **3.659**[a] | N | **−4.8684**[a] | **2.6837** | N | **−3.273**[a] | **2.538**[a] | N |
| | (**0.3655**) | (**0.1008**) | | (**1.4711**) | (**0.3823**) | | (**0.700**) | (**0.278**) | | (**1.9110**) | (**0.2620**) | | (**0.637**) | (**0.221**) | |
| Subsidy assurance | **0.5344**[a] | **1.6979**[a] | T | **0.1004**[c] | **1.6183**[a] | T | **0.751**[a] | **1.683**[a] | T | **1.4439**[a] | **1.3125** | T | **1.429**[a] | **0.892**[a] | T |
| | (**0.0409**) | (**0.1110**) | | (**0.0640**) | (**0.2050**) | | (**0.073**) | (**0.215**) | | (**0.1027**) | (**0.2221**) | | (**0.093**) | (**0.179**) | |
| Land tenure | **0.7088**[a] | **0.7488**[a] | N | **0.3795**[a] | **0.7515**[a] | T | **0.364**[a] | **0.578**[a] | T | 0.0289 | 0.8549 | T | **0.120**[c] | **1.317**[a] | T |
| | (**0.0390**) | (**0.0539**) | | (**0.0815**) | (**0.1762**) | | (**0.060**) | (**0.166**) | | (0.0863) | (0.1976) | | **−0.077** | **−0.2** | |
| Comm. Forest (%) | **0.0102**[a] | **0.0055**[a] | N | **0.0335**[c] | – | | **0.017**[a] | – | | **0.0213**[a] | **0.4477** | N | **0.021**[a] | – | |
| | (**0.0017**) | (**0.0010**) | – | (**0.0202**) | – | | (**0.003**) | – | | (**0.0096**) | (**0.1048**) | | (**0.004**) | | |
| Renting rights | **0.1555**[a] | – | | **0.1674**[a] | – | | **0.346**[a] | – | | **0.0218**[a] | **2.6837** | N | **0.219**[b] | **0.424**[a] | N |
| | (**0.0421**) | – | | (**0.0272**) | – | | (**0.067**) | – | | (**0.0041**) | (**0.2620**) | | (**0.087**) | (**0.096**) | |
| Subsidy amount | **0.0087**[a] | – | | **0.0077**[a] | – | | **0.010**[a] | – | | **0.0133**[a] | – | – | **0.013**[a] | – | – |
| | (**0.0004**) | – | | (**0.0007**) | – | | (**0.001**) | – | | (**0.0007**) | – | – | (**0.001**) | – | – |
| *Heterogeneity in mean (interacted with ASC)* | | | | | | | | | | | | | | | |
| PROVINCE | **−0.9539**[b] | – | | – | – | | – | – | | – | – | – | – | – | – |
| | (**0.5850**) | – | | – | – | | | – | | – | – | – | – | – | – |
| SLCP | **1.3658**[a] | – | | **3.2508**[a] | – | | **1.590**[a] | – | | **0.9539**[a] | – | – | **1.080**[a] | – | – |
| | (**0.1449**) | – | | (**0.5281**) | – | | (**0.390**) | – | | (**0.5164**) | – | – | (**0.314**) | – | – |
| TENSEC | **0.8130**[c] | – | | –1.4187 | – | | – | – | | **1.6144**[c] | – | – | **1.246**[a] | – | – |
| | (**0.5015**) | – | | (1.6274) | – | | – | – | | (**0.9552**) | – | – | (**0.361**) | – | – |
| RENTEASE | **0.2405**[c] | – | | 0.3520 | – | | – | – | | **1.5158**[a] | – | – | **0.745**[a] | – | – |
| | (**0.1586**) | – | | (0.7821) | – | | – | – | | (**0.5029**) | – | – | (**0.354**) | – | – |
| CREDIT | **0.5116**[a] | – | | 0.3053 | – | | – | – | | **1.5673**[c] | – | – | **0.943**[a] | – | – |
| | (**0.1455**) | – | | (0.8448) | – | | | – | | (**0.9558**) | – | – | (**0.312**) | – | – |
| EMPLC | **0.7665**[c] | – | | −0.4387 | – | | – | – | | **0.8608**[c] | – | – | – | – | – |
| | (**0.5417**) | – | | (0.7663) | – | | – | – | | (**0.5725**) | – | – | – | – | – |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DISTANCE | **−0.0766**[a] | – | −0.0911 | – | **−0.206**[b] | – | −0.0356 | – | – | – | – | – |
| | (**0.0160**) | – | (0.0735) | – | (**0.102**) | – | (0.1053) | – | – | – | – | – |
| PRCOFFHHL | 1.0191 | – | 2.7494 | – | – | – | 1.0504 | – | – | – | – | – |
| | (0.9841) | – | (2.2395) | – | – | – | (2.2487) | – | – | – | – | – |
| ELDERS | **−0.3984**[c] | – | 0.4618 | – | – | – | **−0.9527**[a] | – | – | **−0.765**[a] | – | – |
| | (**0.2444**) | – | (0.4185) | – | – | – | (**0.3821**) | – | – | (**0.286**) | – | – |
| AVOFFWAGE | **0.0001**[a] | – | 0.0004 | – | – | – | 0.0001 | – | – | – | – | – |
| | (**0.0000**) | – | (0.0003) | – | – | – | (0.0001) | – | – | – | – | – |
| OFFLABOUR | **0.0037**[a] | | −0.0021 | – | – | – | 0.0003 | – | – | – | – | – |
| | (**0.0008**) | – | (0.0059) | – | – | – | (0.0006) | – | – | – | – | – |
| EDUSPOUSE | **0.4297**[a] | – | **1.0630**[a] | – | **0.800**[a] | – | 0.3997 | – | – | – | – | – |
| | (**0.1241**) | – | (**0.3926**) | – | (**0.282**) | – | (0.4101) | – | – | – | – | – |
| AGE | **−0.0120**[a] | – | **−0.0483**[a] | – | **−0.038**[a] | – | 0.0118 | – | – | – | – | – |
| | (**0.0050**) | – | (**0.0143**) | – | (**0.012**) | – | (0.0150) | – | – | – | – | – |
| LIVESTOCK | **0.0879**[a] | – | **0.1052**[a] | – | **0.092**[b] | – | **0.0682**[c] | – | – | **0.072**[b] | – | – |
| | (**0.0188**) | – | (**0.0443**) | – | (**0.043**) | – | (**0.0399**) | – | – | (**0.038**) | – | – |
| HHYIELD | −0.0016 | – | 0.0013 | – | – | – | **−0.0003**[c] | – | – | – | – | – |
| | (0.0012) | – | (0.0010) | – | – | – | (**0.0002**) | – | – | – | – | – |
| FARMLAND | **0.0310**[a] | – | 0.0512 | – | **0.077**[a] | – | −0.0068 | – | – | – | – | – |
| | (**0.0072**) | – | (0.0489) | – | (**0.014**) | – | (0.0377) | – | – | – | – | – |
| | $N = 2288$; $R^2$-Adj = 0.33; LL = −1620.99 | | $N = 1240$; $R^2$-Adj = 0.41; LL = −777.2 | | $N = 1240$; $R^2$-Adj = 0.41; LL = −784.43 | | $N = 1048$; $R^2$-Adj=0.46; LL = −593.70 | | | $N = 1048$; $R^2 = 0.45$; LL = −600.51 | | |

*Notes*: All parentheses denote standard errors; Superscripts a, b, c, and d denote 1%, 5%, 10%, and 15% levels of significance, respectively. [†]Derived standard deviations of random parameters.

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Table 6. *Post-estimation estimates from random parameters logit models*

| | Model 1 | | | Model 2 | | | Model 3 | | | Model 4 | | | Model 5 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | ME[†] | MWTA[‡] | ΔWTA[±] | ME[†] | MWTA[‡] | ΔWTA[±] | ME[†] | MWTA[‡] | ΔWTA[±] | ME[†] | MWTA[‡] | ΔWTA[±] | ME[†] | MWTA[‡] | ΔWTA[±] |
| ASC | – | 445.25[a] | – | – | 462.21[a] | – | – | 471.77[a] | – | – | 445.72[a] | – | – | 423.7255[a] | – |
| | | (33.52) | – | | (48.677) | – | | (35.168) | – | | (56.781) | – | | (42.193) | – |
| Subsidy assurance | 7.57 | −114.87[a] | – | 15.14 | −187.67[a] | – | 18.45 | −199.524[a] | – | 5.25 | −22.871[c] | – | 6.34 | −17.828 | – |
| | | (11.19) | – | | (22.905) | – | | (15.378) | – | | (13.552) | – | | (12.112) | – |
| Land Tenure | 09.67 | −171.23[a] | – | 7.23 | −20.55[c] | – | 9.33 | −21.45[b] | – | 21.75 | −161.762[a] | – | 25.64 | −178.796[a] | – |
| | | (16.20) | – | | (12.15) | – | | (12.285) | – | | (15.871) | – | | (16.212) | – |
| Comm.Forest (%) | 0.165 | −1.168[a] | – | 0.09 | −0.632 | – | 0.12 | −0.89484[a] | – | 0.17 | 1.485[b] | – | 0.22 | −1.509[a] | – |
| | | (0.272) | – | | (0.451) | – | | (0.234) | – | | (0.812) | – | | (0.277) | – |
| Renting rights | 3.21 | −26.18[a] | – | 4.01 | −27.871[a] | – | 4.09 | −25.545[a] | – | 3.78 | 45.651[a] | – | 5.83 | −41.11[a] | – |
| | | (10.82) | – | | (13.105) | – | | (11.202) | – | | (17.955) | – | | (11.979) | – |
| Subsidy amount (¥/mu/year) | 0.14 | – | – | 0.15 | – | – | 0.16 | | – | 17 | | – | 0.19 | | – |
| PROVINCE[D] | −8.21 | – | 82.193 | – | – | – | – | – | | – | | – | – | – | |
| SLCP[D] | 6.78 | – | −101.167 | 31.87 | – | −125.65 | 25.78 | – | −140.673 | 17.90 | | −15.183 | 13.61 | – | −51.309 |
| TENSEC[D] | 7.11 | – | −65.018 | – | – | – | – | – | | 28.11 | | −45.050 | 25.77 | – | −64.041 |
| RENTEASE[D] | 4.94 | – | −52.510 | – | – | – | – | – | | 6.14 | | −28.251 | 4.55 | – | −25.527 |
| CREDIT[D] | 5.45 | – | −69.613 | – | – | – | – | – | | 21.71 | | −67.110 | 19.94 | – | −56.070 |
| EMPLC[D] | 4.87 | – | −62.847 | – | – | – | – | – | | – | | – | – | – | |
| PRCOFFHH[C] | – | – | – | – | – | – | | – | | – | | – | | – | |
| DISTANCE[C] | −0.39[§] | – | 9.265 | −0.06[§] | – | 56.613 | −0.01[§] | – | 42.497 | – | | – | – | – | |
| ELDERS[D] | −4.82 | – | 43.167 | – | – | – | – | – | | −15.56 | | −87.15 | −11.14 | – | 90.606 |
| AVOFFWAGE[C] | 11.21[§] | – | −155.42 | – | – | – | – | – | | – | | – | – | – | |
| OFFLABOUR[C] | 5.76[§] | – | −51.106 | – | – | – | – | – | | – | | – | – | – | |
| EDUSPOUSE[D] | 5.23 | – | −72.851 | 18.32 | – | −98.781 | 12.12 | – | −131.974 | – | | – | – | – | |
| AGE[C] | −2.25[§] | – | 82.713 | −9.67[§] | – | 101.256 | −6.23[§] | – | 126.689 | – | | – | – | – | |
| LIVESTOCK[C] | 3.30[§] | – | −41.01 | 2.95[§] | – | −35.167 | 1.35[§] | – | −42.239 | 5.165 | | −23.10 | 4.67[§] | – | −62.582 |
| HHYIELD[C] | – | – | – | – | – | – | | – | | – | | – | | – | |
| FARMLAND[C] | 4.15[§] | – | −76.671 | 7.15[§] | – | −98.713 | 7.77[§] | – | −115.453 | – | | – | – | – | |

*Notes*: All parentheses denote standard errors; Superscripts a, b, c, and d denote 1%, 5%, 10%, and 15% levels of significance, respectively.
[†]Marginal effects; [‡]Marginal WTA estimates in (¥/mu/year); [±]Change in min WTA to participate in new SLCP for changes in socioeconomic variables (¥/mu/year). For continuous variables this is estimated for their mean values. For binary variables this is estimated when variable = 1.
[§]Marginal effects of continuous variables evaluated for a change equal to one standard deviation of the variable.
Superscripts C and D denote continuous and dummy variable, respectively.

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commercial trees (the commercial forest—continuous—attribute), we see that (*ceteris paribus*) participation rates double across the two provinces (from 9–12% in Ningxia to 17–22% in Guizhou). When examining the ME of the binary attributes, it is interesting to note the further differences in factors affecting participation between provinces, with the subsidy assurance being more prominent in Ningxia and land tenure rights in Guizhou. This may be attributable to the negative track record of subsidies implementation in Ningxia (Tu *et al.*, 2007; Weyerhaeuser *et al.*, 2005), which makes participants more cautious about future subsidy distribution. It may also be due to the fact that secure subsidies are a more important program attribute for participants in Ningxia, because (compared to participants in Guizhou) they have less off-farm opportunities, they have larger average land holdings and enrolled land, and they tended to have been overcompensated by the program (Uchida *et al.*, 2007). On the contrary, households in Guizhou have more abundant and lucrative off-farm activities and the land rights dimension becomes more important to them.

As for the marginal effects of variables in household and village characteristics, we find that village level off-farm wage is among the most important factors affecting the participation in the pooled model. An increase in that variable by one standard deviation would raise participation by nearly 11%. Also, previous participation in the SLCP is also an important factor; and its higher impact on the likelihood of re-enrollment in Ningxia rather than in Guizhou is consistent with the considerably higher income impacts from the existing SLCP that have been found in Ningxia (Uchida *et al.*, 2005).

It is also interesting to go beyond ''point'' estimates and examine the entire distributions of the probabilities of participating in a new program for different subsidy levels and for different levels of institutional reforms. These distributions were recovered using simulation techniques. As an illustration, Figure 1 presents these distributions for the pooled sample (based on Model 1). The outer distribution depicts the percentage of households rejecting the SLCP at different subsidy levels under the status quo or ''no reforms'' scenario. As different reforms are introduced, the density function shifts to the left. The size of the shift depends on the magnitude or relative importance of each reform. This provides useful decision aiding tools to policy makers concerned with designing sustainable and cost effective land set aside programs. For example, from these distributions we can infer that in order to achieve a 50% participation rate in the pooled sample, households would need to be offered an average subsidy (keeping all other policy attributes at the status quo levels) of ¥370/mu/year. Yet, by introducing land tenure reforms alone the same participation rate can be achieved with approx ¥145 (*ceteris paribus*). Alternatively, from the probability distributions obtained for the provincial models we can infer that if the authorities were to offer rural households the current levels of pledged compensation (i.e., approx. ¥210 in Ningxia and ¥280 in Guizhou) without any complementary institutional reforms, then participation rates would be 20% in Ningxia and 10% in Guizhou. Such low participation rates raise questions over the long-run viability of the program unless either higher subsidies are offered or additional reforms are introduced.

The final set of results relevant for assessing the sustainability of a future land set aside program that can be derived from the CE relate to the measures of consumer surplus. Table 6 presents measures of the implicit prices or marginal willingness to accept (MWTA) in Yuan per mu per year. We see that the minimum average compensation required to participate in the SLCP when no other policy reforms are introduced (i.e., the value of ASC) is ¥445/mu/year and is comparable across provinces. Yet, our results show that significant cost savings could be achieved by changing the attribute levels of the program toward their most ''desirable'' level, that is, the level which maximizes respondents' welfare. For example, introducing tenure security (*ceteris paribus*) can reduce compensation levels by ¥171/mu/year. This complements the results of Section 3 as well as a vast literature, in that increased tenure security stimulates land savings investments (Jacoby *et al.*, 2002; Li *et al.*, 1998). If the full set of reforms are introduced (i.e., a ''first best'' scenario), then the *total net* willingness to accept such a program (for the pooled sample) drops to just ¥16/mu/year, which for all purposes is a very low amount. This brings home the implications for making such integrated-conservation programs sustainable and self-sufficient: large cost savings can emerge from providing adequate institutional and implementation reforms that address the constraints that bind people into inefficient production decisions.

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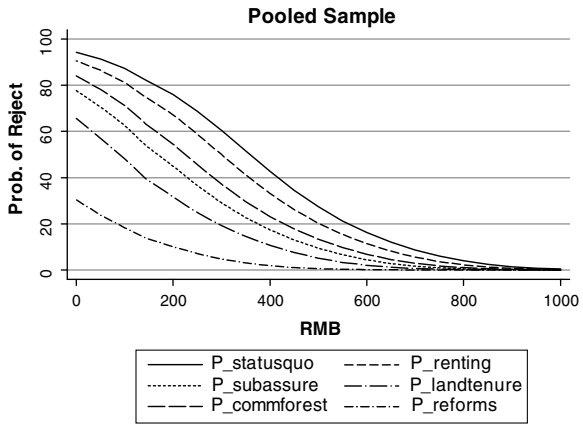


Figure 1. *PDF of households rejecting the SLCP at different subsidy levels and for different reforms.*

Our analysis further provides tools to policy makers to make more targeted reforms in different provinces as they can prioritize these reforms that have the highest cost-savings implications. In Ningxia, this would entail enhancing the quality and assurances of the implementation of the program (which entail cost savings of close to ¥200/mu/year) while in Guizhou, reforms should focus on land rights (savings close to ¥170/mu/year) and allowing commercial forests (savings of ¥150/mu/year for granting full rights). Introducing the "first best" scenario in each of these two regions would entail a total net WTA of ¥130–160 in Ningxia (from Models 2 and 3) and ¥35–66 in Guizhou (in Models 4 and 5) with only the former of these figures being substantial. These results are in accord with the findings discussed above. It appears that Ningxia farmers (based on their past experience with the SLCP, on current land holdings as well as off-farm land opportunities) would prefer to sign up to a program that would involve subsidizing communities to become foresters. On the contrary, households in regions such as Guizhou would prefer to sign up to a scheme more akin to an agri-environmental program where farmers pursue wider conservation objectives together with direct productive uses of their lands.

Finally, Table 6 also shows how the CE approach yields information over the change in the minimum WTA to participate in the new SLCP for different levels in the variables that appear in the vector of household and village characteristics, **z**. [32] For example, if farmers were to receive the average village off-farm wage then (*ceteris paribus*) they would be willing to accept ¥155/mu/year less as compensation. Similarly, an increase in the spouse educational level is associated with a reduction of the household's compensating surplus by ¥73/mu/year, while introducing a government employment program can reduce total net WTA by ¥63/Mu/year.

## 5. CONCLUDING REMARKS

Sustainable development programs in the developing world are often characterized by limited budgets and finite time horizons reflecting both financial constraints and changing priorities in the policy world. These characteristics enhance the need for detailed *ex ante* assessment of the long-run viability of the benefits of such programs so that both the interim corrective measures can be adopted during the life-span of the current program but also appropriate new policies can be put into place after the termination of the old ones. This paper provides a framework for comprehensive *ex ante* assessment of the long-run viability of one of the world's largest sustainable development programs, the SLCP in China, a massive subsidization program that aims at reforesting sloped rural terrain and address rural poverty.

The analysis-based on household and village level survey data obtained from Ningxia and Guizhou provinces—aims at exploring the viability of the SLCP under the three plausible

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post-SLCP scenarios: where subsidies are stopped, where they are renewed in their current form and where a new program is instated. The challenge of obtaining *ex ante* information for making such an assessment was overcome by utilizing contingent behavior and choice experiment (stated preference) data. This allowed for a *direct* assessment of the program's sustainability thereby providing valuable and unique insights that complement those obtained from other *indirect* assessments of the SLCP (Groom *et al.*, 2006; Uchida *et al.*, 2005, 2007). Our analysis was able to provide the following main conclusions.

First, we have shown that the viability of such "win–win" policies relies in their capacity to address the root causes of household inefficient allocative decisions, which in turn constrain farmers in poverty traps and environmental harmful production practices. In particular, weak and incomplete property rights coupled with high labor mobility transaction-costs that are associated with oversupply of on-farm labor emerge as major constraints on the sustainability of the SLCP. Further, the analysis has shown that securing the long-run viability of the program's objectives would require policies that target both land *and* labor allocation decisions, as a strong simultaneity relationship between these two variables was found. This result has not been adequately acknowledged by previous research which has focused on examining the determinants of household land decisions alone.

Second, in cases where the SLCP is renewed, we show that an important determinant of securing high levels of long-term community support is the provision of better forestry training to local households as well as enhanced autonomy in managing their reforested trees.

Third, in the event that subsidies are not renewed, we have shown that farmers will tend not to reconvert back their reforested lands provided that the expected commercial value of the reforested trees is high. This finding further brings into question the prevailing mindset governing the design of the SLCP, which allows for very limited commercial exploitation of reforested lands. Further, secure property rights (both tenure and forest management rights) were also shown to be important factors in the post-SLCP scenario, where subsidies were terminated as they were found to contribute greatly to both securing forest land and freeing surplus labor away from farming on slopped lands. As inevitably subsidies will be terminated at some point in the future, the importance of such institutional reforms for the success of current sustainable development programs becomes even more evident.

Fourth, in the scenario where a new SLCP program is offered, we find that the likelihood of re-enrollment is affected not just by the subsidy amount but also by the implementation assurances offered to farmers, by the average off-farm wage they can expect to earn as well as by further land tenure reforms. Hence, specific policy interventions that alleviate constraints and transactions costs associated with off-farm employment (e.g., creating employment centers, reducing local travel costs, enhancing education, and access to credit) coupled with wider institutional reforms (e.g., land tenure, land renting, and land management reforms) may increase the participation rates for a given level of subsidies or may reduce the minimum compensation levels required to be offered to farmers for a given participation rate. Hence, we display how specific social interventions and institutional reforms can provide wider social external benefits in the form of considerable cost-savings in the implementation of a development program, and in turn contribute toward its long-term viability as funds can be spread across a longer time horizon.

Fifth, the CE results shed unprecedented insights on Chinese farmer preferences over tenure reform and how these preferences impact upon the viability of the SLCP. Though there is some work on the determinants of past or current forest land tenure arrangements in China (e.g., Brandt *et al.*, 2004; Xiao-Yuan, 1996) there is hardly any systematic research on actual farmer's preferences for such arrangements. The current analysis shows that farmers display a strong aversion for land redistribution and favor the development of more secure land rental rights. This is an interesting contribution to the debate over institutional reform in China. Indeed, an obstacle to individualization of land rights is the fear that it might undermine the function of land as a social safety net and insurance mechanism (Burgess, 2001). For that reason, a key concern of Chinese policy makers preoccupied with land tenure reform has been that, even though it may be associated with economic and environmental benefits, a deepening of land property rights privatization would be opposed by a majority of the rural population. Our analysis shows that this is not the case and thereby contradicts

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a significant literature, which may now be outdated, that has found household opinion to be strongly in favor of land redistribution (Kung, 1995; Kung & Liu, 1997; Liu, Carter, & Yao, 1998, 2002).

Sixth, our CE analysis shows that a sustainable design of a land conversion program requires a more flexible approach that takes under account regional heterogeneities. To date, the discussion (both within policy and academic circles) over how to achieve efficient (i.e., welfare enhancing) and cost-effective targeting has mainly focused on how to determine different levels of subsidies across regions. Our results highlight the need to also allow for further flexibility and differential design of other policy attributes. For example, our results show that households in Guizhou would be willing to maintain reforested lands even if hardly any direct subsidies are offered provided that they receive enhanced tenure and renting rights over their reforested lands as well as improved usages rights that would allow for the uninhibited selection and management of planted tree types as well as their full commercial exploitation.

Finally, our paper displays the relative merits of using a framework that relies on contingent and stated behavior data for assessing the long-run viability of sustainable development programs. Areas for further consideration and research include the combination of revealed and hypothetical data as well as using experimental economic techniques where participants are placed in a more controlled setting. Given the interest and financial commitments made toward sustainable development programs we feel that such further detailed *ex ante* analyses are warranted.

## NOTES

1. We would like to thank a referee who justly pointed out the possible confusion deriving from different connotations of the word "sustainability." We would like to clarify here that we use the term sustainability as one that encapsulates the connotations of "viability," "enduring," "long-lasting," and "self-sustaining."

2. Examples of choice experiment techniques applied to policy evaluation in developing countries include Asfaw, Von Braun, and Klasen (2004), Birol, Kontoleon, and Smale (2005), or Hope (2006). To our knowledge, the present application is the first to be conducted in rural China.

3. In the case of conversion to grassland, which is not included in our sample, compensation is received for 2 years.

4. Beyond adopting this direct assessment approach, our analysis also improves upon the aforementioned studies in that: we examined both participants and non SLCP participants, we undertook our study at a much later time in the lifespan of the SLCP (and not in its first couple of years where opinions about the program are less clear), we explored *both* land and labor allocation decisions, and we undertook a systematic exploration of household preferences with respect to the program by using a choice modelling approach.

5. The survey was part of wider project that was completed in 2006. The survey was designed, piloted, revised, and implemented during 2004–05. In total 155 households in 23 villages (in 3 counties) were selected in Ningxia and 131 households were selected in 20 villages (in 3 counties) in Guizhou province.

6. Known as the "use it or lose it" rule (Brandt, Rozelle, & Turner, 2004).

7. Using the same data set, Groom *et al.* (2006) employed a multi-output distance function approach to estimate a trans-log production function in the two main outputs (wheat and potatoes) against land, household labor, and fertilizer. The cross partial of land and labor was found to be positive and significant at the 5% level, which lends initial support for the simultaneity assumption evoked for the contingent behavior land and labor responses analyzed here.

8. The aforementioned model consists of a household behavioral model where production choices are subject to a land use constraint, given the absence of rental and exchange markets, and to a production requirement constraint. The production requirements may be due to subsistence constraints, imposition of production quotas by local authorities, or the necessity of maintaining production on land in order to avoid land confiscation when tenure is insecure. Under these conditions, allocation decisions are dictated by the production requirement constraint, and labor allocation decisions become residual (Groom *et al.*, 2006).

9. The survey question was "Assuming that your SLCP contract is renewed for another 10 years and that you

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will receive the same amount of subsidies, what would your household do: (a) regarding your land will you (i)Maintain or increase the reforested area (=1) or (ii) return some or all land to cropland (=0) and (b) regarding your labor will you (i) decrease farming activity (=1) or (ii) not change or increase farming activity (0). The household was then proposed the same choices in the second scenario worded as "assuming that your SLCP contract is not renewed and your subsidies are terminated. . .."

10. Similar concerns have been noted in the studies by Tu, Zhang, Mol, and Ruben (2007) Weyerhaeuser, Wilkes, and Kahrl (2005).

11. In addition, the literature has described the risk of land expropriation as mainly motivated by two considerations by local officials in China, efficiency and equity (see Jacoby *et al.*, 2002). The efficiency motive concerns the aggregate agricultural production and requires that underutilized farm land be redistributed in order to equalize marginal returns across households. Since forest land cannot normally be used for farming, such considerations are not at stake. Further, the equity motive aims at the equalization of revenues across households. Since over 90% of the reforested land under the SLCP in our sample has been converted to ecological forests, from which no revenue can be derived, equity considerations are also mostly irrelevant.

12. Obtaining accurate off-farm household level wage data in rural China is often difficult. As such, we followed the suggestion obtained from several studies (e.g., Zhang, Scott, & Jikun, 2001) and proxied individual wage rate with education.

13. The lack of accurate output and input price data precludes calculating more accurate measures of agricultural productivity, and instead we employed a measure related to average agricultural yield (in kg). Also, the VIELD variable was included to account for village level unobserved heterogeneity with respect to productivity on sloped land.

14. This consists of the summation of the actual annual cash subsidy received by the household, the annual value of the grain subsidy obtained and the value of income earned from commercial forest products derived from SLCP land (such as fruits and nuts) (figures summed then averaged over 2000–04). The value of the grain subsidy was estimated by multiplying the amount of grain received by the household (obtained from the household questionnaire) with local grain prices (in RMB) obtained from village authorities). The value of forest products was calculated by multiplying stated quantities (obtained from household survey) with estimate of prices for these outputs obtained from local officials.

15. Xu, Lin, Li, and Liu (2006b) reveal that not only the provision of seedlings followed a top-down approach, so that seedlings were not always adapted to particular geographic conditions, but the sudden afforestation tasks increased the demand for seedlings, and seedlings sometimes had to be procured from faraway places, which worsened their adaptability to local conditions. The importance of similar implementation shortcomings has been extensively noted in Weyerhaeuser *et al.* (2005).

16. That is to say, variables consistently not adding to the regression were eliminated from the analysis.

17. Additional variables were explored, such as land endowment variables, variables proxying for assets, and household composition variables, but were not found to add to the regression results based on LR tests. Further, we explored the use of county fixed effects to more accurately capture regional heterogeneity but again these were not found to be significant. This latter finding suggests that local heterogeneity was captured instead by the village level variables included in the specification. Generally, the location variables are not very strong; signaling that most regional variation was captured by the village level variables. We also explored the option of running separate regressions for each province (as was done with the CE data). Yet, due to sample size limitations with the contingent behavior data (only answered by SLCP participants) we could not achieve convergence with the provincial level regressions.

18. The null hypothesis in each case is that the restricted model is the correct one. The log-likelihood test statistic is given by $\lambda = 2(\mathrm{LL_{UR}} - \mathrm{LL_R})$, which follows a $\chi^2_{(m)}$ distribution with $m$ equal to the number of restrictions. We reject the null when $\chi^2_{(m)} \leqslant \lambda$. When comparing Models 1 and 2 we obtain $\lambda = 10.3346$ with $\chi^2_{(6)} = 16.82$ (at $\alpha = 1\%$), while when comparing Models 3 and 4 we obtain $\lambda = 17.0418$ with $\chi^2_{(7)} = 18.47$ (at $\alpha = 1\%$). Hence, in both cases we cannot reject the null at the 1% level of significance.

19. Examining nevertheless the more augmented models (1 and 3) that include the same set of explanatory variables across scenarios we see that their coefficient results display the same general pattern as that observed in the more parsimonious "best fit" model. This provides some added support over the stability and robustness of our estimated results.

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20. The finding that $\rho = 0$ in the second specification does not invalidate the use of the recursive model. The correlation coefficient measures the correlation between the outcomes after the influence of the included factors. For the LABOR equation these factors include *LAND* which as discussed below is the single most important determinant of the LABOR.

21. The direct effect accounts for the direct impact of a change in each explanatory variable appearing at $\mathbf{x}_2$ and $\mathbf{x}_2$ on the likelihood of $y_1 = 1$ and $y_2 = 1$, respectively. The indirect effect accounts for the impact of a change in the explanatory variables in $\mathbf{x}_2$ on the likelihood of $y_1 = 1$ through its effect on $y_2$ which in the specific recursive model appears as a regressor of $y_1$.

22. When interpreting MEs in such a particular qualitative response model it is worth noting that they should be taken as providing indications of tendencies as well as the relative importance of variables and less as quantitatively precise derivatives.

23. Not all parameters in $\beta_{nk}$ are necessarily random but may instead be fixed. In this case, the standard deviation of that parameter will be zero and all behavioral information of that attribute is captured by its (fixed) mean $\beta_k$.

24. By specifying the distributional form of each of the likely random parameters and by assuming that $\varepsilon$ is IID distributed extreme value type 1 independent of $\mathbf{x}$ and $\mathbf{z}$, the probability of choosing the option $j$ in each of the eight choice occasions can be estimated as a mixed logit model using a maximum simulated-likelihood approach (McFadden & Train, 2000; Hensher, Rose, & Greene, 2005).

25. Other interaction terms with specific attribute could be included but their interpretation is less informative in this context.

26. These are the marginal effects of each variable in $\mathbf{x}$ and $\mathbf{z}$, that is, $\partial \Pr(\text{ASC} = 1)/\partial x_k$ and $\partial \Pr(\text{ASC} = 1)/\partial z_n$.

27. This relationship is estimated by simulating the population probability density of each random parameter and subsequently producing a distribution of MWTA.

28. In order to identify the model the scale parameter, $\mu^n$, of the mixed logit was normalized to one. Moreover, categorical attributes were effects coded and possible correlation among multiple choices made by the same household was accounted for by utilizing the panel data specification of the RPL. Not accounting for this possible correlation would violate the IID assumption. Possible reasons for this correlation include the commonality of household characteristics that are invariant across choice sets for each household as well as the specific sequencing of choice sets that can lead to effects (unaccounted for in the estimation process) such as learning, inertia, and strategic responses (Hensher *et al.*, 2005).

29. The log likelihood test statistic for comparing Models 1 and 2 is 7.96, for comparing Models 3 and 4 it is 14.46, and for comparing Models 5 and 6 it is 13.62. The critical values (at $\alpha = 1\%$) are $\chi^2_{(2)} = 9.21$, $\chi^2_{(9)} = 21.66$, and $\chi^2_{(9)} = 21.66$, respectively, and hence in each case the null that the restricted model is the correct one cannot be rejected.

30. Interacted variables are in 2004 levels as reported in the survey.

31. Note that in multinomial choice RPL models estimates of post-regression parameters such as marginal effects and changes in consumer surplus have no economic meaning for insignificant variables. In the case of marginal effects, if a certain coefficient $b$ of a variable $x$ is found to be insignificant, then by implication in the RPL model (in which the MEs are either $-P(i,j)x(k)^*b(k)$ or $[1 - p(i,j)]x(k)^*b(k)$), then a fortiori the corresponding ME also equals zero. Yet, if the coefficient equals zero, then the variable falls out of the specification of the model, which would be the more appropriate place to put the test (Hensher *et al.*, 2005). As such post-estimation estimates for insignificant variables in Table 5 are not included in Table 6.

32. These should be interpreted as partial equilibrium changes and hence are not strictly additive (Hensher *et al.*, 2005).

## REFERENCES

Abbot, J. O., Thomas, D. H. L., Gardner, A. A., Neba, S. E., & Khen, M. W. (2001). Understanding the links between conservation and development in the Bamenda Highlands, Cameroon. *World Development, 29*(7), 1115–1136.

Ahituv, A., & Kimhi, A. (2006). Simultaneous estimation of work choices and the level of farm activity

using panel data. *European Review of Agricultural Economics, 33*(1), 49–71.

Asfaw, A., Von Braun, J., & Klasen, S. (2004). How big is the crowding-out effect of user fees in the rural areas of Ethiopia? Implications for equity and resource mobilization. *World Development*, (12), 2065–2081.

Bennett, J., Lei, Z., Guangcui, D., Chen, X., Jincheng, Z., Dan, L., et al. (2004). A review of the program for conversion of cropland to forests and grassland. Research Report No. 2, Australian Centre for International Agricultural Research (ACIAR).

Birol, E., Kontoleon, A., & Smale, M. (2005). Farmer demand for agricultural biodiversity in Hungary's transition economy: A choice experiment approach. In M. Smale (Ed.), *Valuing crop genetic biodiversity on farms during economic change*. Wallingford, UK: CAB International.

Bowlus, A., & Sicular, T. (2003). Moving towards markets? Labor allocation in rural china. *Journal of Development Economics, 71*(2), 561–583.

Brandt, L., Rozelle, S., & Turner, M. A. (2004). Local government behavior and property right formation in rural China. *Journal of Institutional and Theoretical Economics, 160*(4), 627–662.

Burgess, R. (2001). Land and Welfare, Theory and evidence from China. Working Paper, LSE.

Carter, M., & Olinto, P. (2003). Getting institutions right for whom? Credit constraints and the impact of property rights on the quantity and composition of investment. *American Journal of Agricultural Economics, 85*(1), 173–186.

Carter, M., & Yao, Y. (1999). Specialization without regret: Transfer rights, agricultural productivity and investment in an industrializing economy. World Bank Policy Research Working Paper, No. 2202.

Carter, M., & Yao, Y. (2002). Local versus global separability in agricultural household models: The factor price equalization effect of land transfer rights. *American Journal of Agricultural Economics, 84*(3), 702–715.

Cernea, M., & Schmidt-Soltau, K. (2006). Poverty risks and national parks: Policy issues in conservation and resettlement. *World Development, 34*(10), 1808–1830.

Chen, S., & Ravallion, M. (2005). Hidden impact? Household saving in response to a poor-area development project. *Journal of Public Economics, 9*(11–12), 2183–2204.

Cooper, J. (2003). A joint framework for analysis of agri-environmental payment programs. *American Journal of Agricultural Economics, 85*(4), 976–978.

De Janvry, A., & Sadoulet, E. (2005). Progress in the modeling of rural households' behavior under market failures. In A. Janvry, & R. Kambur (Eds.), *Poverty, inequality and development*. Kluwer Publishing.

De Janvry, A., Sadoulet, E., & Zhu, N. (2005). The role of non-farm income in reducing rural poverty and inequality in China. Working Paper, Department of Agricultural & Resource Economics, UC Berkeley.

Deininger, K., & Jin, S. (2002). The impact of property rights on households' investment incentives, risk coping and policy preferences. World Bank Policy Research Paper 2931.

Deininger, K., Jin, S., Adenew, B., Gebre-Selassie, S., & Negra, B. (2003). Tenure security and land related investment, evidence from Ethiopia. World Bank Policy Working Paper No. 2991.

Duflo, E., & Kremer, M. (2003). Use of randomization in the evaluation of development effectiveness. In *Paper prepared for the world bank operations evaluation department conference on evaluation and development effectiveness*.

Feng, Z., Yang, Y., Zhang, Y., Zhang, P., & Li, Y. (2004). Grain for green policy and its impact on grain supply in west China. *Land Use Policy, 22*(3), 301–312.

Greene, W. (1996). Marginal effects in the bivariate probit model. Working Paper Number 96-11, Department of Economics. Stern School of Business, New York University.

Greene, W. (1998). Gender economic courses in liberal arts colleges: Further results. *Journal of Economic Education, 29*(4), 291–300.

Groom, B., Grosjean, P., Kontoleon, A., Swanson, T., & Zhang, S. (2008). Relaxing rural constraints: A "Win–Win" policy for poverty and Environment in China? Environmental Economy and Policy Research Working Papers 30.2008, Department of Land Economics, University of Cambridge. Available from: http://www.landecon.cam.ac.uk/RePEc/pdf/200830.pdf.

Hensher, D., Rose, J., & Greene, W. (2005). Applied choice analysis. Cambridge: Cambridge University Press.

Hope, R. A. (2006). Evaluating water policy scenarios against the priorities of the rural poor. *World Development, 34*(1), 167–179.

Jacoby, H. G., Li, G., & Rozelle, S. D. (2002). Hazards of expropriation, tenure insecurity and investment in rural china. *The American Economic Review, 95*(5), 1420–1447.

Johnson, P., Misra, S., & Ervin, T. (1997). A qualitative choice analysis of factors influencing post-CRP land use decisions. *Journal of Agricultural and Applied Economics, 29*(1), 163–173.

Key, N., Sadoulet, E., & De Janvry, A. (2000). Transactions costs and agricultural household supply response. *American Journal of Agricultural Economics, 82*(2), 245–259.

Kung, J. K. (1995). Equal entitlement versus tenure security under a regime of collective property rights: Peasants' preference for institutions in post-reform Chinese agriculture. *Journal of Comparative Economics, 21*(1), 82–111.

Kung, J. K., & Liu, S. (1997). Farmers' preferences regarding ownership and land tenure in post-Mao China: Unexpected evidence from eight counties. *The China Journal, 38*, 33–63.

Langpap, C. (2004). Conservation incentives programs for endangered species: An analysis of landowner participation. *Land Economics, 80*(3), 375–388.

Lewbel, A. (2007). Coherence and completeness of structural models containing a dummy endogenous variable. *International Economic Review, 48*(4), 1379.

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Li, G., Rozelle, S., & Brandt, L. (1998). Tenure, land rights and farmer investment incentives in China. *Agricultural Economics, 19*(1–2), 63–71.

Liu, S., Carter, M., & Yao, Y. (1998). Dimensions and diversity of property rights in rural China: Dilemmas on the road to further reform. *World Development, 26*(10), 1789–1806.

Louviere, J., Hensher, D. A., & Swait, J. D. (2000). Stated choice methods: Analysis and applications. Cambridge: Cambridge University Press.

Maddala, G. S. (1983). Limited-dependent and qualitative variables in econometrics. New York: Macmillan.

McFadden, D., & Train, K. (2000). Mixed MNL models for discrete choice response. *Applied Econometrics, 15*(5), 447–470.

Mercer, E., & Snook, A. (2004). Analyzing ex-ante agroforestry adoption decisions with attribute based choice experiments. In J. R. R. Alavalapati, & D. E. Mercer (Eds.), *Valuing agroforestry systems* (pp. 237–256). Netherlands: Kluwer Academic Publishers.

Mullan, K., & Kontoleon, A. (2008). Farmer participation in set-aside programmes in a developing country context. Working Paper, Environmental Economy and Policy Research Group, Department of Land Economy, University of Cambridge.

Park, A., Wang, S., & Wu, G. (2002). Regional poverty targeting in China. *Journal of Public Economics, 86*(1), 123–153.

Parks, P. J., & Schorr, J. P. (1997). Sustaining open space benefits in the Northeast: An evaluation of the conservation reserve program. *Journal of Environmental Economics and Management, 32*(1), 85–89.

Pattanayak, S. K., Mercer, D. E., Sills, E., & Yang, J. C. (2003). Taking stock of the Agroforestry adoption studies. *Agroforestry Systems, 57*, 173–186.

Scherr, S. J. (1995). Economic factors in farmer adoption of agro-forestry: Patterns observed in Western Kenya. *World Development, 23*(5), 787–804.

Tu, Q., Zhang, L., Mol, A., & Ruben, R. (2007). Do trust and property security increase household's contribution to public goods? The case of the sloping land conversion program in China. *Mimeo*. The Netherlands: Department of Economics, Wageningen University.

Uchida, E., Xu, J., & Rozelle, S. (2005). Cost effectiveness and sustainability of China conservation set aside program. *Land Economics, 81*(2), 247–264.

Uchida, E., Xu, J., Xu, Z., & Rozelle, S. (2007). Are the poor benefiting from China's land conservation program?. *Environmental and Development Economics, 12*, 593–620.

Vanslembrouck, I., Van Huylenbroeck, G., & Verbeke, W. (2002). Determinants of the willingness of Belgian farmers to participate in agri-environmental measures. *Journal of Agricultural Economics, 53*(3), 489–511.

Wang, X. Han, H., & Bennett, J. (2004). China's land use management. Australian Center for International Agricultural Research Project: ADP/2002/021.

Weyerhaeuser, H., Wilkes, A., & Kahrl, F. (2005). Local impacts and responses to regional forest conservation and rehabilitation programs in Chin's northwest Yunnan province. *Agricultural Systems, 85*, 234–253.

Xiao-Yuan, D. (1996). Two-tier land tenure system and sustained economic growth in post-1978 rural China. *World Development, 24*(5), 915–928.

Xie, C., Zhao, J., Liang, D., Bennett, J., Zhang, L., Dai, G., & Wang, X. (2005). Livelihood impacts of cropland to forest and grassland project. Australian Center or International Agricultural Research Project: ADP/2002/021.

Xu, J., & Cao, Y. (2002). The sustainability of converting the land for forestry and pasture. *International Economic Review, 3*(4), 56–60.

Xu, J., Bennett, M., Tao, R., & Xu, J. (2004). China's Sloping Land Conversion Program four years on: Current situation, pending issues. *International Forestry Review, 6*(3), 317–326.

Xu, Z., Xu, J., Deng, X., Huang, J., Uchida, E., & Rozelle, S. (2006a). Grain for green versus grain: Conflict between food security and conservation set-aside in China. *World Development, 34*(1), 130–148.

Xu, J., Lin, R., Li, Z., & Liu, C. (2006b). China's ecological rehabilitation: Unprecedented efforts, dramatic impacts, and requisite policies. *Ecological Economics, 57*(4), 595–607.

Zhang, Linxiu, Scott, Rozelle, & Jikun, Huang (2001). Off-farm jobs and on-farm work in periods of boom and bust in rural China. *Journal of Comparative Economics, 29*(3), 505–526.

Zuo, T. (2002). 'Implementation of the SLCP'. In J. Xu, E. Katsigris, & T. A. White (Eds.), *Implementing the natural forest protection program and the sloping land conversion program: Lessons and policy recommendations*. Beijing: China Forestry Publishing House.



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