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# Normative, livelihood, and demographic influences on enrollment in a payment for ecosystem services program

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ABSTRACT

Payment for ecosystem services (PES) has emerged as a leading conservation mechanism worldwide, and its success depends largely on landholders' willingness to enroll in and comply with these programs. Researchers have suggested program duration and perceived social norms may influence enrollment, but empirical evidence is sparse. There is also conflict over the influence of other socioeconomic, demographic, and farm characteristics. This study, based in Fanjingshan National Nature Reserve in southwestern China, uses a choice experiment and mixed-effects model to quantify how payment level, duration of program, social norms, and demographic and economic factors affect farmers' willingness to enroll in a PES program. Results suggest higher neighbor participation increases willingness to enroll, as does higher payment level, but contract duration does not. Other factors associated with higher enrollment include being allowed to plant economically productive trees, having lower educational attainment, having local off-farm work, owning no livestock, and not having lived in one's current neighborhood since birth. These results suggest PES implementers may improve enrollment by targeting households with these conducive characteristics and by utilizing tree species with sellable products like tea and herbs. Moreover, results suggest implementers may improve enrollment by emphasizing neighbors' enrollment while recruiting new participants, thereby capitalizing on perceived social norms.

## 1. Introduction

Since the turn of the millennium, much of the discourse on environmental conservation has turned toward the "ecosystem services" framework, which emphasizes the importance of ecological processes to human survival and quality of life (Millennium Ecosystem Assessment, 2005). The concept of ecosystem services as economic assets has been embraced by many local and national governments (Daily et al. 2009) and NGOs around the world (Milder et al. 2010), which have come to see environmental protection as more than a moral inclination, but as an economic and humanitarian imperative. It is estimated we lose between $4 trillion and $20 trillion worth of ecosystem services each year as a result of environmental degradation (Costanza et al. 2014), and these losses may largely be attributed to economic externalities that go uncorrected in the free market (Kremen and Miles, 2012). Given the non-excludability of many critical ecosystem services, conserving them requires collective action, often through representative institutions (e.g. governments or NGOs) (Farley and Costanza, 2010). One policy mechanism by which institutions have aimed to preserve ecosystem services is through "payment for ecosystem services" (PES), wherein landholders receive financial or in-kind incentives for managing their land in ways that promote ecosystem service production (Engel et al. 2008). PES is rooted in straightforward economic theory, wherein a willing buyer (i.e. society, often represented by a government or NGO (Engel et al. 2008)) purchases ecosystem services from a willing seller (i.e. landholder) (Ferraro and Kiss, 2002). Rather than imposing strict environmental regulations, which can put substantial economic burdens on local communities and make such programs unsustainable over long term (James et al. 1999), PES sets up a "market" for ecosystem services. In addition to payments, landholders may also be inclined to enroll to manage economic risk, adapt to changing household labor availability, or diversify income (Milder et al. 2010).

Opportunity cost is inherently a leading factor in landholders' willingness to enroll. For landholders to experience net financial benefits, PES payments must exceed what they expect to earn from keeping the land under an alternative use now and in the future (Wunder, 2005).

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Still, economic considerations that affect enrollment can go beyond the simple subtraction of opportunity cost from payment level. Household composition and labor availability can play a role (Zbinden and Lee, 2005); for example, some studies (Chen et al. 2012; Chen et al. 2009a; Zanella et al. 2014) have found households with more people (i.e. potential on-farm laborers) living in the home are less likely to participate, although others have found no significant relationship between household size and participation (Gauvin et al. 2010). Along these lines, age of household head may also influence enrollment through labor availability. Chen et al. (2009b) found households headed by older adults were less likely to reconvert PES land to cropland, likely because older adults were less apt to assume the heavy labor required to reestablish and cultivate cropland, which may bode well for their willingness to enroll in the first place. Older farmers may be drawn to PES as a way to scale down production as they near retirement, although their age may make them more risk-averse and more reluctant to sign onto an unfamiliar government program. Meanwhile a young, less-established landholder may feel greater pressure for short-term revenue, making the long-term restrictions of PES less attractive (Zbinden and Lee, 2005). Existing agricultural assets may also play a role. Those with larger holdings may be able to enroll some land in PES while leaving a satisfactory amount in cultivation, or because those with more land to enroll stand to collect more in total payments to justify the effort and risk of initial signup. Meanwhile livestock may complicate the decision to enroll through its space and capital requirements and potentially lucrative returns.

Another economic influence on PES enrollment is off-farm income; some studies have demonstrated households with off-farm income are more likely to participate (Chen et al. 2012; Zbinden and Lee, 2005), perhaps because they are already less dependent on cultivation. This may even have a compounding effect as farmers who enroll often pursue new off-farm jobs because PES frees up time once used for cultivation (Zbinden and Lee 2005), and several studies have supported a causal relationship from PES to participation in the off-farm labor market (Uchida et al. 2009; Yin et al. 2014). Because PES generally has low labor requirements compared to other income-generating activities, it may be considered a supplement rather than a substitute for the household's existing activities, allowing households to maintain both income streams simultaneously. However, a few studies have shown a negative effect of off-farm income on enrollment (Layton and Siikamaki, 2009; Arriagada et al. 2009), perhaps because those with off-farm income are less in need of payments or are unable to commit enough time to PES (Arriagada et al., 2014). To this end, Uchida et al. (2009) suggest wealthier and poorer households may experience opposite relationships between PES enrollment and off-farm income, where wealthier households receiving PES payments are less likely to work off-farm because it is no longer necessary, while poorer households seize the free time and financial liquidity to pursue more off-farm work. While these authors investigated causation from PES enrollment to off-farm work while we explore the opposite, it stands to reason that poorer households would be more motivated to supplement off-farm income with PES payments than their wealthier counterparts. In addition to the uncertain influence of off-farm income itself, its effect may differ by type of work, whether local agricultural or nonagricultural wage work, small-scale entrepreneurship, or migrant labor in cities. Some studies have found PES encourages off-farm employment (Yin et al. 2014; Uchida et al. 2009). Meanwhile payments may allow for increased migrant work by providing funds for transportation (Adamo and Izazola, 2010). While some researchers theorize PES may encourage entrepreneurial activity in general, evidence is thus far weak; Bremer et al. (2014) found evidence that PES in Ecuador encouraged ecotourism enterprising, but Zhang et al. (2019) found no such evidence in China.

PES enrollment is also influenced by factors separate from the economics of opportunity cost and labor allocation. One motivator that is yet understudied is social norms, or "shared understandings about actions that are obligatory, permitted, or forbidden" (Ostrom, 2000, p. 143). Social norms can act as a form of environmental governance (Guerry et al., 2015) by producing a sense of guilt if violated (Ostrom, 2000) and upholding an informal system of "peer sanctions and rewards" (Narloch et al. 2012, p. 2098). The importance of social norms is espoused in bedrock theories of behavior; the Theory of Planned Behavior (Ajzen, 1991) asserts that perceived social norms, when combined with a positive attitude toward the behavior and the belief the behavior is doable, is highly predictive of action. Meanwhile, the affect heuristic, or a person's rapid judgment that a behavior is "good" or "bad" (Slovic et al. 2007), is affected by social norms; an action that is more common will be judged more positively and more quickly at the individual level (Lindström et al., 2018). Although it is well-documented that social norms influence small, routine environmental behaviors (Cialdini, 2003; Cialdini and Goldstein, 2004; Stern, 2000) and community management of common-pool resources (Ostrom et al. 1999), it is less understood how they influence the high-commitment, financially incentivized, and economically private decision to enroll in PES. The distinction is worth investigating because PES functions like a pseudo-commodities market (Gómez-Baggethun et al., 2010), which, on the surface, may overshadow the influence of social norms and other noneconomic factors. However, research has shown farmers' land management decisions depend largely on norms and attitudes even when substantial incentives are offered (Ahnström et al., 2009), and landholders whose management decisions differ from their neighbors' may experience social pressure to change (Chen et al. 2009b). This has led some authors to theorize that social norms may affect PES enrollment (Kosoy and Corbera, 2010), although so far only a few have demonstrated this empirically (Grillos, 2017; Chen et al. 2009b; Yost et al. 2020).

Despite limited quantitative evidence, there is a growing qualitative discussion of how the external, incentive-based nature of PES interacts with and affects normative motivations toward conservation. Some authors caution that incentive payments may undermine existing pro-environmental norms because explicit payments to individual landholders may shift the "locus of responsibility" for environmental protection to those explicitly receiving compensation, degrading any preexisting ethical or communal motivations (Van Hecken and Bastiaensen, 2010). Further, the PES market may engender competition among neighbors that impedes collective action for the environment (Narloch et al. 2012). On the other hand, a market-based system may also encourage interaction among neighbors, facilitating social learning, encouraging pro-environmental social norms to develop, and benefiting environmental protection over long-term, and if people generally understand PES contributes to the common good, social norms may evolve to encourage participation (Narloch et al. 2012). Pattanayak et al. (2010) offer a compromise position between PES's potential to undermine or encourage pro-environmental norms. They suggest community norms, markets, and government have "complementary roles" in environmental protection, and PES may help close the gap between what is privately optimal (i.e. the landholder's economic interest) and what is socially optimal. Given the complex relationships among normative, regulatory, and economic factors of farmers' land management decisions, it is yet unclear how strong or direct any relationship between social norms and PES enrollment is.

China's Grain to Green Program (GTGP) presents a valuable opportunity to research farmers' motivations for enrolling their cropland in PES, from both economic and other perspectives. Established in 1999, GTGP is among the world's largest PES programs in terms of financial commitment, geographical expanse, number of people impacted, and duration (Li et al. 2011; Liang et al. 2012). Other names for this program include the Sloping Land Conversion Program, Grain for Green Program (GFGP) and Tuìgēnghuánlín. GTGP targets steeply sloping land and compensates farmers with a flat per-hectare payment of grain or cash (based on whether the region lies in the Yangtze or Yellow River basin), plus a one-time subsidy for seeds/seedlings and other planting expenses (Liu et al. 2008). Most enrollees are poor farmers in mountainous areas

(Li et al. 2011; Uchida et al. 2007), where the government hopes to reduce the long-standing practice of cultivating steeply sloping, erosion-prone land (Uchida et al. 2005) and strengthen and diversify the economic structure of agrarian China (Liang et al. 2012). GTGP helps accomplish these socioeconomic goals by transferring state money into rural communities and providing a guaranteed income stream, which may free many enrollees from cultivation and help them enter nonagricultural sectors.

In addition to the relatively passive approach of asking who will participate in PES and why, we may also ask how to design more appealing PES programs in which more landholders are willing to enroll. Two fundamental variables in a PES contract are (1) payment level and (2) contract duration. In prior choice experiments, wherein, landholders are asked whether they would enroll in PES under given conditions, higher payments consistently led to higher willingness to enroll (Fletcher et al. 2009; Chen et al. 2012; Torres et al. 2013; Layton and Siikamaki, 2009). Studies that test preferred contract duration, however, have shown mixed results. A few have found landholders preferred shorter contract periods (Markowski-Lindsay et al. 2011; Torres et al. 2013), but Fletcher et al. (2009) found their subjects preferred longer time commitments. Understanding the sensitivity of enrollment to contract duration will help program designers optimize enrollment and improve landholder satisfaction, which may allow them to allocate funds more efficiently by lowering recruitment costs and avoiding the need for higher payments to make up for suboptimal commitment periods. Another little-studied parameter is how land is to be used after PES contracts end. If post-enrolled land is to be left abandoned or limited to "ecological forest" (i.e. tree species selected mainly for ecological benefit, often Japanese fir), the program may be less appealing than if the land was put under "economic forest," which allows landholders to harvest sellable products such as tea or Chinese medicinal herbs.

Enrollment in PES can also vary considerably by demographic factors. The role of gender is yet uncertain; prior research on GTGP has suggested men hold more positive attitudes toward the program (Hu et al. 2006), but other research has shown women are more likely to reenroll after the initial contract period (Chen et al. 2009a), perhaps because female-headed households are missing an adult male laborer who would have facilitated farm work. This may be because female-headed households are often those wherein the primary male adult has migrated (Zhang et al., 2018) or passed away, perhaps creating a labor shortage within the household and making the less labor-intensive option (i.e. PES) more attractive, especially when the household has a larger area to manage. Older respondents may also be more likely to enroll and remain in GTGP likely due to declining physical abilities amid the manual labor cultivation demands (Chen et al. 2010; Chen et al. 2009a). Along these lines, household size may affect enrollment through labor availability. Chen et al. (2009a) found households with more laborers were more likely to reconvert GTGP lands to agriculture after the initial contract period because these households can more easily meet the increased labor demand to transition from GTGP management to cultivation. Household size may also be indicative of a family's life stage and age of the household head; those with fewer members may be "empty nests" in which household heads are nearing retirement (Lambert et al., 2012) or where parents are raising a young child(ren). It thus stands to reason that larger households are more likely to enroll in GTGP. Another reason may be that larger households received more land during the time of implementing household responsibility contract system in the early 1980s (Krusekopf, 2002), making them more likely to enroll in PES.

Farm characteristics can also be influential. Those with larger holdings may be able to enroll some land in PES while leaving a satisfactory amount in cultivation, or those with more land to enroll stand to collect more in total payments to justify the effort and risk of initial signup. Livestock ownership, a well-established challenge in environmental conservation, may also be influential as its lucrativeness and space requirements are a notorious driver of deforestation (Steinfeld and Gerber, 2010). Conversely, evidence from the United States' Conservation Reserve Program (CRP) suggests farmers are more likely to reenroll after the initial contract period if they had cattle because they could graze them on CRP lands with adjusted payments (Johnson 1997). GTGP does not explicitly prohibit participants from keeping livestock on converted land, so some landholders may plan to maintain their cattle while earning PES payments from a given parcel.

Off-farm income is another important consideration due to the impacts of financial constraints and livelihood alternatives on enrollment. Households that have relatively stable off-farm income streams may be more willing to give up cultivation for PES because they are less economically dependent on the land and may already have knowledge, skills, and social connections necessary to transition from agricultural work into other sectors. Meanwhile the income from off-farm work could affect enrollment because higher-income households have more financial liquidity to transition further out of agriculture into other sectors (Pagiola et al., 2004; Uchida 2009). Along these lines, education may encourage enrollment if more educated farmers feel more confident in their ability to find off-farm jobs to replace on-farm earnings. Higher educational attainment has also been shown to increase support for GTGP (Hu et al. 2006), which may further increase propensity to enroll. Alternatively, there might exist different pathways that we can test, e.g., less-educated farmers may be more inclined to enroll if they are seeking a more reliable income stream than what they expect to earn from cultivation, and lack of education limits their ability to stabilize or diversify their income in other ways.

This study, conducted at China's Fanjingshan National Nature Reserve, uses a choice experiment to measure landholders' propensity to enroll in PES under different payment levels and contract periods, with special attention to perceived social norms (Yost et al. 2020). It tests the effect of social norms by correlating a landholder's willingness to enroll with the randomly selected percentage of neighbors who would enroll, while also evaluating the influences of various payment levels, contract durations, and household characteristics. Results will demonstrate the influence of perceived social norms on enrollment, providing insight into whether messaging that emphasizes the pervasiveness or popularity of a given PES program will promote further enrollment. Results will also show the sensitivity of enrollment to other variables, especially various payment and duration constraints, to help design more appealing, cost-effective PES programs.

## 2. Methods

### 2.1. Study Area

Fanjingshan National Nature Reserve (N27°44′42″—28°03′11″, W108°34′19″ –108°48′30″) is located in Guizhou Province, southwestern China (Fig. 1), and is considered one of the world's top 25 "biodiversity hotspots" (Morris et al., 2000). Since its establishment in 1978, the reserve has attracted global attention from conservationists. This 419-km$^2$ site is home to about 13,000 people, most of whom are farmers, although some have migrated to cities for manufacturing work or found employment in the area's burgeoning tourism sector (Yost et al. 2020). However, benefits from the economic upturn and access to employment provided by the tourism industry are uneven and concentrated near accessible areas (Aitken and An, 2012). As a mountainous area inhabited primarily by impoverished subsistence farmers, the area has been involved in GTGP since 2000 for eight years (An et al. 2020). Households enrolled in the program receive an average of US$507 per ha between 2000 and 2008, with some variation by year and parcel location. The region's natural vegetation includes evergreen, deciduous, and mixed broadleaf forests, while GTGP has provided for the expansion of pine, Chinese fir, and bamboo. The second round of GTGP contracts began in 2008 for another cycle of eight years.

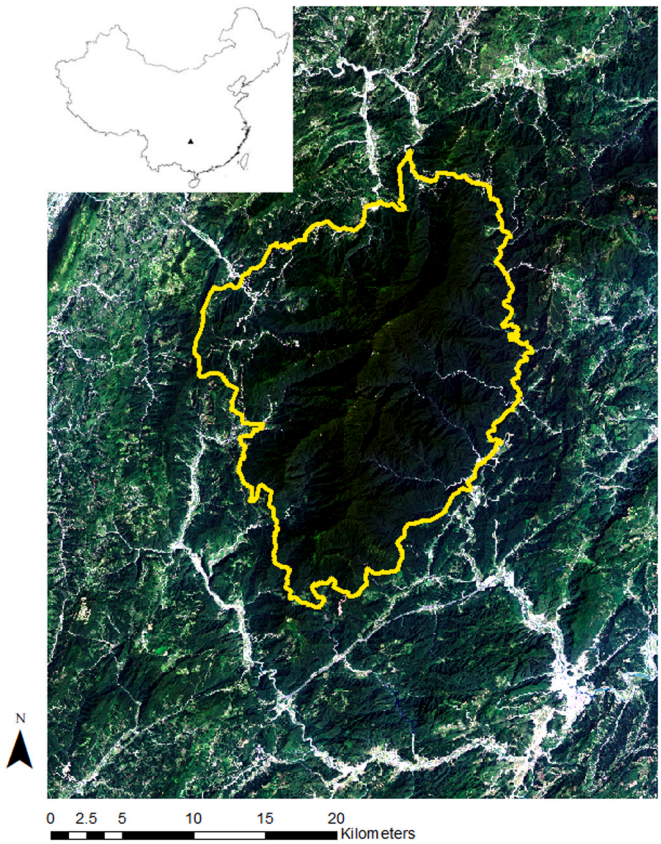


**Fig. 1.** Aerial image of Fanjingshan National Nature Reserve (boundary in yellow) with position in China (top left).

### 2.2. Household Survey

In-person interviews were conducted with households in a stratified random sample. 605 households were interviewed based on a stratified random sampling design (for detail see Yost et al. 2020). The household head (i.e. primary breadwinner) was interviewed when possible; if this person was not available, another respondent (ideally this person's spouse) was selected based on the priority hierarchy in Appendix A. The most common reason the household head was unavailable was that he was working away from the home at the time of the interview, whether locally or as a migrant. In all, 605 household interviews were completed. Respondents answered demographic questions including gender, education, age, duration of residence, household composition, agricultural holdings, and off-farm earnings. Respondents then participated in a choice experiment (Markowski-Lindsay et al. 2011; Layton and Siikamaki, 2009; An et al. 2002) in which they were presented with three different PES contract scenarios. Each scenario was comprised of a randomly selected payment level (242, 484, or 726 USD per ha), contract duration (4, 8, or 12 years), percentage of neighbors who would enroll (25%, 50%, or 75%), and how the parcel would be used post-program (abandoned, ecological forest, and economic forest). Among the post-program land use categories, "abandoned" means the parcel will never be cultivated again; "ecological forest" is the maintenance of trees that do not provide marketable or consumable products, and "economic forest" is the maintenance of trees that provide tea, food, or other products the household could sell or consume. This hypothetical rate of neighbor enrollment served as a proxy for social norms because rate of behavior is the most straightforward, albeit imperfect, measure (Labovitz and Hagedorn, 1973), although we recognize the potential for partial conflation by other motivators like the program's perceived trustworthiness. For each scenario, the respondent was asked whether he or she would be willing to enroll any of their existing cropland plots, to which he or she responded "yes," "no," or "unsure." Although it must be noted that expressing intent to enroll is an imperfect indicator for actual enrollment, intentions are generally effective predictors of behavior (Madden et al. 1992) and are thus deemed a reasonable proxy here.

### 2.3. Data Analysis

Data were grouped by respondent and analyzed with a mixed-effects logistic regression approach to random utility maximization, which helps account for heterogeneity from unobserved variables (McFadden and Train, 2000), especially when one respondent is asked to make a similar choice repeatedly (Revelt and Train, 1998) as these respondents were. The binary dependent variable was whether or not the respondent would be willing to enroll in the given PES scenario, with "yes" coded as 1 and "no" and "do not know" coded as 0. The independent variables included payment level (yuan per mu), contract duration (years), post-enrollment land use option (abandoned, ecological forest, or economic forest), and neighbor participation rate (25%, 50% or 75%). With three options for each of these four variables, and each parameter selected randomly and independently from the others, 81 different scenarios were possible. There were 282 usable respondents with three responses each: 835 responses in all. Due to the discrete, three-level nature of each parameter, they were treated as categorical variables. Analysis also controlled for farm and socioeconomic characteristics that may have impacted propensity to enroll in PES, including area of cropland holdings, livestock ownership, off-farm income, household size, gender, age, and education of the respondent (years), and whether or not the respondent had lived in the neighborhood since birth. Off-farm income was divided into three categories: local wage work, self-employment (i.e. operating a small business or cottage industry), or migrant work. Each was coded as 1 (yes) if at least one member of the household performed that type of work. The primary model for probability of enrollment is specified below. In addition, a separate regression was run for the lowest payment group and the combined moderate and high payment group to shed light on whether the effects of social norms and other factors were consistent among those receiving low, moderate, and high payments. Similarly, we ran separate regressions for households with and without off-farm income streams to illustrate how and why a household's degree of economic dependence on agriculture impacted enrollment. Let p be the willingness to enroll (1 = yes); model specification is as follows:

$$
\begin{aligned}
ln\frac{p}{1-p} = {} & \beta_0 + \beta_1(payment = low) + \beta_2(payment = moderate) + \beta_3(payment = high) + \beta_4(duration = 4yr) + \beta_5(duration = 8yr) + \beta_6(duration = 12yr) \\
& + \beta_7(postuse = fallow) + \beta_8(postuse = ecological\ trees) + \beta_9(postuse = economic\ trees) + \beta_{10}(total\ cropland\ area) + \beta_{11}(female) \\
& + \beta_{12}(education\ years) + \beta_{13}(age) + \beta_{14}(wage\ work\ in\ household) + \beta_{15}(self\ employment\ in\ household) + \beta_{16}(migrant\ in\ household) \\
& + \beta_{17}(lifelong\ resident) + \beta_{18}(household\ size) + \beta_{19}(livestock\ ownership) + \mu + \varepsilon
\end{aligned}
$$

## 3. Results

Across all responses to PES scenarios, 56.9% of responses were "yes," 43.1% were "no" or "unsure." Contract parameters (i.e. payment level and duration), which were randomly selected for each scenario, were approximately evenly distributed. 34.4% of scenarios offered the lowest payment level (242 USD per ha), 34.0% offered the middle payment level (484 USD per ha), and 31.6% offered the highest payment level (726 USD per ha). 33.8% of scenarios were for 4 years, 38.3% for 8 years, and 27.9% for 12 years. Neighbor participation rates were 24.8% at 25%, 44.1% at 50%, and 31.1% at 75%. Sample descriptive statistics are summarized in Table 1. In the primary regression with all payment levels and off-farm work statuses combined, odds of enrollment increased by a factor of 2.34 ($p = 0.014$) when per-ha payment was raised from 242 USD to 484 USD and by a factor of 9.14 ($p = 0.000$) when it was increased to 726 USD. Increasing neighbor participation from 25% to 50% increased odds of enrollment by a factor of 5.66 ($p = 0.000$), and increasing neighbor participation to 75% increased odds of enrollment by a factor of 9.91 ($p = 0.000$). We found no significant effect of contract duration on willingness to enroll. Further, compared to leaving land abandoned post-program, there was no difference in willingness to enroll when land was to be left under ecological trees, but keeping land under economic trees increased odds of enrollment by a factor of 2.49 ($p = 0.013$). Control variables were tested for multicollinearity using variance inflation factors (VIFs) calculated after a placeholder linear regression with the same structure of the logistic regression, separated by scenario number (i.e. whether it was the first, second, or third scenario a respondent was asked about); no VIF exceeded 1.32. Additionally, a correlation matrix among control variables showed the absolute values of all correlation coefficients were less than 0.26, so it was decided multicollinearity was not a major problem for the model. Area of cropland had a marginally positive significant effect (odds increased by factor of 9.01 with a one-ha increase in cropland; $p = 0.058$), while livestock ownership decreased willingness to enroll by a factor of 0.183 ($p = 0.044$). Respondents whose households had local off-farm wage work were also more likely to express intent to enroll (factor of 10.81; $p = 0.005$), although entrepreneurship or migrant work did not. Odds of enrollment increased marginally with age (factor of 1.05 per year; $p = 0.097$) and decreased with education (factor of 0.733 per year; $p = 0.004$). Respondents who had lived in the same neighborhood since birth were considerably less likely to enroll (factor of 0.0680; $p = 0.002$). Household size, and gender showed no significant effect on enrollment. Probability of enrollment by household characteristic with 95% confidence interval is shown in Fig. 2. Odds ratios for all variables' effects on enrollment are illustrated in Fig. 3.

When examining a separate logistic regression by payment group, increasing neighbor participation from 25% to 50% or 75% increased probability of enrollment for the two higher payment levels (484 USD and 726 USD per ha combined), but not at the lowest payment level (242 USD per ha). In the higher payment groups, increasing neighbor participation from 25% to 50% increased odds of enrollment by a factor of 4.16 ($p = 0.004$); increasing neighbor participation to 75% increased odds by a factor of 9.31 ($p = 0.000$). Other variables also displayed disparate effects among payment groups. Specifying economic trees as post-program land use increased odds of enrollment by a factor of 2.75 for the higher payment groups ($p = 0.032$) but not for the low payment group. Cropland area had a marginal positive influence on enrollment for those in the middle and higher payment groups (factor of 7.30; $p = 0.085$) but not significant for the low payment group. Livestock ownership was marginally, negatively correlated with enrollment in the lowest payment group (factor of 0.052; $p = 0.091$) but not significant for the two higher payment groups. Meanwhile the negative effect of education decreased as payment rose; odds decreased by a factor of 0.563 per year when payment was low ($p = 0.030$) and by a factor of 0.780 when payment was moderate or high ($p = 0.016$). Similarly, the significance of local off-farm wages diminished as payment increased; it

**Table 1**
Demographic and scenario sample descriptors.

| Variable | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| Willing to enroll | 0.569 | | | |
| Payment (USD/ha/year) | 478 | 196 | 242 | 727 |
| Duration (years) | 7.77 | 3.13 | 4 | 12 |
| Neighbors (%) | 51.6 | 18.6 | 25 | 75 |
| Off-farm wage work in HH (1 =yes) | 0.228 | | | |
| Self-employment in HH (1 =yes) | 0.150 | | | |
| Migrant in HH (1 =yes) | 0.629 | | | |
| Total cropland area (ha) | 0.413 | 0.291 | 0.017 | 1.53 |
| Female (1 =yes) | 0.228 | | | |
| Age (years) | 53.8 | 12.9 | 21 | 86 |
| Lived here since birth (1 =yes) | 0.788 | | | |
| Livestock (1 =yes) | 0.784 | 0.411 | | |
| Household size | 3.11 | 1.46 | 1 | 9 |

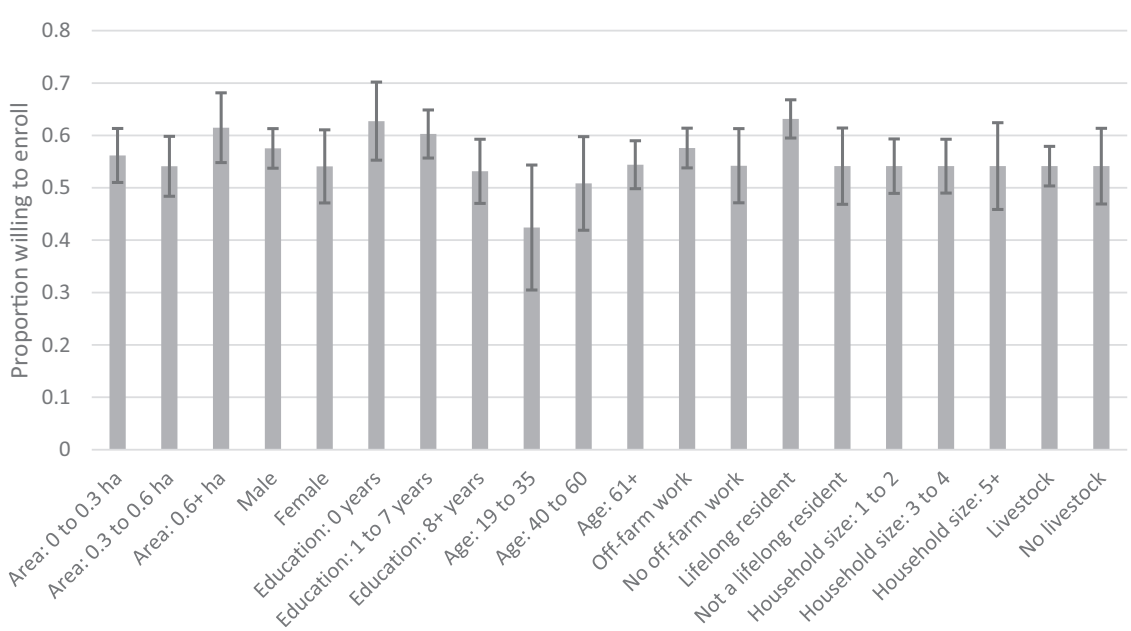


**Fig. 2.** Proportion of households willing to enroll in GTGP by household or respondent characteristic.

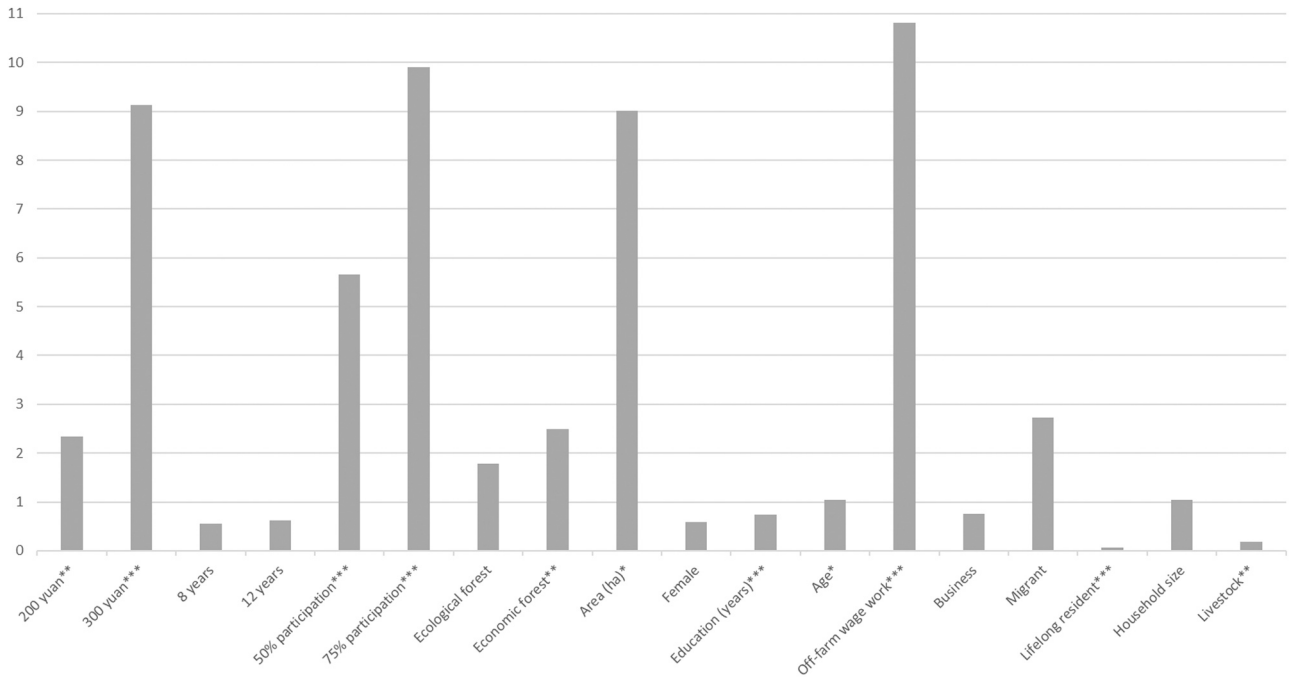


**Fig. 3.** Effect of each variable on odds ratio of enrollment from base condition. *p < 0.10; **p < 0.05; ***p < 0.01.

increased odds of enrollment by a factor of 43.3 when payment was low (p = 0.043) but had a smaller effect when payment was moderate or high (factor of 8.06; p = 0.012). Lifelong residents were less likely to express intent to enroll across all payment levels: by a factor of 0.007 at the lowest payment level (p = 0.014) and a factor of 0.105 at the higher two payment levels (p = 0.006). Contract duration, gender, age, household size, self-employment, and migrant work remained insignificant across all payment levels.

Results also differed between households with and without any type of off-farm income (local wage work, entrepreneurship, or migration) (Table 2). Raising per-ha payment from 242 USD to 484 USD increased odds of participation by a factor of 2.40 (p = 0.028) for households with off-farm income, but showed no significant effect for those without. Similarly, raising payment from 242 to 726 USD increased odds by a factor of 11.7 (p = 0.000) for households with off-farm income, while the effect for those without was smaller (factor of 6.12; p = 0.031). Meanwhile there was a marginal, negative effect of being female on enrollment in households without off-farm income (factor of 0.053; p = 0.076), which was not visible for households with off-farm income. Conversely, the negative effects of lifelong residence (factor of 0.051; p = 0.007) and livestock ownership (factor of 0.109; p = 0.047) were only visible for households with off-farm income. The effects of social norms were similar between the two groups; increasing neighbor participation to 50% marginally increased odds of enrollment by a factor of 4.45 (p = 0.058) for households without off-farm income, and increased odds by a factor of 6.63 (p = 0.000) for those with off-farm income. Increasing neighbor participation to 75% increased odds of participation by a factor of 22.6 (p = 0.005) and 8.17 (p = 0.000) respectively. Contract duration, cropland area, and age were insignificant predictors for both groups.

## 4. Discussion

### 4.1. Contract terms

The positive relationship between intent to enroll in PES and rate of enrollment in the neighborhood offer strong evidence that landholders are more likely to enroll in PES if social norms support the decision. While intentions are imperfect indicators of behavior, they are the fundamental antecedents of behavior (Madden et al. 1992) and are reasonable proxies for actual behavior, especially when beliefs about the behavior are unlikely to change between the time of expressed intention and the time of action (Ajzen et al. 2004). This highlights potential for PES administrators to improve enrollment by communicating existing community participation and support, which may create a positive feedback that further improves normativity and enrollment (Chen et al. 2012). Intuitively, willingness to enroll further increased with payment (Torres et al. 2013; Beharry-Borg et al. 2013; Ma et al. 2012; Chen et al. 2012; Fletcher et al. 2009; Layton and Siikamaki, 2009; Lambert et al., 2012). It also rose when post-program land use was specified as economic trees, but only for the middle and high payment levels. This may be because those willing to accept the lowest payment level are already unconcerned with the opportunity cost of retiring these parcels, perhaps having already retired them. Contract duration, however, was not identified as a significant influence on willingness to enroll in any regression. Wunder and Albán, 2008 point out farmers can escape longer contracts by violating the terms, especially if there is no early withdrawal penalty (Fletcher et al. 2009; Markowski-Lindsay et al. 2011). This may be the case in GTGP, wherein farmers who violate contract terms are not penalized beyond being barred from future funds.

### 4.2. Demographics and livelihood strategies

A few landholder and farm characteristics were also correlated with willingness to enroll in PES. Men were more likely to enroll in GTGP than women, which might be due to their higher propensities to migrate to cities for higher-paying jobs (Zhang et al. 2019). Although we are not aware of any other PES studies with this result, evidence for the role of gender in PES enrollment is yet inconsistent and inconclusive. A few studies that have found no significant effect of gender on PES enrollment (Markowski-Lindsay et al. 2011; Chen et al. 2009a; Chen et al. 2012), although Lambert et al., 2012 found American farms with female operators were more likely to adopt conservation programs. To our knowledge, this is the first study to suggest men are more likely to enroll in PES than women, but it is plausible given evidence that men have more positive attitudes toward GTGP than women do (Hu et al. 2006).

**Table 2**
Odds ratios regression for willingness to enroll in GTGP.

| Variable | All | Low | Moderate-high | No OFI | OFI |
|---|---|---|---|---|---|
| Moderate payment | 2.34** | | | 1.53 | 2.40** |
| | (1.19, 4.61) | | | (0.489, 10.4) | (1.10, 5.25) |
| High payment | 9.14*** | | | 6.12** | 11.7*** |
| | (4.05, 20.6) | | | (1.80, 31.7) | (4.19, 32.5) |
| 8 years | 0.554 | 0.380 | 0.535 | 0.312 | 0.672 |
| | (0.276, 1.41) | (0.0976, 4.81) | (0.203, 1.41) | (0.0546, 1.79) | (0.272, 1.66) |
| 12 years | 0.624 | 0.333 | 0.407 | 0.268 | 0.823 |
| | (0.322, 1.55) | (0.0144, 7.70) | (0.147, 1.13) | (0.0468, 1.53) | (0.314, 2.15) |
| 50% participation | 5.66*** | 6.25 | 4.16*** | 4.45* | 6.63*** |
| | (2.56, 12.5) | (0.256, 153) | (1.58, 11.0) | (0.952, 20.8) | (2.52, 17.5) |
| 75% participation | 9.91*** | 6.36 | 9.31*** | 22.6*** | 8.17*** |
| | (3.81, 25.8) | (0.127, 318) | (2.96, 29.3) | (258, 198) | (2.68, 24.9) |
| Ecological trees | 1.78 | 1.17 | 1.59 | 1.66 | 0.938 |
| | (0.807, 3.39) | (0.119, 86.7) | (0.587, 4.29) | (0.668, 18.5) | (0.554, 3.61) |
| Economic trees | 2.49** | 1.93 | 2.75** | 1.69** | 2.01 |
| | (1.21, 5.12) | (0.349, 137) | (1.09, 6.97) | (1.05, 28.3) | (0.866, 4.66) |
| Area (ha) | 9.01* | 13.1 | 7.30* | 23.8 | 5.48 |
| | (0.926, 87.6) | (0.0580, 2970) | (0.760, 70.1) | (0.287, 1970) | (0.314, 95.8) |
| Female (1 =yes) | 0.592 | 0.184 | 0.835 | 0.0532* | 0.698 |
| | (0.108, 3.23) | (0.0048, 6.90) | (0.166, 4.20) | (0.0021, 1.35) | (0.0766, 6.36) |
| Education (years) | 0.733*** | 0.520** | 0.780** | 0.424 | 0.700** |
| | (0.592, 0.907) | (0.335, 0.945) | (0.637, 0.954) | (0.516, 1.21) | (0.534, 0.917) |
| Age | 1.05* | 1.10 | 1.04 | 1.03 | 1.05 |
| | (0.991, 1.11) | (0.963, 1.25) | (0.982, 1.10) | (0.921, 1.14) | (0.978, 1.14) |
| Off-farm wage work in HH (1 =yes) | 10.8*** | 43.3** | 8.06** | | |
| | (2.05, 57.0) | (1.12, 1680) | (1.60, 40.7) | | |
| Self-employment in HH (1 =yes) | 0.764 | 1.04 | 0.887 | | |
| | (0.115, 5.07) | (0.0160, 6.81) | (0.147, 5.35) | | |
| Migrant in HH (1 =yes) | 2.73 | 10.6 | 2.19 | | |
| | (0.652, 11.4) | (0.453, 248) | (0.560, 8.55) | | |
| Lifelong resident | 0.0680*** | 0.00730** | 0.105*** | 0.137 | 0.0509*** |
| | (0.0127, 0.365) | (0.0001, 0.372) | (0.0210, 0.530) | (0.0047, 3.96) | (0.0059, 0.443) |
| Household size | 1.04 | 1.17 | 0.926 | 0.805 | 1.16 |
| | (0.637, 1.70) | (0.429, 3.20) | (0.595, 1.44) | (0.275, 2.35) | (0.64833, 2.09) |
| Livestock (1 =yes) | 0.183** | 0.0519* | 0.290 | 0.956 | 0.109** |
| | (0.0350, 0.959) | (0.0017, 1.61) | (0.0596, 1.41) | (0.0490, 18.7) | (0.0121, 0.973) |
| Obs. (Groups) | 835 (282) | 287 (267) | 548 (282) | 190 (64) | 651 (220) |
| Pseud-$R^2$ † | 0.2003 | 0.1955 | 0.1613 | 0.2397 | 0.1697 |

*p < 0.10; **p < 0.05; ***p < 0.01
† McKelvey & Zavoina, 1975

Consistent with conventional wisdom, landholders who owned livestock were less likely to enroll in GTGP, especially when payment was low and the household had at least one stream of off-farm income. This may reflect the role of livestock in income diversification (Ellis, 2000); households with livestock and/or off-farm income have already diversified their income portfolios in at least one way, which may make them less inclined to forego cultivation for capped GTGP payments. Meanwhile cropland area was only a marginal predictor in the primary model and insignificant in most sub-models, perhaps because land distribution is meant to be functionally egalitarian with each household allocated parcels of different quality (Tan et al. 2006). Thus, a household with more total land may not have more "usable" land, and thus may not have more to relinquish to PES while maintaining a satisfactory area for cultivation. However, this contrasts with recent results by Yost et al. (2020), who found households with more "leftover" land after enrollment were more likely to express intent to enroll. This suggests the relationship between cropland area and GTGP enrollment needs further elucidation.

Respondents who had lived in the neighborhood since birth were considerably less likely to enroll. This is consistent with Arriagada et al.'s (2009) finding that longer-established farming households were less attracted to PES. Although Arriagada et al. (2009) did not attempt to explain this effect, Lambert et al., 2012 may offer some insight. When given the choice between conservation programs between partial and total retirement of certain crop fields, their study hypothesized more experienced farmers would opt for continued cultivation. This may be because they expected more experienced farmers to feel more confident in their ability to optimize production, although their results failed to show a significant relationship. Farmers who have lived in the same neighborhood since birth may better understand spatial variation in the area's land quality and which techniques to use on challenging plots. These farmers may thus experience less frustration that would motivate others to abandon cultivation for PES payments.

Education was negatively correlated with propensity to enroll; the relationship was marginal among all respondents but highly significant for those without off-farm income. This negative relationship contradicts many empirical studies that have found a positive correlation between educational attainment and PES enrollment (Markowski-Lindsay et al. 2011; Ma et al. 2012; Zbinden and Lee, 2005; Lambert et al., 2012). The effect may be different at Fanjingshan because educational attainment was overall quite low, as is common in rural China (Lu, 2012); almost 20% of respondents had never attended school and less than 4% had completed high school. Although education promotes cooperation with conservation efforts at other sites, Fanjingshan residents' education may not encompass enough environmental studies to produce pro-environmental motivations. Further, consider how education can contribute to PES enrollment by qualifying farmers for off-farm jobs (Yost et al. 2020; Chen et al. 2009a). Farmers with lower education may be less confident in their abilities to diversify their income in other ways, which may attract them to GTGP's income-stabilizing influence. This is reinforced by the finding that education was a significant negative predictor of enrollment only for respondents with off-farm income. Further, the simplicity of GTGP may also dampen any positive influence of education. Zbinden and Lee (2005) suggest education increases

farmers' propensity to adopt new conservation practices by helping them gather and process information, especially if the practices are knowledge-intensive. It may be that GTGP enrollment and execution are simple enough, or because administrators provide enough technical and administrative assistance, that education is not a bottleneck factor. Respondents with local off-farm income were more inclined to enroll, corroborating a few studies that have also found off-farm income encourages PES participation (Chen et al. 2009a; Zbinden and Lee, 2005; Zanella et al. 2014). This is likely because households that already had non-farm income sources were less economically dependent on their cropland. To this end, Zanella et al. (2014) suggest families with more of their labor concentrated on-farm may be reluctant to enroll in PES because of the burden of finding other jobs. (Fig. 4).

Although the effects of social norms were consistent between households with and without off-farm employment, alternate income streams appeared to moderate the effects of payment level, education, gender, duration of residence, and livestock ownership. Increasing payment from the lowest to highest level increased propensity to enroll among all respondents, but increasing from the lowest to the middle level only increased propensity to enroll among those without off-farm income streams. This suggests landholders are more likely to enroll and accept low PES payments if they are completely dependent on agriculture for income, likely because these payments are guaranteed and help mitigate risk, even if they do not fully cover the opportunity cost of foregone cultivation. Conversely, households with off-farm income streams may be less inclined to accept a lower-paying GTGP contract because they have already achieved income diversity that protects them against unstable agricultural returns. This may also be why there is a significant, negative relationship between cattle ownership and enrollment only for those with off-farm income. Farmers in many developing rural areas invest in livestock to diversify and store wealth (Ellis, 2000); households with both livestock and off-farm employment already have two forms of diversification, and may thus be less attracted to PES than households whose only diversification is livestock.

Similarly, the negative relationship between education and enrollment may only be visible for households with off-farm income because education influences the potential lucrativeness of off-farm employment. Those with higher education have likely already diversified and augmented their incomes to the point where PES is less necessary, whereas households that have not diversified outside of agriculture are drawn to PES's income-stabilizing influence regardless of their education. Finally, lifelong residence in the neighborhood was only a significant negative predictor of enrollment among those with off-farm income. This may be because lifelong residents are more familiar with spatial and temporal variability in land attributes that may frustrate more newly-established households, making them less likely to opt for a flat PES payment over potentially more lucrative cultivation especially when they have already diversified their income portfolios. Households completely dependent on agriculture, however, may be attracted to guaranteed PES payments regardless of their experience with their land.

Age was positively but marginally correlated with willingness to enroll, consistent with several studies (Chen et al. 2012; Chen et al. 2009a; Yost et al. 2020), but uncertainty remains as others have found an opposite effect (Layton and Siikamaki, 2009) or no effect (Zbinden and Lee, 2005). This inconsistency may suggest age has a complex effect on PES enrollment. The literature overall supports a positive relationship between age and PES enrollment as older farmers seek relief from the physical demands of cultivation, but this study provides only weak evidence for that narrative. Household size was an insignificant predictor of enrollment, consistent with Lambert et al., 2012 study of American CRP participants but in contrast with Yost et al. (2020) and Chen et al. (2012) studies of GTGP participants which found larger households were less likely to intend to enroll presumably due to higher labor availability for cultivation. While both these preceding studies also took place in rural China, the relationship may have been too weak to be statistically significant in this model because additional members in larger households may be comprised of elders or young children with lower labor capacity. This study does not convincingly contradict the notion that larger households are less likely to enroll, but it does highlight the potentially limited predictive power household size has on enrollment after other factors are controlled.

Separating regressions by payment level suggested social norms are more influential when payments are moderate or high, likely because farmers cannot afford to give heavy consideration to social norms when payment is far lower than opportunity costs. This supports Chen et al. (2012) simulation of landholder decisions that found perceived social norms had a stronger effect on PES participation when payment was moderate versus low. Results reveal considerable potential for program administrators to boost enrollment substantially by leveraging social norms, but suggest these tactics will only work if a reasonable payment is offered in the first place. It also appears the effect of off-farm wages varies by payment level; its effect is significant for the lowest payment group but not significant for the higher two, which suggests households with off-farm income can better afford to accept low returns on their

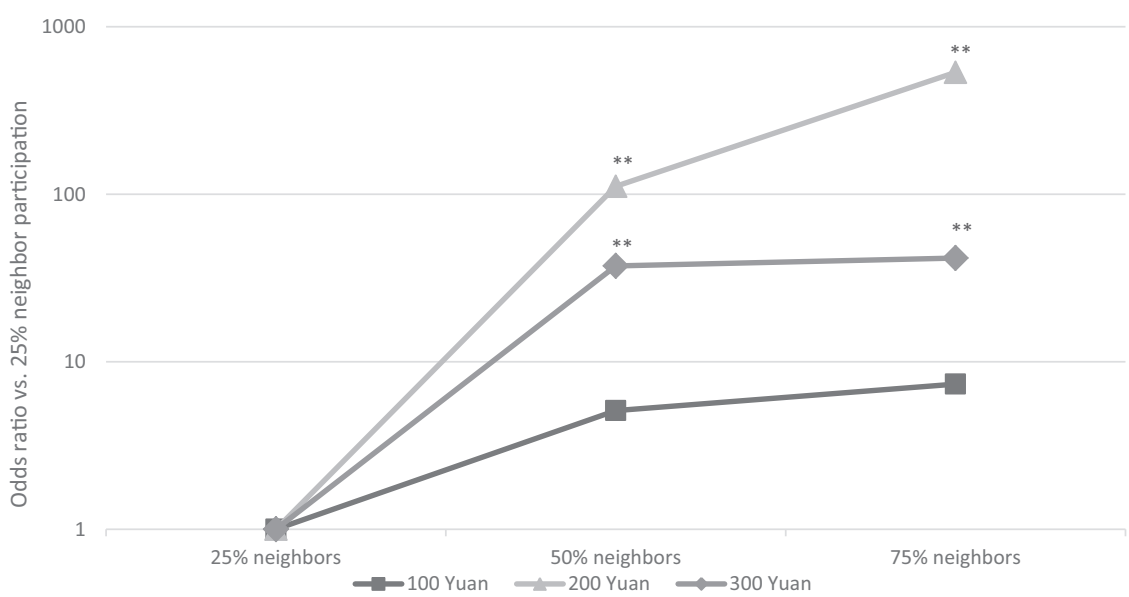


**Fig. 4.** Odds ratios of neighbor participation level by payment level.

cropland. Meanwhile the negative effect of education may weaken as payment level increases because low-education households have fewer options for off-farm work to stabilize their income, making the guaranteed PES payments more appealing even if they are low, whereas higher-educated households will only opt for PES when payments are high. Similarly, livestock ownership is only significant for the lowest payment group, perhaps because the income diversifying effect of livestock (Ellis, 2000) reduces the need to diversify in other ways like PES, especially when PES payments are low.

### 4.3. Optimizing enrollment

Given the greater propensity to accept a PES contract among respondents who are told more of their neighbors will do the same, it appears social norms have a strong positive effect on PES enrollment. Administrators may thus improve recruitment by catalyzing the diffusion of pro-PES social norms. One way to accomplish this is by emphasizing how many others in the community have already committed or expressed intent to enroll. Hosting public meetings may further encourage diffusion of pro-PES social norms by bringing landholders into close interaction. Public meetings would also be an opportunity for administrators to inform landholders on the program, which has been shown to increase propensity to enroll in and of itself (Page and Bellotti, 2015; Zbinden and Lee, 2005; Zanella et al. 2014). Social norm diffusion, whether it arises naturally from regular interactions among neighbors or is facilitated by administrators' efforts, likely has a greater effect on enrollment when contract cycles are only a few years long (Chen et al. 2012), which is not the case for GTGP. Still, social norms may nonetheless be leveraged at the outset of a long-contract program by presenting potential recruits with positive comments participants have made about the program, especially at places like Fanjingshan with large populations of current enrollees.

Results also provide insight into which households should be approached by PES administrators to increase the efficiency of recruitment. The most likely participants are more newly established households that have local off-farm income sources, no livestock, and older or less-educated heads. Targeting these households may produce a greater return on administrators' efforts and secure sufficient participation without needing to greatly adjust the payments or other terms in the contract. Further, the positive relationship between perceived social norms and PES enrollment also supports Narloch et al.'s (2009) suggestion that new norms can develop that encourage PES enrollment for the common good, thereby improving environmental protection in ways that are not completely dependent on sustained incentives. This finding may thus quell fears that PES will degrade environmental protection by tying it too directly to incentives as landholders at Fanjingshan appear motivated by the social norms of land management to a similar extent to which they are motivated by financial offerings. However, this conclusion should not be extrapolated freely to other regions; PES is less likely to degrade environmental ethics in communities where environmentalism is relatively low (Van Hecken and Bastiaensen, 2010), which is the case in much of rural China (Yu, 2014). Such degradation of nonfinancial motives may well be significant in communities with long-standing systems of collectivist conservation.

## 5. Conclusion

This study offers a rare empirical demonstration of the relationship between social norms and PES enrollment, revealing considerable potential for program recruiters to improve enrollment by emphasizing existing community buy-in and creating opportunities for enrollees and supporters to interact with those yet undecided. Results provide a relatively comprehensive illustration of who is likely to enroll in GTGP, providing insight for recruitment into this and other PES programs operating in the developing world. It also strengthens the case for the role of off-farm income on PES enrollment in poor communities, introduces a negative effect of lifetime residence within a neighborhood, and presents an unusual finding that education can decrease propensity to enroll under these cultural and socioeconomic circumstances. These insights may help PES administrators improve financial efficiency by using social norms in conjunction with monetary payments to incentivize enrollment and to improve bureaucratic efficiency by helping to focus recruitment efforts on high-likelihood households.

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## CRediT authorship contribution statement

**Madeline Giefer:** Formal analysis, Writing - original draft, Writing - review & editing, visualization. **Li An:** Investigation, Writing - review & editing, Data curation, Funding acquisition. **Xiaodong Chen:** Methodology, Writing - review & editing.

## Appendix A. Non-migrant prioritization for interview

1. Priority 1: Primary breadwinner in the household
2. Priority 2: Person whose age is closest the age of the migrant selected in the previous survey section.
3. Priority 3: Select based on closeness of relationship to head of household (son or daughter prioritized over sibling or other relative)
4. Priority 4: Prefer non return migrant (never migrated)

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