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**Participation in Payments for Ecosystem
Services programmes in developing countries:
The Chinese Sloping Land Conversion
Programme**

by

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Keywords: Payments for Ecosystem Services; programme participation; latent class model; China ; Sloping Land Conversion Programme, separability.

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This paper contributes to the limited existing empirical evidence on assessing household participation in Payments for Ecosystem Services (PES) programmes in developing countries. We examine this issue for the case of the Sloping Land Conversion Programme (SLCP) in China, one of the largest PES schemes in the world, using household and village level data. Our analysis examines the determinants of both current and future participation in the SLCP and makes three key contributions. First, we show the importance of incorporating the influence of programme administrators in the observed participation outcome. Secondly, we use a novel latent class approach to account for heterogeneity in the determinants of the household decision over whether to sign up to a PES programme. Thirdly, the empirical analysis focuses on the impact of market imperfections that are prevalent in developing countries. We find significant differences between households with good access to markets and those facing market imperfections.

JEL Codes: Q12, Q15, Q28, Q56, Q58

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1 Introduction

Payments for ecosystem services (PES) have attracted considerable interest from both researchers and policymakers, as an incentive based mechanism for achieving conservation objectives on private land (Engel *et al.*, 2008; Wunder *et al.*, 2008; Landell-Mills & Porras, 2002). However, their voluntary nature means that the socially-efficient outcomes will only be achieved if sufficient landowners enroll in the relevant programmes, and fulfil their management requirements (Pagiola, 2008). This implies that it is necessary to understand the factors that determine whether landowners choose to participate. In addition, knowledge of who participates, and why, can help to improve programme design through minimising the cost of attracting landowners, and by encouraging those landowners who provide greatest environmental benefits to join (Kosoy *et al.*, 2008).

The importance of the question of participation in PES schemes has been widely acknowledged, leading to a considerable amount of research being conducted on the factors that determine participation in schemes such as the Conservation Reserve Program in the US (Ervin & Ervin, 1982; Cooper, 2003), Agri-Environment Schemes in the EU (Wossink & van Wenum, 2003; Vanslebrouck *et al.*, 2002; Bonnieux *et al.*, 1998; Brotherton, 1991), or forest conservation schemes in both locations (Nagubadi *et al.*, 1996; Langpap, 2004). However, there is significantly less quantitative analysis of whether landowners in *developing country* contexts are affected by similar factors as those in more developed countries (notable exceptions include Zbinden and Lee (2005) in Costa Rica, Uchida *et al.* (2007) in China and Pagiola *et al.* (2008) in Mexico).

This scarcity of information on PES participation in developing countries is of concern because there are important reasons why households might respond differently to conservation incentive schemes. These primarily relate to the widespread prevalence of market and institutional imperfections in developing countries. Households making decisions about whether to join the US Conservation Reserve Programme or an EU Agri-Environment scheme, operate in a setting

of broadly well functioning markets and institutions. In contrast, households in developing countries frequently face difficulties in accessing credit, or insecure property rights to land. They may also face an absence of markets for farm outputs, and labour, land or other inputs (Ellis, 1988). Alternatively, where markets do exist, they may not work efficiently. It has been shown in many contexts (Feder, 1985; Carter & Yao, 2002; Sadoulet *et al.*, 1998; Benjamin, 1992; Chen *et al.*, 2006; van Dusen & Taylor, 2005) that the presence of constraints on household participation in markets can have significant impacts on how those households make production decisions.

With this gap in the existing participation literature in mind the paper, therefore, makes the following main contributions. First, unlike other studies we explicitly consider how the preferences of those administering the programme affect who participates in practice. We argue below that the *influence of scheme administrators* is particularly important for the developing world context. Our second contribution is that we empirically examine whether households facing market imperfections make participation decisions differently from those facing more complete markets. The significance of this type of *household heterogeneity* in developing countries is shown to be one of the main differences from the findings of the existing PES participation literature obtained from the developed world. Thirdly, we make use of a novel econometric approach compared to past studies that is more appropriate for analysing PES household participation in the developing country context. More precisely, as market failures tend to be household-specific (de Janvry *et al.*, 1991), estimating a single model of household decision-making can lead to biased estimates (Carter & Yao, 2002). On this basis, we estimate household participation in a PES programme using a *latent class model*, which allows us to investigate how participation varies between those who are more or less constrained by market imperfections.

We focus on China's Sloping Land Conversion Programme (SLCP), which constitutes an important and particularly illuminating PES case study for the purposes of this paper. Under the SLCP, participating farmers are paid government subsidies (mostly in the form of cash and

grain) to convert cultivated land back to forest or grassland on steeply sloping hillsides. There are two compensation levels, which are defined at the regional level and which reflect differences in the opportunity costs of reforested land. The duration of the compensation depends on whether the specific plot of land is converted to ‘ecological’ or ‘commercial’ forest, or to ‘grassland’ (Uchida *et al.*, 2005; Zuo, 2002).

The total budget for the programme is ¥337 billion¹, covering 2000 counties in 25 provinces (Xu *et al.*, 2005). Within its first phase (to expire in 2012) the programme aims to convert around 15 million hectares of cultivated land (Xu *et al.*, 2002). The ultimate aim is to provide ecological and health related benefits to wide segments of the Chinese population (such as flood risk prevention and reduction in dust storm health impacts). An auxiliary goal is to reduce the high levels of poverty among rural households (Xu *et al.*, 2002). Given the significance of the SLCP, particularly in the context of PES programmes in developing countries, there is a growing literature analysing its effects. For example, studies have investigated the impacts of the programme on rural incomes (Xu *et al.*, 2005; Uchida *et al.*, 2007); labour allocation (Groom *et al.*, 2009); grain production (Feng *et al.*, 2005; Xu *et al.*, 2005); and environmental outcomes (Wang *et al.*, 2008).

We make use of data collected from 286 households, from 44 villages, in Guizhou and Ningxia provinces. These households include both participants and non-participants in the SLCP. We use both data on current (revealed) participation in the SLCP, and stated participation in a future programme. There has been some initial analysis of patterns of participation in the SLCP, for example by Uchida *et al.* (2007), who focus on factors influencing local government decisions about who to include; and by Grosjean and Kontoleon (2009), who examine the impacts of scheme attributes on participation. We extend this work by considering how the constraints faced by households affect their willingness to participate, and by using hypothetical data to isolate the household decision from the influence of programme administrators.

¹ \$1=approximately ¥7

The next section of this article reviews the findings of previous studies of participation in PES programmes. It then identifies the gaps that remain, particularly in relation to the implementation of such programmes in developing countries. Section 3 describes the data used to analyse the determinants of participation in the SLCP, and explains the mechanisms for selection of households into the programme. In Section 4 we analyse the factors that determine who participates in the SLCP at present. These relate to both the preferences of individual households, and the preferences of the local programme implementation agency. In Section 5 we focus specifically on the decision processes of the individual households, through the use of hypothetical participation data. We use a latent class model to separately estimate the determinants of participation for households that are more or less constrained in their access to markets. In Section 6 we draw conclusions.

2 Determinants of participation in PES programmes

Previous studies of PES participation in developed countries have identified the basic farmer and farm characteristics that tend to be important determinants of whether a landowner participates in the programme. These are the variables that influence the way that production decisions are made on the farm, such as the age and education of the farmer (Ervin & Ervin, 1982; Nagubadi *et al.*, 1996; Langpap, 2004), and the size and management characteristics of the farm (Bonnieux *et al.*, 1998; Vanslebrouck *et al.*, 2002; Zbinden & Lee, 2005). Existing studies have also looked at some economic variables relating to the farm such as debt levels, and farm and off-farm income, but generally have found them to be insignificant (Ervin & Ervin, 1982; Wossink & van Wenum, 2003). Farmer attitudes are important in some cases, as is access to information about the scheme in question (Wilson & Hart, 2001; Dupraz *et al.*, 2003).

These studies are empirical in nature, and many do not explicitly state their assumptions about the microeconomic foundations of the participation decision. However, they implicitly follow Rahm and Huffman (1984) in assuming that land and labour are allocated in order to maximise

a household profit or utility function. Participation may be viewed as a binary decision, such that the landowner enters the programme if the (latent) utility or profit from doing so exceeds the utility or profit from not doing so. In this case, a probit or logit model is used to estimate the determinants of participation (Nagubadi *et al.*, 1996; Vanslebrouck *et al.*, 2002; Langpap, 2004). Econometrically the participation decision may also be treated as a continuous or ordered variable if the landowner chooses an optimal intensity of participation. In this case, intensity is measured either by the amount of land entered into the programme; the extent of change to land use or management practices; or by the length of time spent as a scheme participant (e.g. Ervin & Ervin, 1982; Bonnieux *et al.*, 1998).

While the majority of the studies model actual participation, several authors also examine hypothetical participation using stated preference data (Bonnieux *et al.*, 1998; Wossink & van Wenum, 2003). The use of stated preference data is necessary for the analysis of how landowners respond to changes in scheme design when only a single design occurs in practice. It also enables analysis of the participation decisions of those who are ineligible for an existing programme. Lastly, stated contingent behaviour responses can be useful to *ex ante* assess household land and labour decisions that are likely after the programme expires (e.g. Johnson *et al.*, 1997). Bonnieux *et al.* (1998) find that the determinants of actual and hypothetical participation decisions are largely consistent with one another.

As noted in the introduction this paper addresses significant gaps in the existing PES participation literature. The first of these is that previous studies have viewed programme participation solely as a household decision. In practice, the administrators of the scheme can also affect who participates. For example, a scheme may be designed in such a way that only certain types of farmer or farm are eligible or encouraged to participate. A large literature exists on the design of incentive mechanisms that encourage the voluntary participation of the farmers that the scheme administrators want to include, while discouraging those whose participation would not bring significant benefits. These may be designed to encourage landowners with land of high ecological value to participate (Wu & Babcock, 1996; Smith & Shogren, 2002); those

with low opportunity costs (Stoneham *et al.*, 2003; Goeschl & Lin, 2004; Ferraro, 2008); or those who would not otherwise conserve their land (Wünscher *et al.*, 2008). Alternatively, the objectives of scheme administrators may be to minimise transactions costs of making payments, or the costs of monitoring and enforcing the programme requirements (Falconer, 2000; Antle *et al.*, 2003).

Another way in which the preferences of scheme administrators can affect which farmers participate will be if a scheme is oversubscribed. In this case, the final outcome in terms of who participates in a programme will depend both on which farmers volunteer to participate, and on which are selected from that group. It is also possible that a scheme that is designed to be voluntary at the national level is not voluntary in practice at the local level. This is relevant for the SLCP as there is evidence that participation is not voluntary in all locations (Xu *et al.*, 2002). In some cases, village leaders or local government officials decide which plots of land should be included in the programme. At a less extreme level, local scheme administrators may strongly encourage the participation of particular farmers in a scheme, based either on the centrally agreed objectives of the scheme or their own objectives, which may or may not be compatible.

The second main issue addressed by this paper is that the vast majority of the existing literature on participation in PES programmes has referred to programmes in developed countries². Notable exceptions involve analysis of the determinants of participation in the PSA programme in Costa Rica (Zbinden & Lee, 2005); previous work on the SLCP as discussed above in Section 1 (Uchida *et al.*, 2007; Grosjean & Kontoleon, 2009); and a case study of a silvopastoral project in Nicaragua, which examines the determinants of participation intensity (although not of participation vs. non-participation) (Pagiola *et al.*, 2008).

² We focus here on quantitative analysis of participation vs. non-participation. Some qualitative evaluations of PES programmes have included questions for participants about their reasons for participating (e.g. Kosoy *et al.*, 2007).

There are a number of inter-related reasons why the decision about whether to participate in a PES programme might be different for landowners in less developed countries. In order to highlight these, we use Ellis' (1988) comparison of peasant farmers, the predominant group in our case study regions of China, as well as in many other rural parts of Asia, Africa and Latin America, with commercial family farmers, who are the more typical targets of the PES schemes in Europe and the US as discussed above. Ellis (1988) defines a peasant as follows:

'Peasants are farm households, with access to their means of livelihood in land, utilising mainly family labour in farm production, always located in a larger economic system, but fundamentally characterised by partial engagement in markets which tend to function with a high degree of imperfection.'

This can be contrasted with the commercial family farm, which operates in an environment where markets may not be perfect in a theoretical sense, but are broadly available and functioning, and which is fully integrated into those markets. In the case of the peasant farmer, there are a range of markets that may not exist, or they may not have access to. These include markets for credit, labour, land, insurance, inputs or outputs. These can all be expected to affect the way that the household makes decisions about production, or in this case, about participation in schemes that alter production in some way.

Singh *et al.* (1986) show that when households are fully integrated into markets, household production decisions are made on the basis of market prices for outputs and inputs, including land and labour. Specifically, where households participate fully in markets, their decision-making processes can be modelled under assumptions of separability. This means that the production decisions and the consumption/leisure decisions of the household can be modelled sequentially: the household maximises farm profit given the exogenous prices of inputs and outputs, and the consumption/leisure problem is then solved with farm profit treated as fixed.

In contrast, where markets for one or more factors or products fail, the household's production problem must be solved simultaneously with its consumption problem. This is because the

shadow prices for variables such as food or household labour are determined by an internal equilibrium of supply and demand. Production and consumption are then viewed as non-separable (Sadoulet & de Janvry, 1995). In this case, production decisions will be dependent on shadow prices for inputs and outputs. These are a function of market prices, time endowments, fixed inputs, and utility. As such, they depend on both the household's preferences and its production technology (Singh *et al.*, 1986).

This general theoretical result has been demonstrated for numerous specific production decisions and market failures. For example, it is widely recognised that under multiple market failures, households make labour allocation decisions on the basis of initial endowments of land and labour (Feder, 1985; Barrett, 1996; Carter & Yao, 2002), other household assets (Kevane, 1996; Sadoulet *et al.*, 1998), or household demographics (Benjamin, 1992). Other studies find that where households face market imperfections, household demographics and endowments significantly affect choices of crop varieties (Van Dusen & Taylor, 2005); adoption of soil conservation measures (de la Briere, 2001); crop yields (Gavian & Fafchamps, 1996); and household fuelwood collection (Chen *et al.*, 2006).

Participation in a PES programme such as the SLCP is a further production decision made by the farm household. As such, we test whether households facing market imperfections make participation decisions differently from those with good access to factor and output markets. Specifically, we consider whether the household endowments and demographics determine participation. There is substantial evidence that households in rural areas of China face multiple market failures, in particular, thin rental markets (Brandt *et al.*, 2002; Liu *et al.*, 1998), constraints on off-farm labour supply (Fleisher & Yang, 2006; Whalley & Zhang, 2007; Giles & Mu, 2007; Bowlus & Sicular, 2003), and imperfect credit markets (Tsai, 2004). These constraints are changing over time, and do not affect all households (Groom *et al.*, 2009). As a result, we must account for the potential presence of both constrained and unconstrained households in the empirical analysis. As discussed below this is accomplished using a novel latent class modelling approach.

3 Data

3.1 Data collection

In order to empirically investigate what determines participation in PES programmes in a developing country context, we use current participation data and stated preference data, collected through a survey of rural households and village leaders in China. An initial pilot was carried out in Hebei Province. The final survey was then implemented in July and August 2004 in the Bijie region of Guizhou Province, and the Guyuan region of Ningxia Province. In Guizhou, 131 households from 21 villages in 12 townships were interviewed. In Ningxia, the survey covered 155 households from 23 villages in 15 townships. The households were selected using a stratified random sample within each village. Some of those included in the survey had previously participated in the SLCP while others had not. The interviews were conducted directly by the survey team, without interference from local officials, and the use of face-to-face methods ensured a high level of completeness and accuracy of the data.³

The study areas were selected because they have significant problems of both environmental degradation and poverty, making the outcomes of the SLCP particularly pertinent. Guyuan region of Ningxia, in northern China, is one of the nationally designated 'poverty stricken areas', with average annual rural incomes of ¥1200 per head. The primary source of income is farming, but much of the land is severely degraded due to population pressures. Guizhou Province is in the south of China. As with the study area in Ningxia, Bijie region of Guizhou has high levels of poverty and high levels of environmental risk. It is a very mountainous region, and contains the headwaters for the important Wu, Red and Beipan rivers.

The analysis of current participation uses recall data for the pre-programme variables. Although such data can contain potential errors, we attempted to minimise the recall bias through careful

³ Survey enumerators were hired graduate students from Peking University, who were trained by the authors of the study.

survey design and by training our enumerators to use specific queues as suggested by the literature (Hakim, 2000; Devereux & Hoddinott, 1992) in order to help respondents recollect past information more accurately. Furthermore, we restrict the use of recall data to variables that are by nature less prone to recall bias, such as education level and household composition variables (Henry *et al.*, 1994; Beckett *et al.*, 2001) or relate to information on which the majority of households held written records, such as land holdings and crop production. If some recall errors remain, there is no reason to suggest that these are likely to generate biased results, as might occur for example if there were systematic differences between programme participants and non-participants in their recall abilities.

3.2 Programme selection process

Participation in the SLCP is voluntary in principle. However, there is evidence to suggest that it has not been voluntary in practice in all villages (Xu *et al.*, 2004; Xu *et al.*, 2002; Bennett, 2008). As a result, the extent to which households can decide whether or not to participate is currently unclear. Our survey of village leaders included questions about the selection process. The finding was that in our sample areas, there are two main methods for selection. Households are either selected for participation by the local SLCP implementing agency (without actively volunteering); or households can volunteer for selection, and the implementing agency decides who to accept. In the latter case, we can conclude that those who participate were willing to do so. However, the non-participants will include both households who volunteered and were not selected, and households who did not volunteer.

In our sample, 53% of households came from villages where the implementing agency designated which plots of land should be included in the programme, without consulting the households. Further, 47% were in villages where households could volunteer for selection if they chose to. Given this, the use of current participation data provides us with information on the decision processes of local government officials as well as of farm households. We therefore need to model the current participation in the SLCP as a function of the preferences of

farm households and of local officials. As it is not possible to isolate the household preferences within the observed participation decision, we also use hypothetical data on whether households would choose to participate in a future scheme, to assess the determinants of the participation decision from the point of view of the household alone.

3.3 Dependent variables

Current participation is modelled as both a binary and a continuous decision. We use a binary variable for participation vs. non-participation, and a variable measuring the proportion of the household's total agricultural land that was entered into the programme. Both were obtained from the household survey. The descriptive statistics for all the dependent variables are shown in Table 1.

[Insert Table 1 about here]

The dependent variable for the future participation decision is a binary variable generated from the responses to a choice experiment. Each respondent was offered the choice between two versions of a future SLCP, with different attributes, as well as the option of not participating in either of these programmes. This process was repeated over eight choices. From these data, a new variable was created with a value of 1 if the respondent chose one of the programmes, and a value of 0 if they preferred not to sign up to any future programme.

There are three reasons for creating this binary participation variable from the choice experiment responses, rather than simply modelling the multinomial participation decision. First, the results are more straightforward to interpret, and to compare with previous studies of participation. Second, the size of the sample limits the complexity of the analysis that can be carried out using a multinomial model. The use of the simpler binary model allows the inclusion of a greater range of explanatory variables for participation, as well as investigation of the sources and impacts of preference heterogeneity through the use of the latent class probit

model. Last, for the purposes of this analysis we are interested specifically in the participation decision rather than the welfare estimates that can be obtained from multinomial analysis of programme choice⁴.

3.4 Explanatory variables

Table 2 contains the descriptive statistics for the independent variables used for the econometric analysis. For the analysis of the current participation decision, we include the standard household and farm characteristics that have been suggested by previous studies. These include the age and education of the household head, and the total area of arable land. Following Wilson and Hart (2001) and Dupraz *et al.* (2003), we also include whether the village has television reception as an indicator of access to information⁵.

[Insert Table 2 about here]

In addition to variables likely to affect the household participation decision, we include variables relating to the decisions of scheme administrators regarding who should participate. As discussed above, this is necessary because participation was not always voluntary at the household level. Based on the literature regarding the scheme operation (Xu *et al.*, 2002; Xu *et al.*, 2004; Uchida *et al.*, 2007), there are three main observable factors that would be expected to determine the probability that the implementing agency would include a particular plot of land in the SLCP.

First, the key environmental selection criteria is intended to be the slope of the land in question, which should be more than 25° in the southwest regions of China and more than 15° in the northeast regions. In the absence of data on plot slope, we use the average yield of the households' arable land as a proxy for slope. Feng *et al.* (2005) find a strong negative re

⁴ This analysis can be found in Grosjean and Kontoleon (2009).

⁵ The results of our survey suggested that television was the most common source of information for sampled households.

relationship between slope and crop yields in SLCP programme areas⁶. The secondary objective of the SLCP is poverty reduction. We therefore include household income in order to test whether the programme is being targeted at poorer households. Finally, the implementing agency will also be responsible for monitoring the programme, and this will be easier for plots of land that are closer to a main road. Xu *et al.* (2002) indicate that land that was easier to access had a higher probability of inclusion in the programme. We test this finding for our dataset, including the distance between the village and the nearest road as an explanatory variable.

The explanatory variables for the future participation model include the standard household and farm characteristics as before. However, we also account for potential non-separability in household decision making. Specifically, we look at whether initial endowments of land, labour and physical assets affect the participation decision. Land is measured as the area of crop land prior to the SLCP. Labour is measured by the number of adults of working age (between 17 and 75) in the household. Asset holdings are proxied by ownership of a telephone. In rural China, telephone ownership is considered to be a good indicator of overall household living standards (Sun & Wu, 2004)⁷, and within our sample, variation in telephone ownership provided the highest correlation with variation in other types of assets. We also include the number of household dependents (children and adults aged over 75 years). As this is a demographic variable, which relates to consumption, but not production, it should only affect participation if decision making is non-separable. The model of participation in a future programme also includes a dummy variable for whether the household has already participated in the SLCP.

Pre-programme explanatory variables are used to estimate the model of current participation. 1999 was selected as the pre-programme year because although the official launch of the programme was 2002, it was piloted in some regions prior to that. The model of future participation in a new version of the SLCP is estimated using 2004 data.

⁶ As different crops are grown in the sample regions, the yield variable is an index, calculated relative to the mean productivity of the primary crop planted by each household.

⁷ This is not the case in urban China, where telephone ownership is more widespread.

4 Current participation decision

4.1 Econometric model

There are two elements to the question of household participation in the SLCP. The first is whether a particular household participates in the programme or not, and the second relates to the intensity of participation. We estimate both a probit model of the determinants of the binary choice between participation and non-participation, and a truncated regression model of the factors determining the proportion of each household's total land area that is included in the SLCP⁸.

As discussed above, some households were selected to participate by the local implementation agency, while others could volunteer and were then accepted or not accepted in the scheme. We perform a χ^2 test on a pooled sample vs. separate samples for the two selection mechanisms. The hypothesis of homogenous parameters is rejected ($\chi^2=19.88$), so we model participation separately for households from villages with voluntary participation, and households from villages where the local implementing agency selected the participants. In the former group, although households could volunteer for the programme, this did not guarantee participation because the implementing agency could choose which land was finally included if the scheme was over-subscribed.

4.2 Results

The results in Table 3 indicate that there are differences in the determinants of participation between households located in areas with voluntary participation and households that were selected for participation by the local SLCP implementation agency.

⁸ Models are estimated in NLOGIT 3.0.

Among the ‘selected’ households, the first important finding is that characteristics such as the age or education of the household head do not affect either the likelihood of participation or the area of land included in the programme. Access to information, as indicated by television reception in the village is also not a significant determinant. However, there are significant differences in participation rates between Guizhou and Ningxia Provinces, and households with larger initial areas of land are more likely to be selected for participation. Of the variables relating to administrator preferences, we find that low income households who participate have larger areas of land included in the programme. However, households with higher yields also have more land included. This indicates that to the extent that yield and slope are related, less steeply sloping land is being entered into the programme. Previous studies have suggested that land may be selected based on how easy it is to monitor. However, we find that in this case, households located furthest from a main road had larger shares of their arable land included in the SLCP. Overall, these results suggest that there is some targeting of the scheme towards poorer households. However, the programme is not being targeted at the most steeply sloping land.

[Insert Table 3 about here]

For the households that could volunteer for the SLCP, we again find that household characteristics and access to information do not affect participation. There is also no indication that income affects participation, either through impacts on household decisions or as an outcome of administrator targeting. The area of land held by the household is no longer significant, but the distance from the nearest road is positively related to the intensity of participation again. There is also evidence that larger areas of low productivity land are entered into the programme. This may be because households with low yields have a lower opportunity cost of entering land into the SLCP, or because scheme administrators select the poorer land, which is also likely to be more steeply sloping.

The difficulty in analysing the current participation decision is particularly clear with these latter results. Participation is affected by both household decisions and administrator decisions, but we can only observe the sum of the two processes. As a result it is not possible to ascertain what the driving factors are for each. Furthermore, the decisions may cancel out, leaving us with no systematic pattern of participation overall. Unlike the more consistent evidence available for the determinants of current PES participation in the developed world, this murky picture derived for the case of the SLCP may in fact be quite common in many developing country contexts where the voluntary nature of participation is more likely to be compromised.

In order, therefore, to isolate household decisions from administrator decisions, we model the hypothetical household-level choice of all potential participants regarding whether to sign up in a new version of the SLCP. The results are presented in the following section.

5 Future participation decision

5.1 Econometric model

The model of future participation focuses specifically on household-level decision making. In Section 2, we discussed the theoretical literature suggesting that when households face market imperfections, production decisions can no longer be treated as separable from consumption decisions. On this basis, we predicted that households in developing countries, where market failures are prevalent, may not make decisions about participation in PES programmes in the same way as households in developed countries.

However, an important result of the theoretical models of household behaviour is that there is likely to be heterogeneity in the extent to which individual households face market failures. For example, de Janvry *et al.* (1991) propose that market failure is household specific, rather than commodity specific. Numerous studies demonstrate that a market will fail when the cost of a transaction in that market creates a disutility higher than the utility from the transaction itself. If this is the case, the market will not be used for that transaction; this is something that varies

between households (Key *et al.*, 2000; Carter & Yao, 2002; Vance & Geoghegan, 2004; Sadoulet *et al.*, 1998).

If some households participate in particular markets, while other do not, using a single model of household decision making will not correctly estimate the parameters for either group (Carter & Yao, 2002). Instead, it is necessary to carry out regime-specific analysis in order to obtain unbiased estimates. One way to distinguish between the multiple regimes is to directly ask households about their involvement in particular markets (e.g. Feder *et al.* (1990) segment the sample on the basis of self-declared access to credit markets). Alternatively, observed market participation may be used (e.g. Sadoulet *et al.*, 1998; Carter & Yao, 2002). However, Vakis *et al.* (2004) recommend that the basis for separation into different regimes should not be confined to a single market. This is because the theoretical prediction of non-separability is based on multiple market failures. In this case, whether a household behaves in a separable or non-separable manner is a latent variable, although it may be related to some observed characteristics.

In order to separately model household behaviour for households that are constrained in their access to markets and those who are unconstrained, we use a latent class probit model. The principle behind the use of the latent class model is that there is unobserved heterogeneity within the sample that affects the preferences, and in turn the choices, of the respondents (McFadden, 1986). The form of this heterogeneity is such that, based on their latent characteristics or attitudes, individuals are assigned probabilistically to one of a finite number of groups or population segments. The preferences of individuals differ between segments, but are assumed to be homogeneous within segments. The latent class model simultaneously estimates the segment specific membership and the choice parameters (Boxall & Adamowicz, 2002). This allows us to estimate the preferences of individuals, conditional on segment membership (Hynes *et al.*, 2006). The latent class probit model, therefore, takes the following form:

$$\Pr(P = 1 | j) = \Phi(x' \beta_j) \quad \text{Eq. 1}$$

where $P(\text{segment } j | z) = \frac{e^{\beta_j' z}}{\sum_{j=1}^J e^{\beta_j' z}}$

The vector of observable characteristics that determine scheme participation is given by x , and β_j is a segment-specific parameter vector. We assume a standard normal cumulative probability distribution, Φ . The probability that an individual is a member of segment j is a function of a further set of observable characteristics, z . This model therefore allows us to explain both the factors that determine segment membership, and the factors affecting scheme participation for each segment of the sample.

Latent class modelling has primarily been used in the marketing literature for the purpose of segmenting consumers into groups with homogeneous preferences. However, there are a number of studies that use the latent characteristics of households to explain the utility maximising choices that they make. For example, Crossa *et al.* (2002) and Ouma *et al.* (2007) both use latent class methods to segment small-scale farmers in developing countries into groups based on differences in their resources and the constraints they face. Group membership then contributes to households' choices of crop varieties and cattle traits respectively. Deb and Rosati (2002) find that the determinants of child labour allocation differ between latent classes of households, while Hope (2006) considers the preferences of poor households for alternative water policies. In both of these studies, class membership is a function of the socio-economic characteristics of the households, and the constraints they face.

In this paper, we use a latent class probit model to address the potential heterogeneity in the processes for making decisions about participation in the SLCP. This heterogeneity arises from differences in the extent to which individual households are integrated into factor and output markets. We estimate separate participation equations for households who are constrained and unconstrained in their access to markets. As the presence of market failure is a latent variable, we cannot observe which households are constrained and which are not. We separate the sample into constrained and unconstrained segments based on variables that affect the

likelihood of each household participating in markets. These are variables that (based on theory and past empirical findings) are expected to affect the transactions costs of using markets, such as education or geographical location.

The number of segments in the latent class model is defined by the investigator. This may either be done *a priori* on the basis of economic theory, or by testing alternative numbers of segments against each other using the Aikaike Information Criterion (AIC) or the Bayesian Information Criterion (BIC). The latter option is a statistical method, and as pointed out by Swait (1994), it can provide a guide to the number of segments rather than a clear indicator. As our theoretical framework specifically suggests that the sample should be split into constrained and unconstrained households, we opt to estimate two segments on theoretical grounds⁹.

The dependent variable consists of eight separate participation choices for each household. In order to account for unobservable household specific factors affecting participation, we use a fixed-effects model. We also estimate a fixed-effects probit model with homogenous preferences for comparison with the latent class model¹⁰.

5.2 Results

The results of the fixed-effects probit and latent class fixed-effects probit models are shown in Table 4. In the first of these models, the level of education of the household head and previous participation in the SLCP both increase future participation in a new programme, while households with higher average crop yields are less likely to say they would participate. However, these results arise under an assumption of homogeneous parameters. When we estimate separate parameters for two different segments of the sample, considerably different results are obtained. This suggests that the parameter estimates in the simpler model are not

⁹ To ensure that this was acceptable statistically, we also calculated the AIC and BIC for models with between 2 and 5 segments. The AIC was minimised with 4 segments, and the BIC was minimised with 2 segments. Where the criteria differ, judgement is required, and the recommendation is to use the simpler model (Swait 1994). This lends further support for the use of two segments.

¹⁰ Models are estimated in NLOGIT 3.0.

correctly estimated, and provides support for the use of the latent class model to account for sample heterogeneity.

The latent class model segments the sample into two classes. Household in Class 1 display a higher education level, have fewer dependents, and are nearer to a road. Taken together, these indicate that Class 1 households are likely to have better access to markets than Class 2 households. Therefore we categorise Class 1 households as ‘unconstrained’ and Class 2 households as ‘constrained’.

[Insert Table 4 about here]

There are both similarities and differences in the factors that determine participation for the two classes. Both constrained and unconstrained households are more likely to participate if they are in Ningxia Province, and if they have higher income levels. Previous participation in the SLCP and access to television are also positively related to participation for both groups. This suggests that increased awareness and understanding of the programme has a positive impact on participation, which is in line with previous studies of farmer participation in environmental schemes. It implies that if particular levels of voluntary participation rates can be achieved with subsidy rates of a certain level, then raising awareness of the purpose and operation of the SCLP could potentially allow increased participation or lower rates of subsidy. The result that households with more knowledge of the SLCP would be more likely to participate in a future scheme also indicates that the programme is not welfare reducing, as otherwise previous participants would not wish to re-enrol.

Unconstrained households are more likely to state that they would participate in a future version of the SLCP if they perceive their land tenure to be secure. This is unsurprising because households with secure property rights should have higher expected benefits from reforestation. These benefits may arise either through the anticipated use of forest products, or through reduced soil erosion on remaining agricultural land.

A central objective of this paper is to ascertain whether the presence of market imperfections results in different patterns of participation in PES programmes. The results in Table 4 indicate that there are a number of variables that affect the participation decisions of constrained households, but not unconstrained households. Some of these are production-related variables: in the constrained segment, households with low average yields or in remote villages are more likely to participate in the SLCP. These households are likely to have relatively low opportunity costs of converting crop land.

Of particular relevance, however, are the variables relating to household endowments and consumption preferences. Among constrained households, but not unconstrained households, those with larger endowments of labour are more likely to participate in the SLCP. Households with larger asset endowments, as proxied by telephone ownership, are less likely to participate. Demographic variables are also important for constrained households. Specifically, households with greater numbers of young or elderly members are more likely to indicate a willingness to participate in the SLCP. These dependent household members do not form part of the labour force, but they affect the consumption needs of the household.

The finding that initial household endowments and demographic variables affect the participation decisions of households facing market imperfections indicates non-separability of production and consumption decisions. In contrast, these variables do not affect participation for households with unconstrained market access, suggesting a separable decision-making process. The difference in the determinants of participation for the two sample segments also demonstrates the importance of modelling participation separately for the two segments using the latent class model.

6 Conclusions

This study used the example of the Chinese SLCP to examine the factors that determine whether households in rural areas of developing countries are likely to participate in a PES programme. The SLCP is one of the largest PES schemes in the world, and has been introduced in a context of widespread market imperfections. These features make it a particularly valuable case study.

As is the case with many PES schemes in the developing world, one important characteristic of the SLCP is that participation is not entirely voluntary at the household level. In some cases, households are instructed to participate, while in other cases those who would like to participate are unable to do so due to insufficient funds. The potential role of programme administrators in determining who participates in practice has so far received little attention, even though it is also likely to be important in programmes other than the SLCP. Our results show that modelling current participation picks up the effects of both household and administrator decisions. This is particularly the case where households volunteer and then a subset are selected, which is a situation that is frequently observed in PES schemes. The pattern of current participation may be of interest in certain situations, for example when trying to understand the overall effectiveness of programme targeting. However, if the decisions of households regarding participation are relevant, these cannot be identified by observing the final outcome in terms of who takes part in a programme.

The main focus of this study was to examine whether households faced with imperfect markets respond differently to a PES programme compared with households with good access to markets. We found that the participation decisions of households that were constrained in their access to markets varied according to the household endowments and demographics. This suggests that these households make participation decisions in a non-separable manner, accounting for both production and consumption preferences. In contrast, households with relatively good access to markets made their decisions primarily on the basis of the amount of information about the scheme, and the likely returns from participation (as indicated by

expected tenure security). These factors are not related to household endowments or consumption requirements. Instead they correspond to the variables that have been found to affect participation in studies from developed countries.

The first key conclusion from this is that the findings about PES participation from studies conducted in Europe, the US, and other developed countries cannot necessarily be applied to programmes elsewhere in the world. In addition to this, we found that even within local areas, households do not respond in the same way to a PES programme. If we model the participation decision as though the sample households are a homogenous group, we fail to identify the ways that individual households behave. By estimating separate models for households with and without access to markets, we can investigate the differing underlying processes relating to each. The latent class model was shown to be an effective way to do this because it allows the sample to be segmented on the basis of unobservable household characteristics. It also provides results that are easily interpreted.

A related implication of our results is that the determinants of participation are likely to be more complex in cases where markets operate imperfectly. It will be more difficult for policymakers to predict in advance who is likely to volunteer for participation. This in turn may make the environmental outcomes of the programmes less predictable as well.

Beyond the generally applicable findings discussed so far, we can also draw conclusions about the SLCP specifically. Although there is some evidence of targeting on poor households in the current scheme, the lack of targeting on the basis of land slope raises concerns about whether it can meet its environmental objectives. However, the results suggest that if the extent to which the programme is voluntary increases, poorer quality land, which is likely to have steeper slopes, would be entered to a greater extent. Among households with incomplete access to markets, those with lower yields, fewer assets, and in more remote locations, would be most likely to participate. These findings would imply improvements in terms of both environmental and poverty-reduction outcomes.

Another important finding is that overall, there appears to be a high willingness to participate among farmers. The results of this paper suggest that as households become more aware of the scheme, either through participation or through access to information about it, their willingness to participate will increase further. The finding that former participants are more likely to participate in future also suggests that the programme is welfare enhancing for participants.

There is currently considerable interest within China in the development of PES programmes beyond the SLCP, and policy debate regarding ways to promote market-based instruments is highly active (Scherr *et al.*, 2006). This implies that lessons regarding participation in the SLCP, which is the most prominent existing scheme, will be critical for the effective design of future programmes.

7 References

- Antle, J., S. Capalbo, S. Mooney, E. Elliott, and K. Paustian 2003. "Spatial heterogeneity, contract design, and the efficiency of carbon sequestration policies for agriculture." *Journal of Environmental Economics and Management* 46(2): 231-250.
- Barrett, C. B. 1996. "On price risk and the inverse farm size-productivity relationship." *Journal of Development Economics* 51: 193-216.
- Beckett, M., J. da Vanzo, N. Sastry, C. Panis, and C. Peterson 2001. "The quality of retrospective data." *Journal of Human Resources* 36(3): 593-625.
- Benjamin, D. 1992. "Household Composition, Labor Markets, and Labor Demand: Testing for Separation in Agricultural Household Models." *Econometrica* 60(2): 287-322.
- Bennett, M. T. 2008. "China's sloping land conversion program: Institutional innovation or business as usual?." *Ecological Economics* 65(4): 699-711.
- Bonnieux, F., P. Rainelli, and D. Vermersch 1998. "Estimating the Supply of Environmental Benefits by Agriculture: A French Case Study." *Environmental And Resource Economics* 11(2): 135-153.
- Bowlus, A. J, and T. Sicular. 2003. "Moving Toward Markets? Labor Allocation in Rural China." *Journal of Development Economics* 71(2): 561-583.
- Boxall, P. C, and W. L Adamowicz. 2002. "Understanding Heterogeneous Preferences in Random Utility Models: A Latent Class Approach." *Environmental and Resource Economics* 23(4): 421-446.
- Brandt, L., J. Huang, G. Li and S. Rozelle 2002. "Land rights in rural China: Facts, fictions and issues." *The China Quarterly* 47(1): 67-97.
- de la Briere, B. 2001. "Imperfect Food Markets and Household Adoption of Soil Conservation Practices in the Dominican Republic Highlands: Household Probit and Duration Models." in N. Heerink, H. van Keulen and M. Kuiper (eds) *Economic Policy and Sustainable Land Use: Recent Advances in Quantitative Analysis for Developing Countries* Heidelberg: Physica-Verlag. pp 93-114.
- Brotherton, I. 1991. "What Limits Participation in ESAs?." *Journal of Environmental Management* 32(3): 241.
- Carter, M. R., and Y. Yao. 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.
- Carter, Michael R, and Yang Yao. 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): 14.
- Chen, L., N. Heerink, and M. van den Berg. 2006. "Energy consumption in rural China: A household model for three villages in Jiangxi Province." *Ecological Economics* 58(2): 407-420.
- Cooper, J. C. 2003. "A Joint Framework for Analysis of Agri-Environmental Payment Programs." *American Journal Of Agricultural Economics* 85(4): 976-987.

- Crossa, J., M. R Bellon, and J. Franco. 2002. "A Quantitative Method for Classifying Farmers Using Socioeconomic Variables." In M. R Bellon and J. Leevés (eds). *Quantitative Analysis of Data from Participatory Methods in Plant Breeding*, Mexico: CIMMYT.
- Deb, P., and F. C Rosati. 2002. "Determinants of Child Labour and School Attendance: The Role of Household Unobservables." *Contact* 6: 500.
- Devereux, S., and J. Hoddinott. 1992. *Fieldwork in developing countries*. Harvester Wheatsheaf.
- Dupraz, P., D. Vermersch, B.H. de Frahan and L. Delvaux 2003. "The Environmental Supply of Farm Households: A Flexible Willingness to Accept Model." *Environmental and Resource Economics* 25(2): 19.
- van Dusen, M.E., ME, and JE Taylor, J.E. 2005. "Missing markets and crop diversity: evidence from Mexico." *Environment and Development Economics* 10(04): 513-531.
- Ellis, F. 1988. *Peasant economics: farm households and agrarian development*. Cambridge: Cambridge University Press.
- Engel, S., S. Pagiola, and S. Wunder. 2008. "Designing payments for environmental services in theory and practice: An overview of the issues." *Ecological Economics* 65(4): 663-674.
- Ervin, C. A, and D. E Ervin. 1982. "Factors affecting the use of soil conservation practices: Hypotheses, evidence and policy implications." *Land Economics* 58(3): 276-292.
- Falconer, K. 2000. "Farm-level constraints on agri-environmental scheme participation: a transactional perspective." *Journal of Rural Studies* 16(3): 379-394.
- Feder, G. 1985. "The Relation between Farm Size and Farm Productivity: The Role of Family Labor, Supervision and Credit Constraints." *Journal of Development Economics* 18(2-3): 297-313.
- Feder, G., L.J. Lau, J.Y. Lin and X. Luo 1990. "The relationship between credit and productivity in Chinese agriculture: A microeconomic model of disequilibrium." *American Journal of Agricultural Economics*: 1151-1157.
- Feng, Z., Y. Yang, Y. Zhang, P. Zhang and Y. Li 2005. "Grain-for-green policy and its impacts on grain supply in West China." *Land Use Policy* 22(4): 301-312.
- Ferraro, P. J. 2008. "Asymmetric information and contract design for payments for environmental services." *Ecological Economics* 65(4): 810-821.
- Fleisher, B. M, and D. T Yang. 2006. "Problems of China's Rural Labor Markets and Rural-Urban Migration." *Chinese Economy* 39(3): 6-25.
- Gavian, S., and M. Fafchamps. 1996. "Land tenure and allocative efficiency in Niger." *American Journal of Agricultural Economics*: 460-471.
- Giles, J., and R. E. N Mu. 2007. "Elderly parent health and the migration decisions of adult children: Evidence from rural China ." *Demography* 44(2): 265-288.
- Goeschl, T., and T. Lin. 2004. *Biodiversity Conservation on Private Lands: Information Problems and Regulatory Choices*. Fondazione Eni Enrico Mattei, Venice, Italy.
- Groom, B., P. Grosjean, A. Kontoleon, T. Swanson and S. Zhang 2009. "Relaxing rural constraints: A 'win-win' policy for poverty and environment in China?." *Oxford Economic Papers*. (forthcoming).

- Grosjean, P., and A. Kontoleon. 2009. "How Sustainable are Sustainable Development Programs? The Case of the Sloping Land Conversion Program in China." *World Development* 37(1): 268-285.
- Hakim, C. 2000. *Research Design: Successful Designs for Social and Economic Research*. London: Routledge.
- Henry, B., T.E. Moffitt, A. Caspi, J. Langley and P.A. Silva 1994. "On the" Remembrance of Things Past": A Longitudinal Evaluation of the Retrospective Method." *Psychological Assessment* 6: 92-92.
- Hope, R. A. 2006. "Evaluating water policy scenarios against the priorities of the rural poor." *World Development* 34(1): 167-179.
- Hynes, S., N. Hanley, and E. Garvey. 2006. *Using Continuous and Finite Mixture Models to Account for Preference Heterogeneity in a group of Outdoor Recreationalists*. Rural Economy Research Centre.
- de Janvry, A., M. Fafchamps, and E. Sadoulet. 1991. "Peasant Household Behaviour with Missing Markets: Some Paradoxes Explained." *The Economic Journal* 101(409): 1400-1417.
- Johnson, P. N, S. K Misra, and R. T Ervin. 1997. "A Qualitative Choice Analysis of Factors Influencing Post-CRP Land Use Decisions." *Journal Of Agricultural And Applied Economics* 29(1): 163-174.
- Kevane, M. 1996. "Agrarian Structure and Agricultural Practice: Typology and Application to Western Sudan." *American Journal of Agricultural Economics* 78: 236-245.
- Key, N., E. Sadoulet, and A. de Janvry. 2000. "Transactions Costs and Agricultural Household Supply Response." *American Journal of Agricultural Economics* 82(2): 245-259.
- Kosoy, N., E. Corbera, and K. Brown. 2008. "Participation in payments for ecosystem services: Case studies from the Lacandon rainforest, Mexico." *Geoforum* 39(6): 2073-2083.
- Kosoy, N., M. Martinez-Tuna, R. Muradian and J. Martinez-Alier 2007. "Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America." *Ecological Economics* 61(2-3): 446-455.
- Landell-Mills, N., and I. T. Porras. 2002. *Silver bullet or fools' gold? A global review of markets for forest environmental services and their impact on the poor*. Instruments for sustainable private sector forestry series. International Institute for Environment and Development, London.
- Langpap, C. 2004. "Conservation Incentives Programs for Endangered Species." *Land Economics* 80(3): 14.
- Liu, S., M. R Carter, and Y. Yao. 1998. "Dimensions and diversity of property rights in rural China: Dilemmas on the road to further reform." *World Development* 26(10): 1789-1806.
- McFadden, D. 1986. "The Choice Theory Approach to Market Research." *Marketing Science* 5(4): 275-297.
- Nagubadi, V., K.T. McNamara, W.L. Hoover and W.L. Mills 1996. "Program Participation Behavior of Nonindustrial Forest Landowners: A Probit Analysis." *Journal Of Agricultural And Applied Economics* 28(2): 323-336.

- Ouma, E., A. Abdulai, and A. Drucker. 2007. "Measuring Heterogeneous Preferences for Cattle Traits among Cattle-Keeping Households in East Africa." *American Journal of Agricultural Economics* 89(4): 1005-1019.
- Pagiola, S. 2008. "Payments for environmental services in Costa Rica." *Ecological Economics* 65(4): 712-724.
- Pagiola, S., A. R. Rios, and A. Arcenas. 2008. "Can the poor participate in payments for environmental services? Lessons from the Silvopastoral Project in Nicaragua." *Environment and Development Economics* 13(03): 299-325.
- Rahm, M. R., and W. E Huffman. 1984. "The Adoption of Reduced Tillage: The Role of Human Capital and Other Variables." *American Journal of Agricultural Economics* 66(4): 405-413.
- Sadoulet, E., and A. De Janvry. 1995. *Quantitative Development Policy Analysis: Exercise Solutions*. Baltimore: Johns Hopkins University Press.
- Sadoulet, E., A. de Janvry, and C. Benjamin. 1998. "Household Behavior with Imperfect Labor Markets." *A Journal of Economy & Society* 37(1): 85-108.
- Sadoulet, E., A. de Janvry, and C. Benjamin. 1998. "Household Behavior with Imperfect Labor Markets." *Industrial Relations* 37(1): 85-108.
- Scherr, S. J., M. Bennett, M. Loughney and K. Canby 2006. Developing Future Ecosystem Service Payments in China: Lessons Learned from International Experience. Forest Trends.
- Singh, I., L. Squire, and J. Strauss. 1986. *Agricultural household models: extensions, applications, and policy*. Baltimore: Johns Hopkins University Press.
- Smith, R. B. W, and J. F Shogren. 2002. "Voluntary Incentive Design for Endangered Species Protection." *Journal Of Environmental Economics And Management* 43(2): 169-187.
- Stoneham, G., V. Chaudhri, A. Ha and L. Strappazon 2003. "Auctions for conservation contracts: an empirical examination of Victoria's BushTender trial." *The Australian Journal of Agricultural and Resource Economics* 47(4): 477-500.
- Sun, T., and G. Wu. 2004. "Consumption patterns of Chinese urban and rural consumers." *Journal of Consumer Marketing* 21(4): 245-253.
- Swait, J. 1994. "A structural equation model of latent segmentation and product choice for cross-sectional revealed preference choice data." *Journal of Retailing and Consumer Services* 1(2): 77-89.
- Tsai, K. S. 2004. "Imperfect Substitutes: The Local Political Economy of Informal Finance and Microfinance in Rural China and India." *World Development* 32(9): 1487-1507.
- Uchida, E., J. Xu, and S. Rozelle. 2005. "Grain for Green: Cost-Effectiveness and Sustainability of China's Conservation Set-Aside Program." *Land Economics* 81(2): 247.
- Uchida, E., J. Xu, Z. Xu and S. Rozelle 2007. "Are the poor benefiting from China's land conservation program?." *Environment and Development Economics* 12(04): 593-620.
- Vakis, R., E. Sadoulet, A. de Janvry and C. Cafiero 2004. *Testing for separability in household models with heterogeneous behavior: a mixture model approach*. Working Paper-Department of Agricultural and Resource Economics and Policy, Division of Agriculture and Natural Resources, University of California: 18pp.

- Van Dusen, M. E., and J. E. Taylor. 2005. "Missing markets and crop diversity: evidence from Mexico." *Environment and Development Economics* 10(04): 513-531.
- Vance, C., and J. Geoghegan. 2004. "Modeling the determinants of semi-subsistent and commercial land uses in an agricultural frontier of southern Mexico: A switching regression approach." *International Regional Science Review* 27(3): 326.
- Vanslebrouck, I., G. Van Huylenbroeck, and W. Verbeke. 2002. "Determinants Of The Willingness Of Belgian Farmers To Participate In Agri-Environmental Measures." *Journal Of Agricultural Economics* 53(3): 489-512.
- Wang, X., H. Han, and J. Bennett. 2008. "China's Land Use Management." In J. Bennett, X. Wang, and L. Zhang (eds) *Environmental Protection in China: Land Use Management*. Cheltenham, UK; Northampton, MA : Edward Elgar.
- Whalley, J., and S. Zhang. 2007. "A numerical simulation analysis of (Hukou) labour mobility restrictions in China." *Journal of Development Economics* 83(2): 392-410.
- Wilson, G. A, and K. Hart. 2001. "Farmer Participation in Agri-Environmental Schemes: Towards Conservation-Oriented Thinking?." *Sociologia Ruralis* 41(2): 21.
- Wossink, G. A. A, and J. H van Wenum. 2003. "Biodiversity conservation by farmers: analysis of actual and contingent participation." *European Review of Agricultural Economics* 30(4): 461-485.
- Wu, J., and B. A Babcock. 1996. "Contract design for the purchase of environmental goods from agriculture." *American Journal of Agricultural Economics* 78(4): 935-945.
- Wunder, S., S. Engel, and S. Pagiola. 2008. "Taking stock: A comparative analysis of payments for environmental services programs in developed and developing countries." *Ecological Economics* 65(4): 834-852.
- Wünscher, T., S. Engel, and S. Wunder. 2008. "Spatial targeting of payments for environmental services: A tool for boosting conservation benefits." *Ecological Economics* 65(4): 822-833 .
- Xu, J., E. Katsigris, and T. A. White, eds. 2002. *Implementing the Natural Forest Protection Program and the Sloping Land Conversion Program: Lessons and Policy Recommendations*. China Council for International Cooperation on Environment and Development, Western China Forests and Grassland Taskforce.
- Xu, J., R. Tao, and Z. Xu. 2005. *Sloping Land Conversion Program in China: Background and a Mid-term Empirical Evaluation of Sustainability*. Center for Chinese Agricultural Policy.
- Xu, Z. et al. 2004. "China's Sloping Land Conversion Program Four Years on: Current Situation and Pending Issues." *International Forestry Review* 6(3-4): 317-326.
- Zbinden, S., and D. R Lee. 2005. "Paying for Environmental Services: An Analysis of Participation in Costa Rica's PSA Program." *World Development* 33(2): 255-272.
- Zuo, T. 2002. "Implementation of the NFPP." In J. Xu, E. Katsigris, and T. A. White (eds) *Implementing the Natural Forest Protection Programme and the Sloping Lands Conversion Programme: Lessons and Policy Recommendations*, China Council for Cooperation on International Environment and Development.

Table 1: Descriptive statistics for dependent variables

	Full sample	Selected for participation	for	Volunteered for selection
% of households currently in SLCP	76%	77%		74%
Average % of land included by each participating household	49%	47%		49%
% of households stating that they would participate in a future programme	71%	68%		74%

Table 2: Descriptive statistics for explanatory variables

Variable	Description	1999		2004	
		Mean	S.D.	Mean	S.D.
Province	1=Guizhou; 0=Ningxia	0.458	0.499	0.458	0.499
Age	Age of household head in years	39.83	11.48	44.83	11.48
Education	1=head of household has more than primary education	0.462	0.499	0.462	0.499
Income	Net income of household (in cash and in kind) – 1000 RMB	5.58	7.54	8.16	8.76
Yield	Yield of primary crop per mu of land – index variable (1mu = 1/15ha)	1.00	0.686	1.00	0.685
Land area	Area of household agricultural land	16.23	16.18	16.20	16.08
Television	1=village has television reception	0.325	0.519	0.797	0.430
Distance to road	Distance to nearest road – km	2.16	3.79	2.15	3.77
SLCP	1=household participated in SLCP before 2004			0.755	0.430
Tenure	1=household does not expect agricultural land to be reallocated			0.262	0.441
Labour	Number of adults aged between 17 and 75 in household			3.13	1.34
Dependents	Number of household members aged 17 or under or over 75			1.71	1.19
Phone	1=household owns a telephone			0.427	0.495

Table 3: Determinants of current participation in the SLCP

	Selected for participation		Volunteered for selection	
	Probit (Model 1)	Truncated Reg (Model 2)	Probit (Model 3)	Truncated Reg (Model 4)
Constant	-1.365 (0.830)*	0.271 (0.196)	0.391 (0.584)	1.241 (0.367)***
Province	1.962 (0.567)***	-0.046 (0.140)	-0.480 (0.291)*	0.099 (0.191)
Age	-0.001 (0.014)	0.004 (0.003)	0.003 (0.010)	-0.010 (0.007)
Education	0.428 (0.323)	0.085 (0.077)	0.042 (0.241)	-0.071 (0.138)
Income	0.009 (0.024)	-0.009 (0.005)*	0.014 (0.017)	0.004 (0.008)
Yield	-0.155 (0.197)	0.127 (0.046)***	-0.120 (0.216)	-0.273 (0.145)*
Area	0.070 (0.026)***	0.001 (0.003)	0.009 (0.012)	-0.008 (0.006)
Television	-0.308 (0.272)	0.049 (0.062)	0.029 (0.346)	-0.285 (0.272)
Distance	0.103 (0.081)	0.027 (0.014)**	0.088 (0.056)	0.040 (0.020)**
Observations	286	286	286	286
Log likelihood	-50.16	-7.67	-88.37	-54.62
Correct predictions	82.6%		74.3%	

S.E. in parentheses

*, **, and *** indicate significance at the 10%, 5% and 1% levels respectively

Table 4: Determinants of future participation in the SLCP

	Fixed effects probit (Model 5)	Latent class fixed effects probit (Model 6)		
		Class 1 – unconstrained	Class 2 - constrained	Determinants of Class 1
Constant	-0.644 (0.612)	1.154 (0.526)**	-1.009 (0.333)***	0.320 (0.381)
Province	-0.164 (0.248)	-0.700 (0.226)***	-0.276 (0.145)*	
Age	0.006 (0.008)	-0.006 (0.007)	-0.020 (0.005)***	
Education	0.231 (0.111)**	-0.048 (0.082)	-0.069 (0.059)	0.304 (0.167)*
Income	0.019 (0.013)	0.028 (0.012)**	0.036 (0.010)***	
Yield	-0.002 (0.001)*	-0.001 (0.002)	-0.002 (0.001)**	
SLCP	0.750 (0.194)***	0.916 (0.128)***	1.073 (0.141)***	
Area	0.016 (0.010)	0.002 (0.010)	0.000 (0.005)	
Television	0.399 (0.260)	0.478 (0.158)***	0.457 (0.138)***	
Distance	0.012 (0.037)	0.059 (0.051)	0.076 (0.018)***	-0.121 (0.068)*
Tenure	-0.118 (0.224)	0.345 (0.181)*	0.000 (0.137)	
Labour	0.017 (0.082)	-0.040 (0.063)	0.089 (0.051)*	
Dependents	0.011 (0.079)	-0.003 (0.067)	0.262 (0.043)***	-0.339 (0.137)**
Phone	-0.083 (0.204)	-0.176 (0.148)	-0.668 (0.119)***	0.456 (0.313)
Observations	286		286	
Proportion in Class 1			0.525	
Log likelihood	-1011.35		-1000.76	
Correct predictions	72.76%			

S.E. in parentheses

*, **, and *** indicate significance at the 10%, 5% and 1% levels respectively