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Mechanisms behind concurrent payments for ecosystem services in a Chinese nature reserve

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ABSTRACT

Payments for Ecosystem Services (PES) seek to protect important ecosystems and related ecosystem services while increasing (or maintaining) human wellbeing by paying resource users directly to change their land and resource use behavior. To increase understanding of socio-economic aspects of PES, this study collected data from households to identify variables that may influence Chinese villagers' decisions to enroll land in a PES program, the Grain-to-Green Program (GTGP), in the context of simultaneous participation in another PES, the Forest Ecological Benefit Compensation Fund (FEBC). Previous studies identified a baseline of relevant variables, which we use as control variables. Secondary to this, we explore how hypothetical post-participation land use options might promote or deter GTGP participation. In addition to supporting previous findings regarding the role of control variables, our results generated through regression analysis suggest a negative relationship between GTGP enrollment and FEBC participation. We find that villagers view retiring land from crops to plant ecological trees through GTGP as undesirable under current compensation scenarios. Through exploring latent mechanisms underlying PES enrollment in concurrent PES programs, this research provides new insight about PES effectiveness, as well as bases for policy extension, with lessons for design and implementation of PES in China and globally.

1. Introduction

Payments for ecosystem services (PES) programs are currently implemented worldwide as a conservation tool—especially in rural areas and developing regions. PES programs operate through contracts with landowners or land managers providing incentives to change their land use behavior to protect ecosystems and their associated services, such as water filtration, carbon sequestration, and protection of wildlife habitats (Wunder, 2005, 2008). PES programs rely on community support and voluntary participation and are considered adaptive conservation tools because their contracts can be set according to the ecological services they provide and available resources (Sorice et al., 2018). Since PES programs are considered voluntary, studies have assessed which elements of PES programs are most attractive and what opportunity costs are associated with enrolling land parcels in a PES program (Bremer et al., 2014). It has been suggested that multiple factors may affect PES decision making (Clements and Milner-Gulland, 2015; Engel, 2016; Wunder, 2005, 2008). In addition to the financial incentives, previous PES research has focused on the impacts of several other program components, including duration of contract, social/community perceptions, and conservation methods/effort (Arriagada et al., 2015; Chen et al., 2009; Sorice et al., 2018). These other components are important to consider because they may significantly contribute to participation in PES programs (Adhikari and Agrawal, 2013; Adhikari and Boag, 2013; Bremer et al., 2014; Wunscher et al., 2011). Successful PES programs also need to consider participants' desires and needs when developing program components (Adhikari and Boag, 2013; Chen et al., 2017; Meemken et al., 2017; Shoyama et al., 2013; Sorice et al., 2018).

To balance ecological and human needs across the world, PES programs covering the same geographic area and/or involving the same participants—which we define as *concurrent PES programs*—have been simultaneously implemented with increasing popularity. Surprisingly, concurrent PES programs have thus far been treated independently as if

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there were no links among them. According to a recent paper that synthesizes PES review articles published since 2008 (Börner et al., 2017), the existing literature does not explicitly acknowledge the existence of concurrent PES programs, nor potential links among them. While the drivers of participation in disparate PES programs have been studied, research on participation in concurrent PES programs is very limited. The literature regarding PES stacking or bundling suggests that combining PES credits or incentives may lead to greater economic rewards for landowners and, simultaneously, more ecosystem services, if done properly (Deal et al., 2012; Gillenwater, 2012; Hejnowicz et al., 2014). However, it is still unclear whether, and under what conditions, concurrent PES programs may produce additional benefits or, alternatively, counteract one another (Wendland et al., 2010; Bennett et al., 2009; Bianco, 2009). In this context (for details, see Participation in Concurrent PES Programs below), there is a dire need to examine whether and how concurrent PES programs link to each other.

To better understand and account for potential links among concurrent PES programs, we examine two of the largest PES programs in the world—the Grain-to-Green Program (GTGP) and the Forest Ecological Benefit Compensation (FEBC) Fund in China. GTGP was developed in response to a major flood along the Yangtze River in 1998 caused by soil erosion due to intensive land use practices and deforestation (Liu et al., 2008). GTGP is a government-led PES program that provides participants with monetary and/or in-kind payments in return for replacing croplands on steep hillslopes with forestland or grassland. FEBC, on the other hand, was initiated in 2001 to conserve China's declining forest lands. Roughly speaking, under FEBC, the Chinese government pays citizens to protect existing forestlands from timber extraction. Since citizens enrolled in GTGP in much of the country may also enroll in FEBC, we are interested in assessing how enrollment in FEBC might influence GTGP participation. In addition to exploring concurrent PES programs, a secondary goal is to address whether and how post-enrollment land use options might affect PES participation. With other potential variables controlled, these two sets of variables—the linkages between concurrent PES programs and factors affecting post-enrollment land use—will be evaluated and analyzed using detailed household survey data.

2. Background

2.1. The Grain-to-Green Program policy

The GTGP was introduced in China starting around 2000 with varying payment levels and types depending on the province. GTGP has been re-extended in roughly 8-year increments starting in 2007 and is now in its third phase (Gauvin et al., 2010; State Forestry Administration of China, 2017). In Guizhou Province, there was an initial compensation of 239 yuan (roughly 29 USD; estimated using yearly average exchange rates from 2000 to 2007) per mu (1 mu = 1/15 ha) of land per year for the first 8 years, but in 2007 compensation for the subsequent 8 years dropped to 134 yuan/mu/year (19 USD). Upon enrolling in GTGP, participants are required to plant seedlings (provided for free) of either "ecological trees", such as Japanese fir, or "economic trees", such as tea plants (*Camellia sinensis*) or Chinese herbs used for medical purposes (e.g., Astragalus root of Huang Qí). Harvesting of products from economic trees is allowed under the GTGP policy, which provides additional income for participating households much more quickly than ecological tress do. It is also possible that converting land from cropland, thus reducing land available for crops, could encourage farmers to explore other income-earning opportunities outside agriculture (Chen et al., 2009; Liu and Diamond, 2005), such as non-agricultural work or even out-migration of a household member who subsequently sends remittances back to the origin household. This can provide income benefits by allowing landowners to rely less on their land for income, therefore increasing their economic resilience (Tuanmu et al., 2016; Zhen and Zhang, 2011). Such income diversification for households in rural China may also allow villagers to cope better with environmental changes (e.g., uncertainties due to weather vicissitudes) and make them more economically stable (Wan et al., 2016).

GTGP functions at a local scale as local households can, to some degree, choose to participate in the program or not based on their own perceived value and social and economic needs. Decision-making about whether and how to invoke conservation efforts is thus, for the most part, left up to households (Chen et al., 2009). By 2014, over 9.2 million ha of cropland was enrolled in GTGP nationwide, and there were plans to convert 600,000 ha more (State Forestry Administration PRC, 2014). Furthermore, a success of GTGP is that the vast majority of local populations seem to support GTGP and its initiatives in areas selected for reforestation. For example, in a case study in Qira, China, researchers found that almost 90% of survey respondents supported GTGP (Ma et al., 2009). However, it was also found that even those in favor of GTGP might reconvert their land to its previous state for agricultural or timber extraction purposes once they stop receiving money (Uchida et al., 2005). Methods to sustain conservation successes beyond the termination of PES contracts have yet to be studied, or observed, as the policies are still ongoing.

2.2. The Forest Ecological Benefit Compensation Fund policy

The Chinese central government launched the experimental phase of its Forest Ecological Benefit Compensation (FEBC) Fund (also referred to as the Ecological Welfare Forest Program or EWFP) in 2001 initially in 11 provinces, autonomous regions, and municipalities (Dai et al., 2008; Deng et al., 2011). The FEBC Fund started formally in 2004, and has been used to establish, nurture, protect, and manage existing forestland that provides ecological benefits (Ministry of Finance and State Administration of Forestry, 2007). While the state government has ultimate land ownership, farmers have long-term usufruct rights under the current land tenure system. Consequently, rural households receive FEBC payments if their forest parcels are in the FEBC program. Although they are still allowed to collect wood from their forests for subsistence purposes (e.g., fuelwood), FEBC fund recipients are required to abandon commercial logging and to instead protect forests from fire and theft (Zhang et al., 2018a, 2018b). By the end of 2006, FEBC programs had been expanded to 25 provinces, autonomous regions, or municipalities (Deng et al., 2011). As of 2008, the total area of FEBC forestland was 105.2 million ha in China.

2.3. Participation in concurrent PES programs

Participation in two or more PES programs simultaneously implemented in the same household or at the same site (i.e., concurrent PES programs) has raised some controversy due to the potential for households to be paid under multiple PES contracts, which may be redundant or have counteracting effects (Cooley and Olander, 2011). The alternative viewpoint is that participation in concurrent PES programs can increase the effectiveness of PES programs due to higher total payments (Gillenwater, 2012; Hejnowicz et al., 2014). In the U.S., the term "stacking" is used to denote sellers/landowners receiving multiple payments for multiple ecosystem services when each ecosystem service is paid separately. Stacking is commonly seen in FNNR

(and elsewhere) when qualified households receive payments from GTGP for transforming their cropland on steep hillslopes while also receiving FEBC payments for not logging and instead using their time to patrol their enrolled forests at different locations. FEBC-eligible land parcels are forestlands to which households have use or usufruct rights (including for commercial logging unless enrolled). The government mandates that essentially all FEBC-eligible land parcels in program areas be enrolled in FEBC. While a household may have FEBC-eligible land parcels, it may not necessarily have GTGP-eligible land parcels: GTGP-eligible land parcels are farmland on moderately steep slopes and spatially distinguishable from FEBC parcels. The two programs are administered by the same local government agency (usually the local township forestry service), which provides seedlings and technical support for GTGP while also supervising FEBC implementation. While the same land parcel cannot be enrolled in both PES programs, a household may enroll some parcels in GTGP and others in FEBC. This is an example of *horizontal* stacking, in which the landowner receives independent payments for each ecosystem service derived from each distinct area of land (Cooley and Olander, 2011).

Concurrent PES programs may counteract or complement one another. Opponents of PES stacking or participation in concurrent PES programs claim that individuals may focus on only one of multiple contracts and put minimal effort into the remaining one(s) because multiple contracts involve too much responsibility or time commitment. However, proponents argue that if PES payments are combined, thus allowing households to receive higher payments, households may be able to provide greater ecosystem services (Deal et al., 2012; Gillenwater, 2012; Hejnowicz et al., 2014) as well as free farmers to diversify into more remunerative livelihoods depending on their new time obligations for monitoring occasionally their FEBC forests versus the time freed up from farming less land (Hejnowicz et al., 2014). Despite these theoretical claims, as far as we know, no published studies have assessed the effects of concurrent PES programs in regard to horizontal stacking, on individuals, households, or communities.

2.4. Enrollment land use options

Typical land use options under PES programs include planting native or ecologically beneficial species, fallowing the land, and planting economic trees (Chen et al., 2017; Zhang et al., 2018a, 2018b). Landowners generally prefer to refrain from plants that do not provide quickly salable commodities as a reliable source of income, such as native ecological tree species that are profitable only in the long-term (for fuelwood or timber) (Sarkissian et al., 2017). Thus, other "economic trees" are preferred, such as tea, fruit, or nut producing trees because they provide monetary rewards far sooner (Chen et al., 2017; Sarkissian et al., 2017).

Payment levels are known to be significant factors that influence decisions to enroll land in PES programs but are not the sole deciding factors for enrollment (Balderas Torres et al., 2013; Bremer et al., 2014; Chen et al., 2018; Wunscher et al., 2011). Other considerations, such as the total amount of land the household has, social/community connections, the promised duration of the program, and land use options are likely influential in decision-making regarding PES participation (Adhikari and Boag, 2013; Bremer et al., 2014; Chen et al., 2008).

We are also interested in the possible land use options available in the future for those enrolled currently in the PES programs, as they have not been studied in detail and may affect continued participation. For example, people may prefer more flexible PES policies that allow them to separate their land parcels into different uses rather than be mandated specific land uses for each land parcel enrolled (Bremer et al., 2014). This is likely because PES payments represent only a very small part (e.g., less than 10%: Song et al., 2018) of mean household incomes, so households, mostly with low-incomes, seek to establish as many income streams as possible, both on their land and elsewhere, such as wage work (Liu et al., 2008; Zhang et al., 2000). Post-enrollment land use options—defined as what types of land use practices would be allowed on a household's land upon re-enrolling in GTGP—have not been investigated so far. This variable relates to the forgone opportunity cost of the land retirement and constitutes the PES policy dimensions below in Table 3.

2.5. Establishing control variables

We use current literature to inform most of our variable selections. Payment levels and program length have each been previously studied, and logically both have proven to be key indicators of PES participation as they directly connect to the level and duration of compensation, which together offset the benefits forgone from farmland retirement (Chen et al., 2009; Kaczan and Swallow, 2013; Stevens et al., 1999; Wandersee et al., 2012).

Demographic characteristics of heads of households, such as age, gender, and educational attainment, are also likely influential on GTGP decision-making (Chen et al., 2012; Liang et al., 2012; Zhang et al., 2018a, 2018b). In addition, to describe household characteristics, we incorporate household size, yearly agricultural expenses, local off farm income, and area of land not currently enrolled in GTGP (Lugauer et al., 2013; Wunder, 2008; Zbinden and Lee, 2005). Neighbors' choices may also be important in PES decision-making, reflecting people's psychosocial tendency to interact and to agree with neighbors (e.g., Bremer et al., 2014; Chen et al., 2009, 2012; Van der Horst, 2011). Bremer et al. (2014) also indicate the importance of social relationships by stating that social networks contribute to informing villagers about PES programs and can even help individuals enroll in such programs.

3. Methods

3.1. Study site

We choose the Fanjingshan National Nature Reserve (FNNR) located in the Wuling Mountains, Guizhou Province, China (27°55'11.2"N 108°41'50.1"E) as our case study site to assess the mechanisms behind GTGP participation (Fig. 1). FNNR is an ideal site because it is located in a rural area of China with a population that has traditionally relied on cropland for a mostly subsistence lifestyle. Over 16,000 people live within the reserve, a majority of which (about 70%) are ethnic minorities (GEF Project Team, 2004). FNNR, 419 km^2 in size, is also an important conservation area because it has been identified as one of the world's biodiversity hotspots, with over 5000 species (GEF Project Team, 2004). Many species found in FNNR are protected by China's Wild Animal Protection Law, such as the Guizhou snub-nosed monkey (*Rhinopithecus brelichi*) and the Asian black bear (*Ursus thibetanus*). The humid subtropical climate and steep terrain of FNNR provide optimal habitats for a variety of animal and plant species, but also has big risks of soil erosion. Within the core area of the reserve, the forest remains well preserved, while at the edges and beyond the immediate boundary it is heavily utilized by local populations and has been converted to agriculture, houses, and tourist facilities (Tsai et al., 2018).

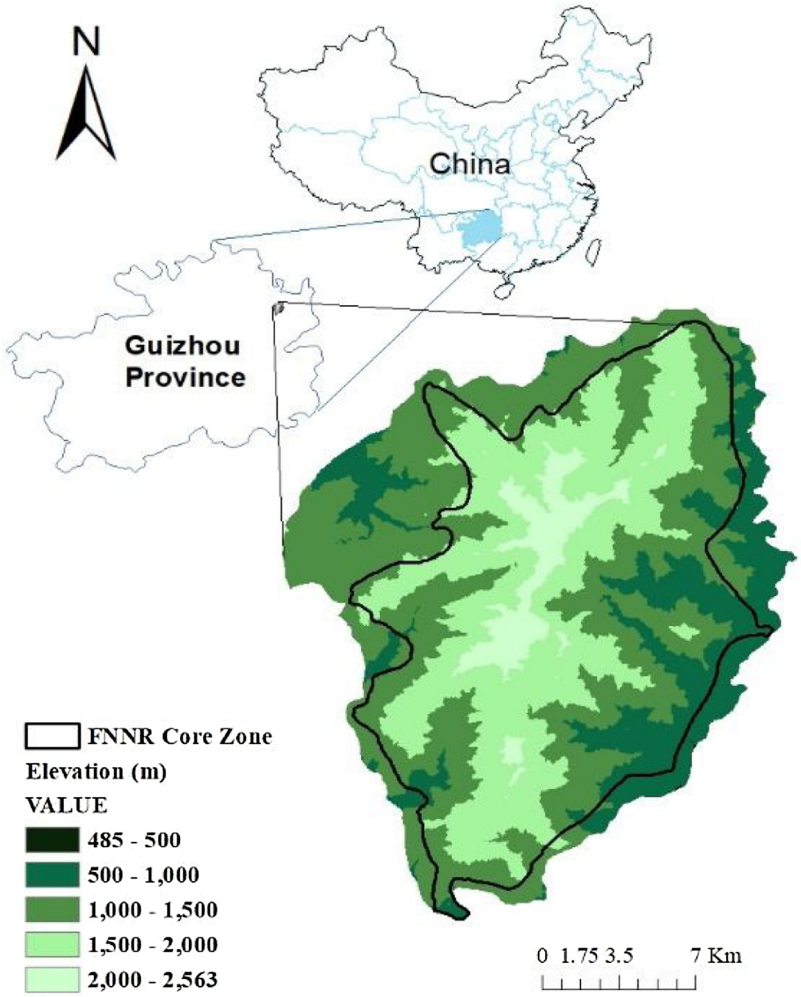

Fig. 1. Location of study site.

Households in FNNR have the same land tenure system as elsewhere in rural China. Farmland nominally belongs to the community, with each resident household receiving usufruct rights to use its portion since the early 1980s (shortly after the beginning of the "opening up and reform" policy in China). Similarly, households received forestland, where limited use of the forest resources (e.g., fuelwood collection, timber harvesting for household use subject to application and government approval) are allowed (Dachang, 2001). Since harvesting of ecological service trees under designated conditions is allowed under GTGP policy, it provides a small additional income or fuel source for participating households but only after a number of years. An average household (e.g., one with 3.89 mu of GTGP land and 57.25 mu FEBC land: Table 1) receives payments from the two programs that are roughly comparable: 844 yuan from FEBC and 930 yuan (521 yuan after 2007) from GTGP. If the household does not fulfill its subsidy program obligations, it may face penalties, including termination of GTGP and/or FEBC funding and even a lawsuit. At the same time, during the study period local markets remained fairly stable, with prices for key commodities (e.g., rice, corn, pork) changing little (China Daily, 2016).

The GTGP program started several years earlier than FEBC, providing considerable income (particularly in the first 8 years), and

Table 1
Comparison of GTGP and FEBC programs (based on Liu et al. (2008) and Ministry of Finance and State Forestry Administration (2014)).

Program	GTGP	FEBC
Goal	Recover vegetation and reduce ground runoff and soil erosion	Protect existing forests and seek ecological security by reducing water runoff and erosion
Qualification	Farmland sloping ≥15° in northwestern China and ≥25° elsewhere	Eliminate commercial timber harvesting, protect ecological benefits, restore natural forests, and produce timber in plantation forests
Start year	2001 (variable by location)	2004 (variable by location)
Compensation (Yuan/mu/year)	239(1)	14.75(2)
Obligations	Return farmland to forestland or grassland	No illegal logging, forest fires, or animal poaching
Average land enrolled per household (mu)	3.89	57.25

Note: (1) This dropped to 134 yuan/mu for Phase II of the program from 2007 to 2015; and varies with year and place.
(2) This rate applies to forestland contracted to individual households. A different rate (5 yuan/mu) applies to state-owned forestland monitored by households, subject to change depending on year and place.

released labor from farmland, contributing to changes in local people's livelihoods and lifestyles (Liu et al., 2008). Due to FNNR's standing as a national nature reserve, there is no cap on GTGP participation in FNNR. Therefore, we posit that GTGP had a much more important influence on changing local lifestyles than FEBC, e.g., stimulating off-farm work and rural-urban migration. In addition, FEBC participation is more heavily prescribed by the government than GTGP participation is. Therefore, this study focuses on whether FEBC participation affects GTGP enrollment when other important variables are controlled for. We also acknowledge the potential impact of GTGP on FEBC, which is of both theoretical and practical importance and should be examined in the future.

3.2. Household survey data

A detailed household survey was administered in 2014, which included over 200 questions. Based on the enumeration of 3256 households in the recent 2013 FNNR census, 123 sampling units were created, each representing an average cluster size of 26 households (the exact number varying with the number of households in the natural villages; details are at http://complexities.org/pes/research/recent-updates/). From the 123 sampling units, a large number (58) were randomly selected to ensure good coverage of the local population, since there was no a priori data on which households in which villages were participating in GTGP. This sampling strategy allows for a more efficient sample. From the 58 selected sampling units, the survey team randomly selected 605 households (around 33%), using disproportionate sampling to oversample households participating in GTGP. Heads of households (or adults who know the household livelihoods well, if the heads were unavailable) were asked to participate in the personal survey. Survey questions focused on 1) individual-level characteristics: age, gender, education, marital status, etc. of each member in the sample household; 2) household characteristics: migration, living conditions, household assets, and economic activities; and 3) household land use and PES characteristics: total farmland area, area of farmland enrolled in different crops and in GTGP, and GTGP payment as well as FEBC land area and payment (Table 1). From our sample, we calculated the number of GTGP participating households, total and average (per household) area of land enrolled in the two programs, and several other descriptive statistics to provide a profile of the two programs at FNNR. As previously mentioned, GTGP had been implemented in FNNR for 12+ years by the time of our survey. As a result, some households had enrolled land in GTGP before FEBC had begun.

All of the above-mentioned attributes were considered in developing a choice experiment to identify the socioeconomic, demographic, PES policy, and environmental factors that might influence a household's decision to enroll new land in the Grain-to-Green Program in the future (or re-enroll) under a set of hypothetical conditions. A choice experiment provides respondents with sets of hypothetical conditions to evaluate their perceptions and latent feelings about PES participation (Kaczan and Swallow, 2013; Stevens et al., 1999). Our survey asked respondents if they would be willing to enroll their available land in GTGP under three hypothetical scenarios of PES policy. This approach will indicate which attributes and associated factors are likely to most significantly affect future or continuing PES enrollment.

The three PES policy components presented in this study as hypothetical choices were level of payment, program length, and enrollment land use options allowed. Previous studies indicated that level of payment and program length are significant considerations in PES choice experiments (Chen et al., 2009; Stevens et al., 1999; Wunder, 2008; Zbinden and Lee, 2005). Here, we added variables regarding land use options to examine their impacts on PES participation and also incorporated more control variables than in prior research.

Perhaps most novel, we first developed appropriate combinations of the levels for the three PES policy conditions through a pilot study of non-sample households living in the study region. In the pilot study, we randomly selected 40 households, and also asked about their existing experience with the GTGP: whether and how much land was enrolled, what concerns (if any) they had, and perceived impact on their livelihoods. We first tested various levels of payment amount and program length. Starting with a payment level that had been determined based on the existing policy (Table 1), we asked whether they would continue participation (or commence if not involved before) instead of switching land back to farmland at various future hypothetical payment levels. If the level was so high that over 50% would say yes, we lowered the level; otherwise we raised the level. Our aim was to identify roughly three payment levels (from high to low) such that approximately 75%, 50%, and 25% of the respondents would choose to participate in GTGP at each level. It turned out that the three levels of 300 yuan/mu/year, 200 yuan/mu/year, and 100 yuan/mu/year would satisfy this aim. In addition, we tested payment length and found the corresponding payment lengths turned out to be 12, 8, and 4 years. This choice set is appropriate for discrete choice modeling under hypothetical conditions regarding these three variables (An et al., 2002; McFadden, 1974). Similarly, land use options for the choice experiment were asked of respondents: leave land fallow, grow economic trees, or grow ecological trees. The first two options (grow economic trees or ecological trees) were based on the GTGP policy implemented at FNNR. Leaving land fallow is officially not allowed in the FNNR, but some households actually did so anyway (or did not continue to plant trees and conduct the related required maintenance). Therefore, we chose leaving land fallow as an alternative in the hypothetical set of land use options.

In conjunction with the three PES policy conditions, we also included three hypothetical conditions under which 25%, 50%, or 75% of their neighbors would agree to enroll land in GTGP, given the likely importance of *impact of neighbors' choice* (or the social norm; see Chen et al., 2009). Therefore, in our main interviews, we prepared four boxes of choice sets: one for three payment levels based on paper slips marked 100, 200, and 300 yuan; one for GTGP length (4, 8, and 12 years), one for land use (grow economic trees, ecological trees, or fallow), and one for hypothetical neighbors' choice (25%, 50%, and 75% of their neighbors choose to participate). Each time before we went out for interviews with the main household sample, we randomly drew a paper slip from each of the four boxes and recorded the four hypothetical outcomes (e.g., 100 yuan, 8 years, to fallow, and 75% neighbors) on the corresponding questionnaire. This draw-and-record operation was repeated three times for each household, so the household would have three chances to make decisions under different hypothetical, "scenario" conditions. For each scenario, we asked each respondent: "Under this combination of hypothetical values, would you be willing to enroll part of your farmland in assumable GTGP?" Each respondent thus participated in three experiments, and within each, the respondent evaluated the combination of four options and stated his/her corresponding preference.

3.3. Statistical model

Lancaster's approach to consumer theory views utility as determined by the *attributes* of the goods rather than the goods per se (Lancaster, 1971). Based on this theory, any stated preference revealed from our household interview questions using discrete choice methods is based on a random utility model (RUM) (McFadden, 1974), a well-established method for quantifying preferences of individuals choosing a product (or service) from a finite set of alternatives. The assumption of the RUM is that a consumer will choose the alternative that yields the highest utility (from An et al., 2002). Our model builds on Lancaster's approach. We will use the RUM to quantify the preferences of individuals choosing from available alternatives assuming that the respondent obtains the highest utility by so doing.

In our case, each individual is presented with three experiments, and each experiment consists of a combination of a randomly chosen payment level, a program length, a land use option, and the neighbors'

choice, as explained earlier. At experiment i (i = 1, 2, 3), individual j (j = 1, 2, …, J) who lives in village k (k = 1, 2, …, K) may have two alternatives in the choice set: (1) enroll part of available land in GTGP, or (2) do not enroll and continue the current land use (farming). In each experiment, households decide to participate if the utility associated with participation (in GTGP) exceeds the forgone opportunity cost of the land withdrawn. Here we assume that the respondents understand fairly well the pros and cons of these two alternatives. For instance, they know that farming could be time-consuming and topographically and physically difficult yet produces grain and vegetables that they can consume or sell, and thus also provides food security. This way they do not need to spend cash income to purchase these goods from local markets. On the other hand, enrolling land in GTGP implies loss of agricultural harvests but offers cash income that they can use to purchase goods or services. Equally—if not more—important is that they would have more time to engage in other activities, such as migration to cities for higher paying jobs, working locally off-farm, or managing or working in a local business (e.g., hotel, restaurant, tour guide).

Based on the pilot survey results, we can reasonably assume that all households in the reserve have access to local markets and related information and are aware of these pros and cons of each alternative. In FNNR, local households sell varying amounts of their farm produce in local markets (e.g., to hotels, restaurants, or tourists), but are not allowed to harvest timber for sale due to FNNR's standing as a national nature reserve. As for other potential land use substitutes such as selling or renting to other people, we exclude them from the choice set here because they are not legally allowed (sale of usufruct land) or not currently practiced (renting land from or to other people) within the reserve.

Given the choice set thus described, we constructed a multilevel discrete choice model that considers random intercepts at experiment, individual (household), and village levels. We used a vector $\boldsymbol{x_i}$ to denote all variables that affect their enrollment decision at experiment, individual/household (the selected household respondent, the head if available; spouse or another adult if not), and village levels: see Table 1. For Alternative 1 (to enroll), denote U_{ijk}^{1} to be the conditional, yet indirect utility derived from experiment i (i = 1, 2, 3) by individual/household j (j = 1,2…J), who lives at village k (k = 1,2…K). We can represent it as the sum of an intercept $(\alpha_i+u_j+u_k)^1$, a deterministic component $\beta\boldsymbol{x_i1}$, and a random error term ε_i^1, where α_i, u_j, and u_k are intercepts that vary at experiment, individual, and village levels, and β represents the fixed effect of all independent variables. Therefore, the model is as follows:

$$U_{iik}^{1} = (\alpha_i+u_j+u_k)^1 + \beta\, \boldsymbol{x}_{ijk}^{1} + \varepsilon_{ijk}^{1} \tag{1}$$

On the other hand, experiment i (i = 1, 2, 3) may obtain a different level of utility if the respondent chooses to engage in alternative 0 (not to enroll):

$$U_{iik}^{0} = (\alpha_i+u_j+u_k)^0 + \beta\, \boldsymbol{x}_{ijk}^{0} + \varepsilon_{ijk}^{0} \tag{2}$$

If the utility associated with alternative 1 is greater than that the respondent derives from alternative 0 (i.e., $U_{ijk}^{1} > U_{ijk}^{0}$), then individual j at experiment i will adopt alternative 1 (i.e., enroll land in GTGP under the hypothetical conditions in our situation).

Let Y_{ijk} be the associated variable indicating individual j's choice at Experiment i about whether or not to enroll land in GTGP (1 for enrollment and 0 for no enrollment), then the probability of enrollment is:

$$\text{Prob. } (Y_{iik} = 1) = \text{Prob. } (U_{ijk}^{1} > U_{ijk}^{0}) = \textit{Prob } (\alpha_i^1 + u_j^1 + u_k^1 + \beta\, \boldsymbol{x}_{ijk}^{1} + \varepsilon_{ijk}^{1} > \alpha_i^0 + u_j^0 + u_k^0 + \beta\, \boldsymbol{x}_{ijk}^{0} + \varepsilon_i^0) = \textit{Prob.}\ [\beta\, (\boldsymbol{x}_{ijk}^{1} - \boldsymbol{x}_{ijk}^{0}) + \alpha_i^1 - \alpha_i^0 + u_j^1 - u_j^0 + u_k^1 - u_k^0 + \varepsilon_{ijk}^{1} - \varepsilon_{ijk}^{0} > 0] \tag{3}$$

where U_{ijk}^{1} and U_{ijk}^{0} are as defined above. Vectors $\boldsymbol{x_i}^1$ and $\boldsymbol{x_i}^0$ represent the hypothetical and current conditions, respectively, in terms of GTGP policy (payment level, length, and the two enrollment land use options). The terms α_i^1 and α_i^0, u_j^1 and u_j^0, and u_k^1 and u_k^0 represent intercepts under these hypothetical and current conditions at experiment, individual (household), and village levels, β is the parameter vector associated with $(\boldsymbol{x}_{ijk}^{1} - \boldsymbol{x}_{ijk}^{0})$.

In addition, we seek to examine the extent to which other non-policy factors, such as demographic variables, farm size, and income (Table 1), can also explain differences in enrollment decisions as control variables, so these types of factors (described by the vector $\boldsymbol{z_{ijk}}$ with an associated parameter vector χ) should also be included in Eq. (3). The common practice in this circumstance is to assume that the error terms are distributed following a type I extreme value, which yields the familiar logit model (McFadden, 1974). In our case, the probabilities take the following form:

$$\textit{Prob}\ (Y_i = 1 \mid \boldsymbol{x_{ijk}}, \boldsymbol{z_{ijk}}, \alpha, uj - u_k, \beta, \chi) = \exp\,[\alpha + uj + u_k + \beta\,(\boldsymbol{x_{ijk}1}-\boldsymbol{x_{ijk}0}) + \chi\, \boldsymbol{z_{ijk}}] \,/\, [1 + \exp(\alpha + uj + u_k + \beta\,(\boldsymbol{x_{ijk}1}-\boldsymbol{x_{ijk}0}) + \chi\, \boldsymbol{z_{ijk}})] = 1/[1 + \exp(-\alpha - \beta\,(\boldsymbol{x_{ijk}1}-\boldsymbol{x_{ijk}0}) - \chi\, \boldsymbol{z_{ijk}})] \tag{4}$$

Note that from Eq. (3), the final variables entering the logit model take the form of differences in variable levels (i.e., the term $(\boldsymbol{x_{ijk}1}-\boldsymbol{x_{ijk}0})$[1]) except the non-policy factors $\boldsymbol{z_{ijk}}$, which we add as control variables, as described above.

The descriptive data (Table 2) reveal some useful information about our surveyed households. The first five variables (GTGP_Pay, GTGP_Span, CashCrop, EcoPlant, and NB_Choice) represent policy and social norm variables; their values are set for experiment purposes (See Household Survey Data). The forest land a certain household is responsible for ranges from 0 to 5000 mu (with a mean of 39.85 and standard deviation of 250.01 mu), bearing big variability across different households. The three demographic variables age, sex, and education have average values of 53.57 years of age, 1.25 (indicating male respondent population is three times larger than that of females), and 4.53 years of education (where 6 years of education indicates graduating from elementary school). The agricultural expenses range from 0.005 to 13.2 (with an average of 0.87) thousand yuan, suggesting big variability in local households' commitment to agriculture. The annual local off-farm income in the last 12 months has even much bigger variability, ranging from 0 to 96 (average 3.69) thousand yuan per household. The households we surveyed range from 1 to 9 persons/household in size (average = 3.09 people/household), and farmland that had not been enrolled in GTGP ranges from 0 to 60 mu (average = 3.53 mu). Compared to forest land (mean = 39.85 mu and standard deviation = 250.01), GTGP land is much smaller in size but compensated with much higher rate (Table 1).

To evaluate if existing participation in FEBC affects the decision to enroll (or enroll more, if already enrolling some) farmland in GTGP, we use the logarithm of the amount of land enrolled in FEBC. We did not use percentage of FEBC land as compensation in FEBC is directly proportional to the amount of forestland enrolled to FEBC (Table 1). This minimizes potential confounding influences of outliers: e.g., one household has 5000 mu of FEBC land (Table 2 and S1). Conceptually, there may be *negative* links between the two PES programs because sizable FEBC compensations may reduce pressures of cash shortages in the household, decreasing pressures to use farm labor to grow crops. A negative relationship was observed in another nature reserve in China (Zhang et al., 2018a, 2018b). Conversely, another pathway is possible: if sufficient income is secured through participating in FEBC, local farmers might increase their interest in participating in GTGP as they would not have to worry as much about farming land for food security since they would already have cash for purchasing part of their food needs.

At the same time, we include seven variables for control purposes:

[1] Existing values (at the time of experiment, or time of interview) for all four GTGP policy variables– GTGP_Pay, GTGP_Span, CashCrop, and EcoPlant– are zero, so the differences between hypothetical and current conditions are equal to the values of these hypothetical variables.

Table 2
Variable definitions and descriptive statistics.

Attributes	Definition	Types of Factors	Mean	Standard deviation	Min	Max	Unit
GTGP_Pay	PES payment levels for the three scenarios (Yuan/mu/year)	PES policy dimensions *(xi)*	0.20	0.08	0.10	0.30	1,000 Yuan
GTGP_Span	PES program duration for the three different scenarios in years		7.85	3.12	4	12	Years
CashCrop *	Would plant economic trees after enrolling in program		0.40	0.49	0	1	
EcoPlant *	Would plant ecological plant after enrolling in program		0.28	0.45	0	1	
NB_Choice	Hypothetical % of neighbors participating in GTGP	Social norm	0.51	0.19	0.25	0.75	25%, 50%, or 75%
FEBCLandArea	Forest land household is responsible for	Concurrent PES variable (*zi*)	39.85	250.01	0	5000	Mu
Age	Age of respondent	Socioeconomic, demographic	53.57	14.09	19	86	Years
Sex	Sex of respondent	controls *(zi)*	1.25	0.43	1 (M)	2 (F)	
Edu	Education of respondent		4.53	3.56	0	14	Years
Yr_ag_exp	Agricultural expenses last 12 months		0.87	0.93	0.005	13.2	1,000 Yuan/ Year
localOffFarmInc	Local off-farm income (sum of remittances from prior out-migrants, off-farm local employment, and local business income), last 12 months		3.69	9.87	0	96	1,000 Yuan/ Year
HH_size	Household size		3.09	1.58	1	9	People
Non_GTGP_Land	Amount of household land not enrolled in GTGP		3.53	5.08	0	60	mu

*Fallow as reference.
Note: Variables are chosen to reflect theoretical perspectives about driving forces in the PES decision-making literature, but also to avoid multicollinearity (the variance inflation factor VIF for each variable in this table is less than 1.50.

1) demographic variables: age, gender, and education level of the respondent, presuming that being younger, male, or more educated would make it easier for the person to find off-farm work and thus achieve more potential benefits associated with participating in GTGP (Chen et al., 2012; Liang et al., 2012; Zhang et al., 2018a, 2018b); and 2) income or household asset variables: household size, agriculture expenses per year, total off-farm income, and area of land not currently enrolled in GTGP (Wunder, 2008; Zbinden and Lee, 2005). Household size is a reasonable proxy for labor available for livelihood activities, since the one-child policy in China had led most couples to have only one child in the decades prior to the survey date (Lugauer et al., 2013). Local off-farm income, in many instances, accounts for a major source of rural household income, in China as well as in most developing countries nowadays (Anderson and Leiserson, 1980; Barrett et al., 2001). In addition, agricultural expenses are typically the highest expenses among households in rural China (Wang et al., 2006). Therefore, we used both agriculture expenses per year (Yr_ag_exp; Table 2) and local off-farm income (localOffFarmInc) as proxies, the first representing farm income from existing farm operations, and the two together tending to capture overall income. Both could affect participation negatively and positively, respectively, and hence should be controlled for. The area of land not currently enrolled in GTGP is evidently a measure of available land supply, which is important for households with concerns about food security. In the aforementioned hypothetical choice experiments, respondents with more land will be more disposed to say yes to GTGP participation since they would be more likely to still have other farmland remaining to farm. We also examine the results for two different datasets: one based on only the households that participated in GTGP and one also including those that did not, to examine the impact of past experience in GTGP on future participation.

All these variables comprise the "socioeconomic-demographic control" dimension in Tables 2 and 3. There is abundant literature about the impacts of most of these variables, as shown in references, except for agriculture expenses per year. Agriculture expenses represent the level of engagement in farming, the traditional livelihood strategy in FNNR (as well as throughout rural China), which in a sense indicates the importance of farming for the household livelihood. Expenses are also easier to collect and more accurate than agricultural (farm) income as most households have a better memory about how much they spend than the total production of harvested products, including not only what they sell (which they tend to know), but also what they consumethemselves, feed to their animals, or give to others.

We build and compare two models: The first model includes all variables in the four categories of PES policy dimensions, including the social norm, concurrent PES variables, and socioeconomic/

Table 3
Model results for determinants of new GTGP participation.

		Full model		Simplified model	
Category	Variable	Estimate	Pr > |t|	Estimate	Pr > |t|
	Intercept	−0.6409	0.5023	−0.9623	0.0104
PES policy dimensions *(xi)*	GTGP_Pay	3.7826	< .0001	3.2808	< .0001
	GTGP_Span	−0.0057	0.8186	−0.0104	0.6519
	CashCrop*	0.3313	0.0619	0.3003	0.0652
	EcoPlant*	0.1516	0.4317	0.1619	0.3610
Perceived social norm	NB_Choice	1.5083	0.0003	1.5871	< .0001
Concurrent PES variables (*zi*)	FEBCLandArea	−0.1298	0.0837	−1.75	0.0802
Socioeconomic, demographic controls *(zi)*	Age	0.0197	0.0365	N/A	N/A
	Sex	−0.4975	0.1296	N/A	N/A
	Edu	−0.0892	0.0097	N/A	N/A
	Yr_ag_exp	−0.4133	0.0045	N/A	N/A
	localOffFarmInc	0.0184	0.1202	N/A	N/A
	HH_size	−0.1450	0.0788	N/A	N/A
	Non_GTGP_Land	0.0693	0.0273	N/A	N/A

* Fallow as reference.

demographic control factors. This is the full model. Then we build a simplified or reduced model that only includes PES policy dimensions, the social norm, and concurrent PES variables. This simplified model shows whether the impacts of the variables of interest (PES policy dimensions, the social norm, and concurrent PES variables) change when socioeconomic/demographic control variables are dropped. This is based on the partial correlation literature, which states that certain significant relationships may exist when another control variable is included; if this control variable is removed, these relationships may turn to be insignificant (Baba et al., 2004). Here we aim to examine whether and how much the impacts of the policy variables reflected in land use options and concurrent PES variable options change when socioeconomic and demographic control variables are included.

4. Results

4.1. Household characteristics

Out of the 605 households we interviewed following the oversampling strategy mentioned above, 353 (58%) were participating in GTGP. The 605 households had a total of 3474 mu farmland, out of which 1339 mu (39%) were enrolled in GTGP and 2135 mu (61%) were still in cultivation (more information in Table S2 of Appendix). Out of the 605 households we were able to perform 968 experiments (mostly due to missing data for some independent variables; occasionally households were disqualified because they had no land available while a few others declined to answer the hypothetical questions), where the answer was 1 (agreed to participate) in 556 experiments and 0 (declined to participate) in 412 experiments. According to separate regression results based on the two datasets (one containing households that participated in GTGP and one containing those that did not), the potential impacts of past experience are insignificant (Appendix 4, Table S3). We also built a model with a binary variable representing whether or not participating in GTGP prior to our survey as a control variable, and found it is also insignificant (Appendix 5, Table S4). Therefore, we did not include GTGP past experience in the full model. The full model has the random effect intercept significant at the household level ($z = 4.19$, $p < 0.0001$), but not at the village level ($z = 0.66$, $p = 0.25$), which is not surprising as the villages are in the same geographic region and have similar infrastructure and bio-social conditions. The simplified model shows a similar pattern for random intercepts, being significant at the household level ($z = 4.86$, $p < 0.0001$), but not at the village level ($z = 1.10$, $p = 0.13$). We discuss the results of the full model first, focusing on policy variables and latent preferences, then the socio-economic and demographic "control" variables; and then finally, look at the differences when the control variables are dropped and only the simplified model is estimated.

4.2. PES policy dimensions

Among the GTGP policy variables, both the payment level (GTGP_Pay) and expectations about neighbors' inclination to enroll or not (NB_Choice) had very strong positive influences on the enrollment decision ($p = < 0.0001$ and 0.0003, respectively), while duration of enrollment (GTGP_Span) had no effect ($p = 0.8186$). We found that the effects of the three policy variables on GTGP participation to be consistent with a previous study analyzing the same variables in terms of GTGP *re-enrollment* in a different study area (Chen et al., 2009).

Additionally, given the three hypothetical choices of land use options for land parcels not yet enrolled in GTGP, villagers were more likely to participate in GTGP if they were allowed to use the enrolled parcel to plant something that would provide income very soon, such as tea, herbs or nut trees (coefficient = 0.3313, $p = 0.0619$), versus only ecological trees that take many years to produce monetizable timber or fuelwood. The option for ecological service plants (EcoPlant) has an insignificant coefficient ($p = 0.4317$), suggesting that this choice has no impact on local villagers' decisions concerning whether to enroll in the program or not at all, and is thus indistinguishable from just fallowing the land. Thus, using the land to grow income-earning trees is clearly the most attractive land use option.

4.3. Concurrent PES variables

Interestingly, we found a tradeoff between the two PES programs within the FNNR at the $\alpha = 0.10$ significance level: the amount of land enrolled in FEBC (and hence a proxy of the existing payment/income) significantly affected the landowner's decision to participate (or participate further, if already participating) in GTGP (coefficient = -0.1298, $p = 0.084$). In other words, *the more FEBC land, the less likely the household would enroll available farmland in GTGP*. We also did a partial correlation analysis between one (out of three for each household) randomly chosen GTGP choice and FEBC land area with confounding variables (i.e., GTGP payment level, GTGP time span, GTGP land use for economic trees, GTGP land use for ecological plants, and income from off-farm work, business or remittances from migrants) as control variables. The partial correlation coefficient was -0.1211 ($p = 0.0996$), which confirmed this negative relationship.

4.4. Socioeconomic, demographic control variables

The reduced model, which did not contain the socioeconomic demographic control variables, is consistent with the full model that includes all the control variables. Among the three demographic variables, education has a strong *negative* impact on enrollment (coefficient = -0.089, $p = 0.0097$). In addition, age has a strong positive impact (coefficient = 0.0197, $p = 0.0365$), implying the older the respondent, the more likely to participate in GTGP. The third demographic variable, gender, did not show a significant effect on the enrollment decision.

Higher agricultural expenses per year (Yr_ag_exp) (coefficient = -0.4133, $p = 0.0045$) has a strong effect on decreasing the likelihood of participation in GTGP, while the area of land not enrolled in GTGP (Non_GTGP_Land) (coefficient = 0.06926, $p = 0.0273$) also has a big effect on increasing the likelihood of participation, as expected. Meanwhile, household size (HH_size) (coefficient = -0.1450, $p = 0.0788$) has a marginally significant negative effect, which may reflect labor competition between GTGP and other activities such as local off-farm work. Local off-farm income (localOffFarmInc) proved to not be statistically significant in influencing villagers' choices to participate in GTGP.

5. Discussion

5.1. The roles of socioeconomic, demographic control variables

In regard to the control variables (Table 1), there is a bit of evidence from the literature (e.g., Chen et al., 2009) that confirms our findings regarding the impact of age on villagers' decision to enroll land into GTGP. Gender is insignificant ($p = 0.1296$) in our study, however, the significance of gender in PES participation varies among studies and countries (Chen et al., 2009; Kaczan and Swallow, 2013; Meemken et al., 2017; Stevens et al., 1999). A similar study in China (Chen et al., 2009) interestingly found the effect of gender marginally significant ($0.5 < p < 0.10$) as a predictor of enrollment, indicating that males are slightly less likely to enroll. This difference may arise from temporal or geographic contexts. For instance, our data were collected eight years later than those in Chen et al. (2009), during which time continuing changes about the roles of females in livelihood activities in China may have taken place. In addition, other PES studies found educational attainment to be either insignificant (Arifin et al., 2009; Chen et al., 2009; Vorlaufer et al., 2016) or positive contributors to PES

enrollment (Chen et al., 2017; Wunscher et al., 2011), while we found it to be a significant deterrent to PES enrollment. In some situations, higher education levels lead to more informed decision-making regarding the importance of conservation practices long-term (Chen et al., 2017; Wunscher et al., 2011). Our findings were likely the result of higher education levels of the head of household leading to more out-migration and/or higher engagement in off-farm jobs (Uchida et al., 2009). Thus, there is a small but weak positive association of off-farm work of households with likelihood of participating in GTGP.

Farm expenses are among the top household expenses in rural China (Wang et al., 2006) and are negatively linked to GTGP enrollment in our study (Yr_ag_exp). As mentioned earlier, farm expenses stand as an indicator of local villagers' dedication to the traditional, subsistence-oriented lifestyle. Therefore, if a household devotes a substantial amount of money for inputs to farming, it may not have much motivation to give up farmland to enroll it in GTGP. Interestingly, farm expenses do not have a particularly high correlation ($r = 0.34$) with the amount of available land not already enrolled in GTGP (Non_-GTGP_Land), suggesting that "surplus" land exists that is not fully cultivated, or that expenses in a year are not well measured or not a reliable measure of long-term expenses for crop growing. In comparison, the amount of land not enrolled in GTGP is positively linked to the likelihood of participation as it offers villagers more land use options (i.e., some for growing economic trees outside GTGP) and reduces the risk involved in withdrawing some land from crops due to (further) enrollment in GTGP (Wunscher et al., 2011; Zbinden and Lee, 2005).

5.2. The impact of concurrent PES programs

Very little research on concurrent PES programs currently exists, leading us to test how PES programs may inter-relate with one another. As previously noted, GTGP and FEBC apply to two totally disparate classifications or types of land (i.e., farmland and forestland), so there is no substitutability nor direct connection between the two programs. In our context, if landowners enroll in more than one PES program at the same time, they may have to prioritize their resources (time, money, labor) to focus on one PES program while downplaying the other. We found that the log of land area enrolled in FEBC in the FNNR study area significantly reduces the landowners' likelihood to enroll available land in GTGP. This might imply that landowners are less likely to enroll in an additional PES program.

In Section "The Statistical Model", we presented two alternative, yet opposite relationships between FEBC and GTGP participation: a positive one (one reinforcing the other) and a negative one (one weakening the other). Our results corroborated the negative one: more FEBC land leads to less GTGP participation. One possible pathway is through the role of increased cash: sizeable payments from the FEBC program increase the amount of cash local households possess, making them less dependent on cash from the GTGP program (Zhang et al., 2018a, 2018b). We also acknowledge that there might exist other pathways for this negative relationship—for instance, local farmers may spend time patrolling their FEBC land to assure no fires or timber thefts on their FEBC land, which is of particular importance given FNNR's standing as a national nature reserve.

Though few studies address the opportunity costs associated with participating in more than one PES program, there are studies that discuss opportunity costs associated with participating in a single PES program (Layton and Siikamäki, 2009; Sarkissian et al., 2017; Wunscher et al., 2011; Yin et al., 2014). If opportunity costs associated with participating in additional PES programs could be calculated, we might be able to quantitatively determine if there are competing or benefiting relationships between concurrent PES programs in a particular pairing of PES programs, if not in general, and perhaps also if in fact the relationships are contextually determined. Identifying if tradeoffs exist between PES programs is a new frontier for PES studies, and one which is needed given the increasing prevalence of programs and the increasing likelihood of overlapping programs. If there were complementarity effects among program goals, that would be serendipitous indeed. But in many instances, one policy is subverting the goal of the other, calling for reevaluations of the two policies and a policy determination of what goals are most important to achieve, and whether one of the policies should be eliminated or at least modified to reduce the tradeoff.

5.3. PES policy dimensions

Our conclusion that higher payment rates leads to higher likelihood of enrollment is consistent with previous findings (Balderas Torres et al., 2013; Chen et al., 2009, 2018; Nordén, 2014; Uchida et al., 2009; Vorlaufer et al., 2016), and is not surprising. Our results also show that fallowing the land or planting ecological trees (ones yielding high ecological services, yet slow-growing, such as Dove trees) are not viewed as desirable. Yet the option to instead plant economic trees (income-earning plants) is an important inducement to participation in GTGP (Chen et al., 2017). This is likely so because landowners are hesitant to convert lands that have been customarily annual crops to long-gestation trees due to the high opportunity costs linked to their short time horizons mentioned above (Balderas Torres et al., 2013). The cost benefit analysis landowners may contemplate when considering participation in GTGP involves precisely this tradeoff between the value of crops given up by withdrawing land from use in crops vs. the income-earning payment to be received at the end of the calendar year plus the value of additional income that is earned in future years by shifting the labor from the cropland to some other economic activities. GTGP payments only contribute a small portion of household income, which is usually far smaller than the net revenue generated from growing economic trees on the same land (Liu et al., 2008). Therefore, unless GTGP also stimulates changes in livelihoods that yield higher incomes (as found in Anhui province of China by Zhang et al. (2000), via out-migration leading to remittances or local off-farm work), villagers may resist contributing more of their available farmland to GTGP (Bremer et al., 2014). So, the question is, are farm households stimulated to reallocate labor to such other pursuits or not?

Finally, regarding "neighbor" effects—as in other studies (Bremer et al., 2014; Chen et al., 2009, 2012)—we find that neighbors' decisions to enroll land in GTGP have a strong positive impact on respondents' GTGP participation. Thus, if a high percentage of neighbors enroll in GTGP, other, wavering villagers are more likely to enroll in GTGP as well in order to adhere to social norms created by the majority. In our research, we find that simply believing that neighbors are likely to enroll has a strong effect on the latent decision to enroll. Insights on the relevance of community norms on PES participation are thus valuable for practitioners preparing to implement a PES program because it can lead to policies to stimulate such attitudes even before the policy is rolled out, improving acceptance from the outset as well as adherence to requirements.

6. Conclusions

By analyzing three main components of GTGP participation, our research suggests that PES policy, concurrent PES programs, and a number of demographic and socioeconomic factors all influence household decisions to participate in GTGP. Most notably, our results indicate a competitive interrelationship between the two concurrent PES programs studied here, a negative effect of participation in the forest maintenance program, FEBC, on participation in the reforestation program, GTGP.

Since there is little research addressing the net result of stacking two or more PES programs, it would be inappropriate to generalize from our case study and assume any general (competitive/tradeoff, reinforcing, or independent) relationship between stacked PES programs. The speculations that emerge from our study present opportunities for

further research focusing on the effect of concurrent PES programs on participation in each PES of interest. As discussed here, evaluating opportunity costs associated with participation in multiple PES programs is an important step in PES analysis as more and more PES programs come online.

This study has provided insight on land use options upon enrolling in a PES program that the literature has seldom previously provided. While we found that the ability to replace the usual farm crops with plants that produce income quickly, such as tea and herbs (likely the least ecologically beneficial land use options) was most preferred by landowners and most likely to lead them to enroll in GTGP, we did not introduce other new land use options that might be more preferable than current options. In any case, our results show that there is a clear distinction in underlying preferences between land use options for replacing cropland, so research should seek other land use options that might attract individuals to PES programs while still improving the environment. Also in the future, it may be useful to include variables in the determinants of participation model that measure or control for fluctuations in agricultural conditions in the study region (e.g., precipitation, flooding or drought frequency) since participation in PES provides a secure income that can reduce uncertainty due to such fluctuations.

Our research makes several contributions to the PES literature. First, discovering and acknowledging the impacts of concurrent PES programs on individuals' decisions to participate in PES programs. This is important in several ways. Primarily, it encourages PES programs to consider modifying the policy details and rules accordingly in order to better progress towards conservation goals. Thus, PES planners and policy-implementers should heed local, latent, or hidden considerations that are likely to vary spatially and contextually because compliant participants are the backbone for successful PES programs. Our results are derived according to data from the first two phases of GTGP and thus provide an opportunity to modify the third phase of GTGP currently being implemented. Second, detecting and quantifying such latent/hidden factors underlying enrollment can lead to more effective use of conservation funds to achieve environmental goals as well as better benefit local peoples economically. For instance, planners may choose households and villages for the GTGP program that do not have large amounts of forest land and do not receive large FEBC payments. Similarly, before policy implementation, PES managers should further examine land use options, and employ those that are simultaneously more desirable for villagers due to potential economic gains and those that provide high levels of ecological benefits. By utilizing such knowledge about landholders' enrollment preferences, PES managers can incorporate ecological knowledge of the area, maximizing PES success in providing ecosystem services and without compromising villagers' incomes.

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Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:https://doi.org/10.1016/j.ecolecon.2019.106509.

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