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ORIGINAL PAPER

Determinants of out-migration in rural China: effects of payments for ecosystem services

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Abstract

Rural-to-urban migration has been a hallmark of economic development in China and other developing countries and can have profound socio-economic and ecological implications. This study seeks to understand the impacts on this migration of two large payments for ecosystem services (PES) programs implemented by the Chinese Government: the Conversion of Cropland to Forest Program (CCFP) and the Ecological Welfare Forest Program (EWFP). The primary goal of these PES programs is environmental conservation with poverty alleviation as the secondary goal. We use a full model of the factors affecting rural out-migration at the individual, household, and community levels to investigate how these PES programs have influenced out-migration in a mountainous rural area of Anhui, China. Results show that the CCFP facilitates out-migration, while the EWFP overall discourages it, thereby somewhat offsetting the effects of the CCFP. Out-migration is also shown to be affected by a number of other individual, household, and community characteristics. The results are useful for designing concurrent PES programs in the future aiming at both environmental conservation and livelihood improvement in not only China but also other developing countries.

Keywords Migration · Payments for ecosystem services · Forest policy · Household survey · Livelihoods · Multilevel analysis · Rural China

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Introduction

Rural out-migration

Rural-to-urban migration is a major characteristic associated with socio-economic development throughout the developing world (e.g., Bilsborrow et al. 1987), including China, the most populous developing country (Qin and Liao 2016). Since the adoption of the Reform and Opening-up Policy in 1978, China's economy had witnessed double-digit annual growth for three decades. This has led to unprecedented opportunities for residents in the countryside to move to the burgeoning cities. Recent reports revealed that China's migrant population has surpassed 200 million, the vast majority rural-to-urban migrants (NBS 2012; Liang 2016). Such massive population mobility has profound impacts on the Chinese society, including altering demographic and economic landscapes (Fan 2003) and the environment (Song et al. 2008). As a result, the study of rural out-migration in China is of considerable interest to both migration scholars and policy-makers.

Migration refers to the movement of a person or household across a recognized boundary to change their place of residence (UN 1998; Siegel and Swanson 2004; Bilsborrow 2016). Migration from rural to urban areas has been a key transformative process of population re-distribution in China, increasing the urban population from 21% in 1982 to 46% in 2009 (Peng 2011). Understanding rural out-migration in China should not be based on extrapolations from studies in other countries because of the unique Chinese household registration institution, the *hukou* system (Liu 2005). The *hukou* system specifies an individual's residence type (agricultural or non-agricultural) and location of permanent residence. The Chinese Government established the *hukou* institution in the 1950s as a mechanism to monitor and control the movement of the population. The *hukou* system aimed to keep rural residents from seeking employment and housing in cities to reduce the burden on city government budgets on infrastructure and welfare (Chan and Zhang 1999). Thus, a farmer born in the countryside with an agricultural *hukou* was not allowed to reside or work in a city. However, since the Reform and Opening-up Policy in 1978, the Chinese Government has relaxed controls over population mobility, allowing rural migrants to seek temporary employment in urban areas (Cai and Wang 2003). Thus, many rural residents, typically with low education, have since migrated to fill the growing needs for labor in the cities (Sun and Fan 2011). Often referred to as the floating population, they sometimes change jobs frequently, moving from city to city from year to year, although some eventually return to the original location where their *hukou* is located (Liang and Ma 2004). Given the complex behavior of out-migration in rural China, empirical studies on determinants of migration behavior are needed to better understand the mechanism of population re-distribution and its implication to social and ecological environment.

Theories of migration

The many factors that may influence migration have been extensively studied in the literature. Since the 1960s, economists have attempted to model migration from both

micro- and macro-economic perspectives. The micro-economic view conceptualizes migration decisions as a function of the difference between the estimated expected returns and costs of the potential migration, which have been found linked to individual attributes, such as age, gender, and education (Sjaastad 1962; Schwartz 1976). The macro-economic view on migration focuses on disparities between the places of origin and destination, such as wage differentials, unemployment rates, and socio-economic amenities that stimulate migration (Lewis 1954; Wolpert 1965; Todaro 1969; Brown and Lawson 1985; Ravenstein 1889). Such differences underlie the broader sociological push-pull theory of Lee (1966), which considered unsatisfactory conditions in the place of origin as the push factors and perceived socio-economic advantages in a place of destination as pull factors. For instance, weak infrastructure (e.g., poor accessibility to the nearest health facility or school) may contribute to pushing people to migrate for better livelihood options.

More recently, the New Economics of Labor Migration (NELM) has evolved, viewing households as the central decision-makers in allocating labor for migration (Stark and Bloom 1985; Taylor et al. 2003). Rural households allocate labor based on the comprehensive needs of the household and household labor resources. Sending a household member as a migrant may later lead to significant remittances, diversifying income sources and reducing the risks the household faces from agricultural crop and market failures (Taylor and Lopez-Feldman 2010). However, household labor allocation also depends on household size, demographic composition, and land availability (Bilsborrow et al. 2004; Gray and Bilsborrow 2014), as explained by Chayanov's theory (Chayanov 1966) of the household life cycle (Goody 1971) as well as the economic theory of the farm household (Barnum and Squire 1979). In addition, prior migrants facilitate subsequent migration from the same households by providing valuable information and assistance (e.g., employment and housing), which reduce the migration costs (Massey 1990; Curran and Rivero-Fuentes 2003; White 2016). Finally, in addition to individual and household characteristics, community-level factors may influence migration through social networks (Bilsborrow et al. 1984, 1987; Findley 1987; Gray 2009; Gray and Bilsborrow 2013).

Migration often has profound socio-economic impacts not only on the origin households but also on the environment in both places of origin and destination (Charnley 1997; Song et al. 2008). The so called "migration-environment nexus" refers to the mutual interdependence of migration behavior and environmental processes (e.g., climate change) and has received increasing attention in the literature (de Sherbinin et al. 2008; Jiang and Hardee 2011; Bilsborrow and Henry 2012; Hunter and Nawrotzki 2016; Fussell et al. 2017). Land use and land management can affect and be affected by rural migration, which may result in significant environmental changes (Braimoh 2004; Chen et al. 2014). For example, rural residents who migrated out in response to degraded land in one area may subsequently degrade the land in the place of destination, causing further out-migration in a chain process (Charnley 1997). Out-migration has also been viewed as an adaptation strategy by rural farmers to cope with high risks of crop failure under adverse or unpredictable environmental conditions (Konseiga 2007), consistent with the NELM. The migration-environment relationship is thus of crucial importance for regional planning regarding both environmental quality and human welfare.

China's new forest policies

Payments for ecosystem services (PES) has recently emerged as an innovative approach for ecosystem conservation and restoration, particularly when dealing with land use change (Engel et al. 2008; Pattanayak et al. 2010). The PES approach has been widely adopted in the form of cash incentives in the Reducing Emissions from Deforestation and Forest Degradation plus (REDD+) program, which supports conservation, sustainable forest management, and forest carbon stock enhancement (Groom and Palmer 2012). In REDD+, stakeholders, such as governments or non-governmental organizations, pay landholders to provide ecosystem services by preserving or restoring forests (Engel et al. 2008; Wunder et al. 2008; Mahanty et al. 2013). REDD+ programs thus also seek to complement other development policies oriented towards poverty reduction (Brown et al. 2008).

In the late 1990s, China adopted a series of new forest policies based on the PES principles in the aftermath of severe floods caused primarily by decades of deforestation and land degradation (Liu et al. 2008). The largest PES program is the Conversion of Cropland to Forest Program (CCFP), which has been implemented in 25 of the 31 provinces of China starting around 2000. It involved 32 million rural households with an investment of 430 billion Chinese yuan (US$71 billion based on the exchange rate in 2013) by 2013 (Xu et al. 2010; Bennett et al. 2014). Under the CCFP, participating farmers convert croplands on steep slopes (thus, the program is also known as the Sloping Land Conversion Program) or otherwise ecologically sensitive areas in return for grain compensation (making the program also known as the Grain-for-Green Program) based on the area reforested. The grain compensation was quickly replaced with cash compensation to reduce transaction costs. A second PES program is the Ecological Welfare Forest Program (EWFP), which aims at preserving existing natural forests by prohibiting commercial logging (Dai et al. 2009). The government provides cash compensation to farmers who give up timber harvesting based on the area of natural forest owned. At the same time, the central government abolished all land taxes on these forests.

A major challenge that the Chinese policy-makers face is the sustainability of the PES programs. These forest restoration and conservation programs significantly increased China's forest cover and enhanced water and soil conservation (Liu et al. 2008; Bennett et al. 2014; Deng et al. 2014; Zhang et al. 2018a). A secondary goal of these programs is poverty alleviation, since the affected croplands and forests generally belong to low-income households (Song et al. 2014). Although the PES programs (CCFP and EWFP) do not explicitly address the issue of rural out-migration, policy-makers hoped that the cash payments would stimulate rural households to diversify livelihoods via reallocating farm labor to non-farm activities, of which out-migration is a critical component. Such behavioral changes could also reduce the risk that participating households would reconvert recently reforested cropland back to crops or return to timber harvesting in natural forests when government compensation ends.

Several studies have found empirical evidence that off-farm labor allocation may change as a consequence of forest policies and posited out-migration as one mechanism through which the CCFP may alter rural livelihoods. Groom et al. (2009) found significant positive impacts of the CCFP on the off-farm labor supply, particularly for land-constrained households. Uchida et al. (2009) examined off-farm employment

under the CCFP and noted that the number of migrants was almost as high as that of off-farm workers. Lin and Yao (2014) found that the CCFP could indirectly influence income generation through relaxing liquidity constraints, which might facilitate out-migration. Démurger and Wan (2012) found an increased probability of out-migration among CCFP participants, and Liang et al. (2012) suggested that household characteristics may also influence migration under the CCFP. These studies use data from household surveys conducted during the early years of the CCFP (viz., during the first 6 years of program implementation), and all evaluated only one forest policy, namely the CCFP. However, the impacts on migration may be different after more years and may be complicated by joint effects of concurrent programs on household livelihood strategies. As the CCFP and EWFP programs existed for more than 12 years (2002–2014 for CCFP and 2000–2014 for EWFP), it is also important to investigate what may be referred to as their *medium-term impacts* on out-migration.

The present research thus aims to understand the roles played by the two major forest policies (CCFP and EWFP) based on PES principles in rural out-migration, drawing on data from a household survey implemented in Anhui, China, 11–13 years after program implementation. Participation of households in the CCFP requires the household to withdraw cropland from agricultural use, raising the labor/land ratio and creating a short-term labor surplus. Thus, our first hypothesis is that the CCFP is positively associated with out-migration due to the labor surplus. However, since the EWFP does not involve any cropland retirement, it cannot have this effect and its effects are indeterminate, though it usually involves larger cash payments than the CCFP. Those payments could have positive or negative effects on migration. On the one hand, the EWFP compensation increases household income, reducing cash pressure on a household and reducing motives of its members to out-migrate. On the other, the EWFP compensation could be used to finance the migration. Therefore, it is unclear what the net effect of the EWFP will be on out-migration, which can only be settled empirically.

Since rural out-migration is also influenced by a host of other factors, including individual and household characteristics as well as contextual factors, these factors must also be considered to test the two hypotheses. Therefore, the principal objective of this study is to develop a statistical model to study the extent to which the PES programs influence rural out-migration, controlling for other relevant factors. Because the PES programs have been adopted virtually nationwide, our findings will be valuable for policy-makers in designing new or modifying existing PES programs in the future in China as well as in other countries, and the methods we developed in this study should be useful for analyzing the impacts of PES programs on migration in other areas.

Methodology

Study area

The study area, Tiantangzhai Township, is located in a mountainous region in western Anhui Province (Fig. 1), covering 189 km^2 with elevations from 363 to 1729 m. Tiantangzhai has a mild climate (mean annual temperature of 16.4 °C and

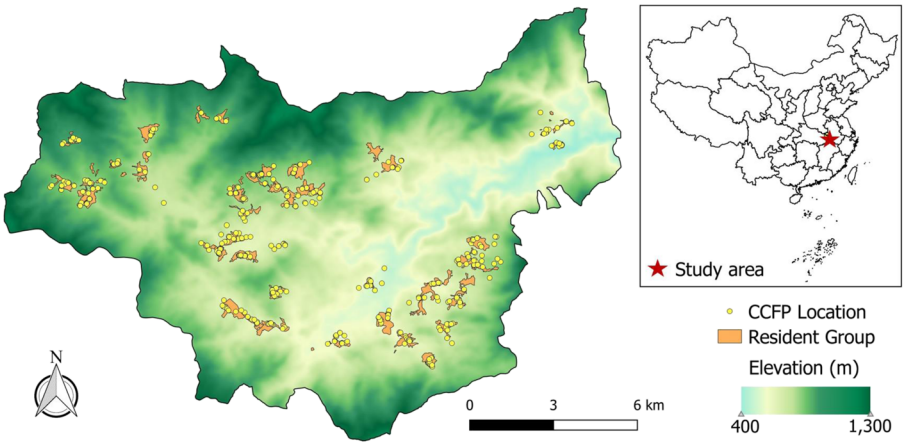

Fig. 1 Study area: Tiantangzhai Township in Anhui, China

precipitation of 1350 mm), albeit with rough terrain, suitable for abundant forest cover (Wang et al. 2018). The township is remote from the county capital (Jinzhai County) and much farther from the provincial capital, Hefei. The county is recognized as a county in poverty by the Chinese Government. The township is part of Tianma National Nature Reserve in the eastern Dabieshan Mountains, which protects the secondary subtropical natural evergreen broadleaf forests and the associated rare plant and animal species in the region (Zhang et al. 2018b).

Tiantangzhai is home to 4369 households, distributed in seven administrative villages with varying economic status. The township has only one junior secondary (middle) school, so students have to go to the distant county capital for high school. Overall social-economic conditions in the township are poor, and local farmers survive primarily from subsistence farming on small land parcels. Before the Household Responsibility System (HRS) was adopted in the early 1980s, land parcels were collectively managed by "production teams" (Li et al. 1998). Under the HRS, the collectively owned land parcels were divided among the households who have complete freedom of cropland management as long as they fulfill the "responsibility" contracted with the government, i.e., the amount of grain to be sold to the government at a low contracted price. Households have long-term or customary usufruct rights to their land parcels, but not legal ownership. Thus, the previous closely-knit households in the "production team" essentially became independent members of a resident group, which usually consists of a cluster of 10 to 40 households. There are currently 165 resident groups in the township.

While the study area is small, it is characterized by rugged terrain with significant amounts of cropland located on slopes. Such croplands are typically not very productive, and prone to soil erosion. The local government enrolled 753 households in the CCFP, about 17% of all households in Tiantangzhai Township. To enroll in CCFP was a complicated process. First, local government authorities identified qualified land patches based on area quotas and the criteria of qualified land parcels (e.g., should be contiguous so as to form large forest patches on slopes) handed down from the upper administration. They then visited the farm households whose land parcels were in the identified areas and encouraged (with implicit "coercion") them to participate in the

CCFP (Bennett 2008; Zhang et al. 2018b). As a result of these procedures, almost all cropland parcels enrolled in the program are exogenously "qualified" and household participation was not significantly influenced by household choice or self-selection. Under the CCFP, farmers could create ecological forests (e.g., sweetgum or maple trees) or economic forests (e.g., walnut or pecan trees). Economic forests could generate income after a few years. Farmers receive cash compensation from the central government based on the area of cropland reforested. The CCFP required that most planted trees be ecological trees, mainly sweetgum (*Liquidambar styraciflua*) in Tiantangzhai. For ecological forests, the payment rate was 230 yuan/mu/year[1] for the first 8-year contract (2002–2010), which was reduced to about half (125 yuan/mu/year) for the second 8-year contract (Song et al. 2014). Despite this reduction, almost all participating households in Tiantangzhai renewed their contracts and thus continued to participate in the program.

The township is also part of a nature reserve where natural forests were designated as ecological welfare forests. The EWFP was created by the Chinese Government to conserve remaining natural forests (Chen et al. 2018). Because of the high forest cover in the study area, virtually every household[2] has some natural forests, but the area owned and hence the amount of payment received by households varies widely. Farmers received 8.75 yuan/mu/year (according to the official records of local forest authorities in 2014) as compensation for foregoing commercial logging in these forests, although subsistence use of the forest, such as for fuelwood, is allowed (Song et al. 2018).

Out-migration has been an on-going process prior to as well as during the implementation of these PES programs in Tiantangzhai. A previous study found that rural households in the study area often had more income from remittances sent by out-migrants than from their croplands (Song et al. 2014). Some household members were observed to move within the local area (i.e., Jinzhai County) and thus were still able to provide farm labor for the origin households when needed, while most migrated out of the county, almost all to remote urban areas. It is important to note that there have been few in-migrants to the township, except for some return migrants. The socio-economic (low-income), mountainous setting with rainfed agriculture in Tiantangzhai is typical of much of central-eastern rural China. Thus, Tiantangzhai is an excellent area for studying migration behavior in relation to environmental change under the two PES programs in China.

Data acquisition

The study draws on data collected primarily from a household survey conducted in Tiantangzhai Township in the summer of 2014. A comprehensive questionnaire was developed with 22 sections to obtain data on socio-economic well-being, household demographics, migration, land availability and agricultural activities, household living conditions, labor allocation to economic activities, and participation in PES programs.

[1] The area unit, mu, is commonly used for cropland in China; 1 mu = 1/15 ha; US$1 = 6.2 Chinese yuan in 2014.

[2] This excludes the "five guaranteed" households that are typically childless elderly without means for self-support. Their basic five aspects of livelihoods (food, clothes, housing, medicine, and end of life expenses) are guaranteed by the community where he/she resides (Shen and Williamson 2010).

Since migration was a topic of major interest, we designed two sections to capture relevant information: a roster of household members and a special section on migrants. Before the survey, definitions of key terms were clarified during the training for interviewers to ensure the collection of consistent data. An *out-migrant* was defined as a person who had been a member of the household and who left at any age between 15 and 59 to live outside the county (Jinzhai County) for at least six consecutive months at some time since 2000. If an out-migrant returned to the origin household before the survey time, this person would become a return migrant but she/he would still be treated as an out-migrant at the time of her/his departure and thus be included in the analysis. A *non-migrant* was defined as a person who never left the household to live away for more than six consecutive months outside Jinzhai County since 2000 and who was living in the household at the time of interview. If a person was living away for *less* than 6 months at the time of the survey, she/he was still considered to be a current household member and *not* an out-migrant. Specifying the age range of 15–59 at the time of migration ensures a focus on those involved in the decision-making process (not dependent children or the elderly).

To understand why some household members left while others did not, we obtained information on personal attributes, including age, gender, education, and marital status for both out-migrants and non-migrants. The questionnaire thus obtained *retrospective* data for each out-migrant pertaining to the *time of out-migration*, with the data obtained from an adult household member remaining in the household, referred to as the proxy respondent. If a person migrated more than once, the questionnaire obtained data pertaining to the *last* migration of this person, which tends to yield more reliable (recent) data compared to data that would include data referring also to additional earlier migrations of the person (Som 1973; Bilsborrow 2016).

Data were also obtained for non-migrants in the migrant household aged 15–59 referring to their demographic characteristics *at the time the migrant left* the household. For example, if a household had an out-migrant who left in 2011, information on the non-migrants from the same household was also obtained (or estimated) for 2011. In households with no qualified out-migrant(s) over the study period (about 24% of our sample), data were also estimated for non-migrants aged 15–59 on their same characteristics 5 years prior to the survey, or approximately the midpoint of out-migration during the study period. This created a comparable population of non-migrants from non-migrant households and is an important contribution of the project methodology here as it contrasts with the usual practice of collecting data for non-migrants only pertaining to the *time of the survey* (Bilsborrow et al. 1984; Bilsborrow 2016).

In designing the sample, households with and without CCFP participation are both needed to study the effects of the CCFP. Because the proportion of households participating in the CCFP in Tiantangzhai is relatively low (17%), we adopted a disproportionate stratified sampling technique to ensure that a sufficient proportion of households participating in the CCFP was included in the sample (Kish 1965; Bilsborrow et al. 1984). This guaranteed that the sample would have roughly similar numbers of participating and non-participating households in the CCFP, through oversampling the former. The sampling procedure consisted of two stages. In the first, we sampled resident groups. We separated the population of resident groups into five strata based on the proportion of CCFP households in each resident group. We oversampled resident groups from the strata with higher proportions of CCFP

households, resulting in a total of 40 resident groups (about one-fourth of the total in the township). Then in the second stage, we selected up to 20 households, from each of the 40 sample resident groups. If a sample resident group had fewer than 20 households, all were selected. If it had more than 20 households, we oversampled those without CCFP in the resident groups with high proportions of CCFP enrollment and oversampled CCFP households from the resident groups with low CCFP enrollment to achieve representativity of both types in all strata (Song et al. 2018). We ended up with 734 households in the final sample, with roughly similar numbers of households with and without CCFP participation. Since nearly all households were enrolled in the EWFP, it was not a factor considered in the sampling design. This sampling technique of oversampling leads to a sample with each person and household having different weights to represent the population of the study area. Weights also take into account non-response based on the number successfully interviewed relative to the number in the stratum at each sampling stage in each resident group and are used to account for the unequal probabilities of selection in the statistical analysis.

For the household survey, five students were recruited from Anhui Agricultural University as the interviewers, with the help of the local project collaborator. We first trained the interviewers for a week and then tested them in trial interviews in non-sample households near the study area. The household survey team, supervised by the first author, contacted the full sample of households, successfully collecting complete data for 481 households, 56% participating in the CCFP, yielding data for 1957 individuals.

In addition to the household survey, we carried out a community survey, administering a short questionnaire to resident group leaders. The questionnaire collected data on resident group size (number of households), infrastructure, and geographic factors such as accessibility to the nearest hospital or clinic and primary school.

Statistical modeling

Before analyzing the factors affecting out-migration, it is useful to first briefly compare individual attributes (i.e., gender, age, education, and marital status) of out-migrants and non-migrants. Because the CCFP started in 2002 and the aim is to investigate its effects on out-migration, only individuals aged 15–59 in any year during 2003–2014 are included, as explained above, creating a pool of persons at risk of out-migration. We assume that there was a 1-year lag in the effect of PES program participation on the migration decision. Thus, out-migrants who left in or before 2002 are excluded from the analysis, as they would have made the decision based on information prior to the CCFP. This results in 1137 individuals from 412 households for the comparison as well as the statistical modeling.

We use a multilevel statistical approach to model out-migration behavior, identifying individual, household, and community effects as well as to isolate the effects of the PES programs. Multilevel models are used to analyze hierarchically structured data, where individuals are embedded in households, which in turn are clustered in communities (Goldstein 1994; Zhu 1998; Raudenbush and Bryk 2002). Based on the history of CCFP and EWFP, once a household entered the program, it stayed in it throughout the study period. Thus, the multilevel model was used to analyze the effects of factors including PES program participation on any (last) out-migration decisions during the period 2003–2014.

In this study, the dependent variable is whether an individual from the population at risk (last) migrated out (= 1) or not (= 0) in each year of the study period of 2003–2014. Thus, with a dichotomous dependent variable, we use logistic regression for modeling the migration decision. Based on migration theories mentioned above, we hypothesize that the decision of individual out-migration is influenced by a number of individual attributes, household characteristics, and contextual factors. At the individual level, these include gender, age, education, and marital status. We also included *single female* to capture possible effects beyond the direct effects of gender and marital status.

Independent variables at the household level include gender, age, education, and marital status of the household head, house elevation (meters above sea level), walking distance to the nearest paved road estimated by the respondent in minutes, household size, cultivated cropland area, and whether any other member of the household had migrated out before the migrant under consideration.[3]

Finally, the model seeks to capture the effects of PES programs by including the *amounts of payments received* from the CCFP and the EWFP in the 12 months prior to the interview. All sample households that participated in each program maintained that participation throughout the study period of 2003–2014 and received payments at fixed compensation rates per unit of land. Although the CCFP payment rate was adjusted downward by half for the second 8-year contract, the total land area enrolled remained the same. In any case, the amount of payment provides a continuous variable that is more informative than a simple dichotomous variable, which would not make sense for EWFP payment since virtually all households received it. The effects of these PES programs on out-migration may be confounded with the household geographic location, as households at higher elevations tend to have more natural forests and a larger proportion of their croplands on slopes and thus receive more compensation from both EWFP and CCFP. This effect is controlled for by including household elevation as an explanatory factor in the model.

Potentially relevant variables collected at the community level include community size and accessibility to facilities such as hospitals and schools, the lack of which may serve as push factors for out-migration. Descriptions of independent variables are presented in Table 1.

The full multilevel model that includes variables at the individual, household, and community levels, along with the PES variables, can be written as:

$$\log\left(\frac{\Pr(M_{ijk}=1)}{\Pr(M_{ijk}=0)}\right)=\alpha+\sum_{p=1}^{P}\beta_p X_{ijkp}+\sum_{q=1}^{Q}\gamma_q Z_{jkq}+\sum_{r=1}^{R}\theta_r C_{kr}+\mu_k+\varepsilon_{ijk} \quad (1)$$

where M_{ijk} denotes out-migration status (out-migrates or not) of the ith individual in the jth household from the kth community; X refers to individual explanatory attributes, Z to household characteristics, and C to community-level or contextual factors; P, Q, and R denote the numbers of X, Z, and C variables and corresponding parameters estimated, respectively. For the fixed effects, α captures the overall intercept, and β, γ, and θ the slopes or effects of X, Z, and C, respectively. The random effects at the individual/household and community levels are captured by ε and μ, respectively.

[3] This includes whether the household has a former member who out-migrated and continues to live outside the county or has a return migrant, someone who migrated out but returned *prior* to the migration of the person being observed, whether an out-migrant or non-migrant.

Table 1 Descriptions of independent variables for modeling out-migration

Variable name	Description
Individual level	
Gender	0 = male, 1 = female
Age	In years
Education	Whether completed primary school (0 = no, 1 = yes)
Marital status	0 = single, divorced or widowed; 1 = married
Single female	1 = single female, 0 = otherwise
Household level	
Gender of head	0 = male, 1 = female
Age of head	In years
Education of head	Whether household head completed primary school (0 = no, 1 = yes)
Marital status of head	0 = single, divorced, or widowed; 1 = married
House elevation	Meters above sea level
Walking distance	Distance to nearest paved road measured by walking time (minutes)
Household size	Number of people living in household
Previous migration	If any current or former household member aged 15+ has previous out-migration experience (0 = no, 1 = yes)
Cultivated land	Total area of cropland under cultivation (mu)
CCFP payment	Compensation received from CCFP in past 12 months (1000 yuan)
EWFP payment	Compensation received from EWFP in past 12 months (1000 yuan)
Community level	
Community size	Number of households in resident group
Distance to school	Distance to nearest primary school in walking time (minutes)
Distance to hospital	Distance to nearest hospital or clinic in walking time (minutes)

It is important to note that the model is developed based on 1137 individuals aged 15–59 from 412 households during the reference period 2003–2014. These individuals constitute the population aged 15–59 exposed to the risk of out-migration. The model implicitly assumes that certain household characteristics and community conditions *as recorded at the time of the survey* are related to the migration in the entire study period. Their values do not usually change with time in this remote community, including walking distance to the nearest paved road, house elevation, and number of households in the resident group.

Results

PES participation

Figure 2 shows the distribution of the amounts of payments received by participating households from the PES programs. Based on our sample, almost all households were

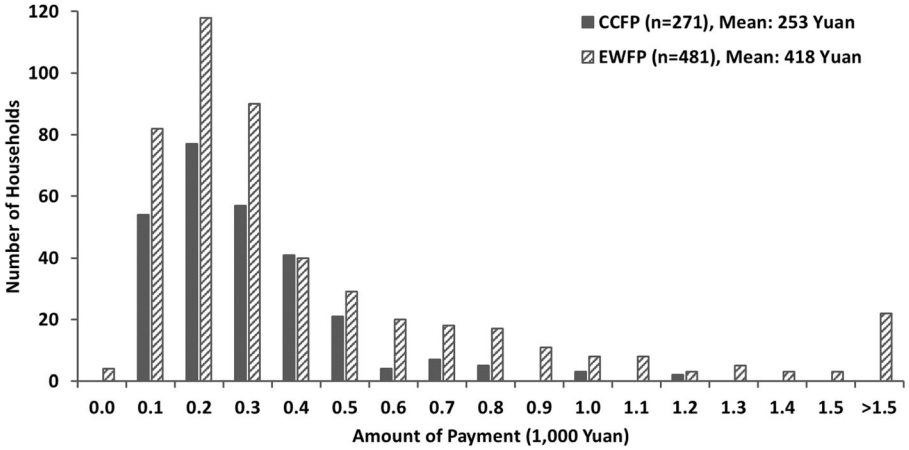

Fig. 2 Distribution of households receiving CCFP and EWFP payments in the 12 months prior to the interview in 2014

participating in the EWFP (with less than 1% not participating). For participating households, the mean amount of EWFP payment is much higher than that of CCFP payment during the 12 months prior to the survey. Thus, despite the low compensation *rate* from the EWFP, participating households on average receive much larger compensation from the EWFP (418 yuan) than the CCFP (253 yuan) due to the large areas of natural forest they have.

Households with and without CCFP participation may have systematic differences in household conditions that could be related to their migration. We thus compare household characteristics of CCFP participants and non-participants (Table 2). Results show that CCFP participants tend to be located in areas with higher elevations and longer distances to the nearest paved roads and tend to also have more (EWFP) forestlands. Households located in more remote, higher elevation areas tend to have larger areas of EWFP forests and hence are more likely also to have their croplands on steep slopes and thus are more likely to have cropland parcels enrolled in the CCFP. These geographic differences could confound the effects of program participation on migration. Hence, we include these two variables (i.e., elevation, walking distance to the nearest paved road) in the model to control for their effects via the two PES programs on out-migration. Other major household characteristics listed, such as household size, are not significantly different between CCFP-participating households and non-CCFP participants, suggesting no confounding effects from them.

Descriptive analysis

Of the 1137 individuals aged 15–59, nearly half (45.4%) of them migrated out of the county during the study period of 2003–2014. Table 3 compares individual attributes for both the out-migrants and non-migrants regarding CCFP participation status and gender. In almost all studies of migration in developing countries, gender differences are observed in migration (Fan 2003; Deere and Alvarado 2016) associated with differences in gender roles in the economy, so it is likely useful to investigate differences in this China sample as well. Compared to non-migrants, out-migrants tend

Table 2 Household characteristics of CCFP participants and non-participants

House characteristic	CCFP = 1 (N = 235)		CCFP = 0 (N = 177)		Difference in means
	Mean	Std. dev.	Mean	Std. dev.	
House elevation (100 m)	6.90	1.10	6.48	0.87	0.43***
Household slope (degrees)	10.49	4.54	10.58	4.34	−0.09
Walking distance to nearest paved road (minutes)	12.57	15.35	9.55	12.94	3.02**
Household size in 2002 (persons)	3.90	1.28	3.93	1.17	−0.03
Household wellness score (range 0–35)	21.10	4.93	20.59	4.74	0.51
Paddy land owned (mu)	4.03	0.15	3.97	0.14	0.07
If raising farm animals (0/1)	0.87	0.34	0.81	0.40	0.06
Costs incurred on extracting forest resources (1000 yuan)	2.25	0.41	1.68	0.38	0.57
Number of household members engaged in local off-farm work	0.76	0.05	0.86	0.06	−0.10
CCFP area (mu)	2.05	1.59	0.00	0.00	2.05***
EWFP area (mu)	55.05	68.20	39.15	44.94	15.89***

T tests test for differences in means of household characteristics between the two household groups

**$p < 0.05$; ***$p < 0.01$

to be better educated, single, younger, and male. Regarding CCFP participation, all four of these variables (i.e., gender, education, age, and marital status) are similar for out-migrants and non-migrants from households with and without CCFP participation, showing that participation in the program does not appear to be confounded by personal attributes at the individual level. Examining male-female differences reveals small differences in age, with male migrants older than females by a mean of 3 years, and both male and female migrants about 15 years younger than their non-migrant counterparts. The education gap between males and females is smaller for out-migrants, compared to the gap for non-migrants of over 2 years. The data also suggest there may

Table 3 Individual attributes for out-migrants and non-migrants by CCFP participation and by gender

Variable	Out-migrants (n = 516)		Non-migrants (n = 621)	
CCFP participation	CCFP = 1 (n = 307)	CCFP = 0 (n = 209)	CCFP = 1 (n = 343)	CCFP = 0 (n = 278)
Gender	0.41	0.47	0.54	0.55
Age	28.8	28.6	43.5	43.0
Education	8.23	8.36	5.43	5.43
Marital status	0.57	0.56	0.87	0.85
Gender	Male (n = 290)	Female (n = 226)	Male (n = 282)	Female (n = 339)
Age	30.1	27.0	44.9	42.0
Education	8.45	8.08	6.53	4.51
Marital status	0.53	0.62	0.83	0.88

be more equality in gender roles among out-migrants than among non-migrants. Finally, marital status differs between migrant males and females, and in a surprising way in that migrant females are only slightly more likely to be married than migrant males. Since there are more males than females migrating, the main explanation is that a large proportion of women who migrate do so with (or following) their migrating husbands, while it is the women who remain behind to care for the elderly.

Table 4 provides statistics (means, standard deviations, minimum and maximum values) of the explanatory variables for the multilevel model. The *t* statistics suggest that all of the individual attributes and some household characteristics are significantly different between out-migrants and non-migrants, while community-level factors do not significantly differ. Among household characteristics, migrant household heads generally tend to be older and less likely to be married, compared to those from households with non-migrants. Moreover, households that sent out-migrants have more prior migration experience than non-migrant households, as expected. Notably, households with out-migrants receive slightly higher amounts of CCFP payments than non-

Table 4 Descriptive statistics of independent variables for out-migrants and non-migrants

Variable	Out-migrants ($N = 516$)				Non-migrants ($N = 621$)			
	Mean	Std. dev.	Min	Max	Mean	Std. dev.	Min	Max
Individual level								
Gender***	0.44	0.50	0	1	0.55	0.50	0	1
Age***	28.7	11.4	15	59	43.3	10.9	15	59
Education***	0.91	0.29	0	1	0.63	0.48	0	1
Marital status***	0.57	0.50	0	1	0.86	0.35	0	1
Single female***	0.17	0.37	0	1	0.06	0.24	0	1
Household level								
Gender of head	0.06	0.23	0	1	0.04	0.19	0	1
Age of head***	51.8	9.4	14	81	47.9	8.6	10	79
Education of head	0.77	0.42	0	1	0.74	0.44	0	1
Marital status of head***	0.88	0.32	0	1	0.94	0.25	0	1
House elevation	666	105	414	974	679	103	413	974
Walking distance	11.0	14.8	1	90	11.7	14.1	1	80
Household size	3.75	1.21	1	8	3.69	1.25	1	8
Previous migration***	0.41	0.49	0	1	0.25	0.43	0	1
Cultivated land***	4.44	3.37	0	18	5.13	3.22	0	18
CCFP payment*	0.16	0.21	0	1.13	0.14	0.19	0	1.13
EWFP payment***	0.44	0.54	0.02	4.15	0.54	0.68	0.02	4.15
Community level								
Community size	26.2	8.7	9	41	25.8	8.6	9	41
Distance to school	20.1	24.4	2	150	20.1	25.6	2	150
Distance to hospital	19.3	16.0	1	60	18.4	15.6	1	60

T test tests differences in means of variables between out-migrants and non-migrants

*$p < 0.1$; ***$p < 0.01$

migrant households (20 yuan or about 14% more). Note that the mean value of the CCFP payment also includes households not participating in the program who receive zero subsidies. In contrast, migrant households receive significantly lower mean amounts of EWFP payments due to having smaller amounts of natural forests, compared to non-migrant households.

Multilevel model results

Table 5 provides results (odds ratios and significance levels) for the effects of the explanatory variables on out-migration. They show significant effects of a number of factors at all three levels: personal attributes, household characteristics, and contextual factors.

Table 5 Results for determinants of out-migration from the multilevel model

Variable	Odds ratio	Standard error
Individual level		
Gender	0.24***	0.06
Age	0.86***	0.01
Education	3.27**	1.90
Marital status	3.71**	2.23
Single female	3.10**	1.73
Household level		
Gender of head	0.23	0.23
Age of head	1.13***	0.03
Education of head	1.55	0.54
Marital status of head	0.36	0.34
House elevation	1.00	0.00
Walking distance	0.97	0.02
Household size	0.95	0.09
Previous migration	3.41***	1.13
Cultivated land	0.82***	0.04
CCFP payment	5.40***	2.93
EWFP payment	0.66*	0.15
Community level		
Community size	1.00	0.02
Distance to school	1.01	0.00
Distance to hospital	1.02**	0.01
Intercept	0.03	0.15
Intercept variance	0.49	0.37
Log pseudo-likelihood	− 3824.96	
Wald chi2	1592.09***	

All data used are weighted to take into account the complex sample design described in the text

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Beginning with the two PES policy variables, which are of primary interest here, both CCFP and EWFP payments have statistically significant effects on individual out-migration, but their effects are in *opposite* directions. For CCFP households, compensation received for enrolling land in reforestation is significantly and *positively* associated with out-migration, as hypothesized. The CCFP effect may involve a small liquidity effect if the modest cash compensation were to be used to contribute to out-migration (Uchida et al. 2009), but the main effect results from the decline in the demand for labor for land cultivation due to the conversion of cropland to forest. At the same time, we observe that the larger the EWFP payment, the less likely is out-migration. Considering all sample households, the mean annual EWFP payment received is more than the mean annual CCFP payment in the township. Thus, despite the extremely low EWFP compensation *rate* per unit of land area (8.75 yuan/mu/year or US$21/ha/year), the mean area of EWFP forests owned by households (49 mu or 3.2 ha) is so much larger than the mean area of CCFP land (2.03 mu or 0.14 ha) that the mean EWFP payment is larger. The fact that those households living higher in the mountains also tend to have lower overall incomes gives the EWFP payments even more leverage on improving their livelihoods to allow them to stay.

Moving onto the individual attributes, the finding that those who are younger, better educated, and male are more likely to out-migrate is consistent with most other studies in developing countries (e.g., Barbieri et al. 2009), including China (e.g., Chen et al. 2014). The results for marital status, along with gender and age, suggest that individuals in rural China are more likely to out-migrate after they reach certain ages and get married (usually together, or the woman following the man), except that a *single female* is more likely to out-migrate than other individuals. These results reflect the rural culture in China where male labor on the farm is considered more valuable than female labor, but at the same time married women are more likely to stay and take care of their child(ren) and the elderly than single women or males.

Regarding the household variables, the household head's age is significantly and positively associated with out-migration. Given the mean age (around 50) for the household heads, it can be anticipated that households with *older* heads are likely to be better off due to having more experience in farming and/or off-farm work and longer times for wealth accumulation and hence are more able to provide support for travel and initial assistance to an out-migrating son or daughter. Among the other household factors, a household with a prior out-migrant is much more likely to send out another out-migrant, because the earlier out-migrant could provide useful information and influence and/or assistance with housing and finding work, as hypothesized above regarding the value of migrant networks, consistent with the literature cited above. In terms of agricultural livelihoods, out-migration is negatively associated with the area of cropland cultivated, as farm activities also require labor.

Finally, one of the community-level variables, the distance to the nearest hospital, exhibits statistically significant effects on out-migration. The lack of adequate access to health care appears as a push factor, leading some individuals to migrate out for better living conditions. Although the effects are small, the results suggest that empirical studies of migration should not neglect contextual factors and, indeed, that models which do may well be misspecified.

Discussion and conclusions

Rural out-migration continues to be the key form of population mobility in developing countries and a major contributor to the transformation and modernization of the economy in China (Lewis 1954; Cai and Wang 2003; Fan 2003). This out-migration also likely contributes to poverty reduction among rural households in many areas of China as in most developing countries around the world (Bilsborrow et al. 1984; Taylor and Lybbert 2015). Over the course of many centuries of civilization, expanding the cropland area in China has been critical to feeding its growing population (Perkins 1969; Ye et al. 2009). Cropland expansion has usually occurred at the expense of forests in China, particularly in the past century, as population size has more than quadrupled. The accompanying extensive deforestation led to severe soil erosion that in turn contributed to devastating natural disasters, such as droughts and flooding. These natural disasters have functioned as a major driving factor in China's developing and continuing its policies for reforestation (Zhang et al. 2017), led by the two PES policies evaluated here, CCFP and EWFP.

The present paper reports the results from a multilevel statistical analysis of the determinants of out-migration from farm households in a typical rural region of central-eastern China. In the migration model, the PES variables are policy instruments, so the results here should be useful for the design of future incentive-based programs. Furthermore, the investigation of the linkages between rural out-migration and the CCFP environmental policy has documented the nexus between migration and environmental change (Carr 2005; Bilsborrow and Henry 2012; Fussell et al. 2017) as manifested in changes in land use (e.g., reduced cultivation and reforestation). Thus, a major finding is that participation in the CCFP is associated with increased out-migration, the main mechanism being the reduced area of cropland available for cultivation, releasing labor that is further reallocated mostly to increased local off-farm employment or out-migration. While the size of the subsidy from the CCFP provides low-income households a little financial support, it appears to be too small to help much with basic household needs or to reduce poverty, though it could assist in helping cover initial costs of out-migration (e.g., transportation). But it is the reduction in cropland area in CCFP-participating households that frees up farm labor for out-migration (Groom and Palmer 2012; Uchida et al. 2009), which then in turn often leads to significant subsequent remittances back to the origin households, significantly reducing poverty. Thus, the CCFP is likely to have indirectly stimulated many CCFP-participating households to diversify their livelihood options and thereby reduce poverty, above and beyond other rural households. While this difference is not huge, it does appear to exist.

At the same time, EWFP payments have some opposite effects, though less strong, tending to discourage rural out-migration. The EWFP has no effect on farm labor because it does not involve cropland retirement. Thus, in addition to its direct effect on increasing household income, EWFP payments may facilitate forest resource (e.g., fuelwood, mushrooms, herbal medicines) regeneration (Zhang et al. 2018a), which may alleviate difficult living conditions, reducing motives to out-migrate. Thus, the EWFP subsidy tends to *partially offset* the effects of the CCFP incentivizing people to out-migrate. Therefore, if a household receives *both* subsidies and has a moderate amount of natural forest area, it is still likely to have an out-migrant, while a CCFP household

with more natural forests than average and/or less cropland enrolled in CCFP is not likely to have an out-migrant.

These effects of the PES programs on migration are therefore of interest not only for policy evaluation regarding their ecological (conserving forests and reforesting croplands) and socio-economic (altering rural household livelihood options) implications but also for the study of human-environment interactions more broadly (Engel et al. 2008; Raymond et al. 2013). If the overall consequences of the PES programs on livelihoods were not favorable for participating households—whatever their positive effects on re-greening the landscape—the policy effects might be *non-sustainable*. Once the PES subsidies end, will farmers revert to previous behaviors, including cutting down the new young forests to restore their land for cultivation (if the CCFP is discontinued) and selling timber for cash (if the EWFP is discontinued)? Since remittances from former household members who migrated away constitute nearly a third of mean household incomes in Tiantangzhai (Zhang 2017), understanding the factors that affect individual out-migration as a household livelihood strategy is essential for understanding the *sustainability* of the forest conservation and restoration programs, where they have been observed to have clear *environmental success* in China (Liu et al. 2008; Lu et al. 2018; Zhang et al. 2018a).

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