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People, Land, and Context: Multilevel Determinants of Off-farm Employment in the Ecuadorian Amazon

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Abstract

This paper investigates the factors that motivate decisions of settler colonists to engage in off-farm employment (OFE) in the Northern Ecuadorian Amazon (NEA). Overall, OFE, as a type of population mobility, may increasingly become a dominant demographic factor in rural frontier regions. Although OFE decisions are primarily a matter of individual choice, factors associated with the farm household and the local community also play key roles in this decision-making. This paper applies a multilevel conceptual framework and uses a multinomial, multilevel statistical model to study OFE in the NEA in 1999 as a result of factors at the individual, farm household, and community levels. The results show important differences between OFE participation choices in personal characteristics, human capital, farm household life cycle, land use, land management, farm environmental conditions, transportation accessibility, community size, and structure of local labor markets. The paper also identifies the effects of policy-relevant variables on choices to engage in OFE in local community, other rural, or urban areas of destination.

Keywords

Population mobility; rural livelihoods; Amazon; multilevel models

INTRODUCTION

Population mobility is one of the most important catalysts of regional change and implies important demographic and economic consequences for movers and their households, changes in communities of origin and destination, and the spatial distribution of labor. This is the case of the Northern Ecuadorian Amazon (NEA), one of the richest reserves of biodiversity in the world, which has faced profound changes due to population redistribution and mobility. A key component of population mobility, particularly in the Amazon, is off-farm employment (OFE), which involves temporary movements such as commuting or seasonal mobility, but do not imply a permanent change of residence. Since the 1990s, OFE

has been greatly adopted as a strategy of risk diversification and income maximization within the NEA (Barbieri, 2006; Barbieri et al., 2009)³.

However, OFE has not been sufficient to alleviate poverty, environmental degradation and underemployment in the frontier nor in the areas of origin (Bilsborrow, 1998; Barbieri, 2006). In fragile tropical environments such as the NEA, an assessment of the causes of population mobility is particularly important to understand the underlying causes of increasing deforestation, urbanization, and changes in income and welfare in the population.

Although OFE decisions are primarily a matter of individual choice, factors associated with characteristics of the farm household and local community also play key roles in decision-making. Little empirical research, however, has been done on the *simultaneous* identification of such factors and their effects on shaping decisions to move in developing countries, and particularly in Amazonian countries. This paper uses a multilevel approach to study OFE which clarifies key associations between rural livelihoods and mobility strategies in frontier areas and articulates three distinct analytical levels: individuals, farm households, and communities. The literature on population mobility and rural livelihoods show a paucity of this type of approach, has relied on single-level approaches that only scratch the complexity involved in population mobility, and usually does not incorporate intergenerational characteristics associated with family succession nor the effects of context on population mobility. This limitation is, to a great extent, the result of disciplinary biases and fragmentation of theoretical perspectives in the empirical literature (Brettell and Hollifield, 2000), and the scarcity of data at multiple scales.

POPULATION MOBILITY AND RURAL LIVELIHOODS

This paper discusses the multi-level structure⁴ of determinants of OFE based on three theoretical approaches which places key individual and collective, familial decisions at the household level: (1) “household life cycle”, (2) “livelihood approaches”, and (3) “Theory of the Multiphasic Response”. These theories have been particularly useful to understand strategies and motivations regarding population mobility - both migration, which includes a permanent change of residence, and temporary movements such as commuting or seasonal mobility, which do not include permanent changes of residence. They also take into account individual aspirations of income and welfare, as well as collective needs of familiar group(s) in rural settings and the context (community, region, nation) in which these decisions are made.

“Household life cycle” approaches discuss how demographic and land use processes at the household level are intertwined and determine, at a given time, a particular demand and supply of labor. As households transition through stages, the supply of labor often exceeds

³This OFE definition coincides with the concept of circulation proposed by Zelinsky (1971): a sporadic and seasonal movement for employment and income generation reasons in which the migrant has no intention of a permanent or long-lasting change in residence.

⁴Gibson et al. (2000, p. 291) define scale as the “spatial, temporal, quantitative, or analytical dimensions used to measure and study any phenomenon”. While the concept of a “multi-scale approach” may be more adequate to refer to multiple levels along spatial and temporal scales, the concept “multilevel” has been used mostly in the literature on population studies to describe regions on spatial scales. This paper also uses this approach, and defines the concept of “level” to describe a “region” along a spatial scale. Following the empirical literature on population mobility (Zhu, 1998; Yang and Guo, 1999; Ezra, 2003; Henry et al., 2003), three regions along a spatial scale are defined in this study: (1) individuals, (2) farm households, and (3) communities.

on-farm labor demand and households are increasingly able to formulate strategies of income or consumption maximization and risk diversification. These approaches draw upon Chayanov's theory of the peasant household (Thorner *et al.*, 1986; Ellis 1988; Leinbach and Smith, 1994) and have been adapted by several authors to the Amazonian context (e.g., Walker and Homma 1996; Marquette 1998; Perz 2001; McCracken *et al.* 2002; Walker *et al.*, 2002; Barbieri *et al.*, 2005; Barbieri *et al.*, 2009).

Household dimensions of wellbeing are also discussed within the conceptual *rural livelihood framework* (Sherbinin *et al.*, 2008; Ellis, 1988). According to the authors, a household livelihood strategy can be seen as a portfolio of assets grouped in five types of capital, which are accumulated over time and are shaped by contextual factors such as social, cultural, political and economic opportunities and constraints (Sherbinin *et al.*, 2008):

- 1) "Natural capital: the natural resource stock, or local environmental endowment (including water, wind, soil, forest resources); 2) Social capital: social resources, such as interpersonal networks, membership in groups, relationships of trust, access to wider institutions of society; 3) Human capital: including formal and informal education, local ecological knowledge, the ability to work, and good health; 4) Physical capital: including productive assets held by the household (land, tools, oxen) as well as communal assets to which they have access (roads, communication infrastructure such as radio broadcasts); 5) Financial capital: typically, the most fungible of assets, including cash savings, supplies of credit, or regular remittances and pensions".

In an original formulation by Davis (1963), the "Theory of the Multiphasic Response" explains how family decisions to migrate or change fertility behavior are alternative responses to population pressures on limited resources. Based on the experience of the industrializing of Japan and Europe in the 1940s and 1950s, Davis suggested that the decline in mortality, sustained natural increase, and the consequent population pressures on land are a powerful stimulus for families to control fertility through demographic responses, such as marriage postponement, contraception, sterilization, abortion, and as a last resource, migration outward (if the other responses proved inadequate). Motivations to adopt one response, or a combination of responses, are linked to the fact that families associate population growth with the loss of opportunities to maximize status and welfare. Responses are concurrent (or "multiphasic") in the sense that households can adopt responses simultaneously as a result of population pressures (i.e., the higher the prevalence of one type of response and the higher its effectiveness in relieving negative pressures on living standards, the less likely other responses will occur) (Bilsborrow *et al.*, 1987).

Bilsborrow *et al.*, (1987) and Bilsborrow and Okoth-Ogendo (1992) suggest that the Theory of the Multiphasic Response as proposed by Davis (1963) is not adequate to consider the effects of nondemographic responses in the face of threats to living standards in rural areas, which include the application of a new technology in the agricultural system (land intensification) and the extension of the land area under cultivation. The incorporation of these responses proposed by Bilsborrow and colleagues is an important step to expand the range of responses and to explicitly incorporate labor mobility as a response to population pressures on farm resources, together with land management strategies (extensification and

extensification) and fertility regulation. These are the four concurrent strategies to diversify risk and achieve desirable income and welfare levels.

These three approaches are inherently intertwined in their views of poverty, natural resource use and population mobility, and define key dimensions or variables that influence population mobility. They implicitly assume the selective nature of migration, since the chosen mover in a household is most likely the one with better personal endowments or attributes (e.g., higher education and OFE experience, being younger, or women moving proportionately more to urban areas compared with men). This selective nature of OFE is discussed in Human Capital approaches on migration, which focus on individual decision-making processes based on individual factors such as age, sex, education, marital status, and occupational background (Sjaastad, 1962; Becker, 1964; Mincer, 1978; De Jong *et al.*, 1981; Da Vanzo, 1981; Massey, 1990; Milne, 1991). Labor mobility is considered a form of investment to maximize income and involves a rational calculus of all the expected monetary costs and benefits over a certain range of time, which affects income based on the decision to move (Wood, 1982). Mobility is thus expected to generate more benefits to the household, especially in terms of remittances (Stark and Levhari, 1982).

The three approaches also consider that households have a portfolio of options to assure a desired welfare and income levels. The portfolio is adjusted to different combinations of land use options suitable to household demographic structure and structural constraints (life cycle approaches), possibilities of increasing or exchanging assets or “capitals” owned by the household (livelihood approaches), and multiphasic demographic and economic responses to perceived changes in household welfare (theory of multiphasic responses). Mobility is thus seen as a strategy of risk diversification and minimization, which can eventually lead households to a “suboptimal” decision to allocate their resources. In other words, and as suggested by the “The New Economics of Labor Migration”, Stark and Bloom, 1985; Stark and Lucas, 1988; Stark and Taylor, 1991), households “trade” absolute income maximization strategies for strategies towards a safer, smaller income level that assures less risk to household income and welfare levels

Finally, OFE decisions take into account the broader socioeconomic and political context. In particular, urbanization is a dimension which demands increasing attention in the literature on frontier areas (Bilsborrow, 1998). Socioeconomic and institutional factors mediating mobility decisions can include, for example, the segmentation of labor markets; policies fostering the opening of roads; inadequate credit or titling policies; and other social, cultural, and political-institutional factors. In particular, policies fostering the opening of roads in frontier areas have reduced physical and economic barriers to population mobility into, or within, rural areas in the Amazon (e.g., Moran, 1983; Rudel, 1983; Schmink and Wood, 1984; Southgate *et al.*, 1991; Almeida, 1992; Pichón, 1996; Nelson and Hellerstein, 1997; Pichón, 1997; Rudel and Roper, 1997; Laurian *et al.*, 1998; Pfaff *et al.* 2010). Road accessibility in frontier areas allows the expansion of consumer markets for agricultural and other types of products in a region, as well as facilitates the mobility of labor within and outside the region, and facilitates policies on property rights, subsidizing lands, or open (or cheap) access to land (e.g., Lisansky, 1990; Almeida, 1992; Angelsen, 1999).

Figure 1 synthesizes the inter-related nature of the three theoretical approaches by showing the positive or negative associations with OFE (or, in other words, acting as incentives or constraints to OFE). It shows the multi-scale structure of incentives and constraints of moving or staying. For example, while population mobility is one of the key household responses to perceived changes in living standards, it does not necessarily follow land management strategies or precede fertility decline, as discussed in the Multiphasic Response model. Household strategies on land management and population mobility can be influenced by, among other factors, individual aspirations, household size, household composition and strategies to diversify risk, as well as perceptions of opportunities and constraints imposed by various community factors (e.g., decreasing costs to move due to transportation improvements, migrant networks, availability of credit for small farmers, etc).

Hypotheses

Based upon the preceding discussion and on the theoretical framework depicted in Figure 1, hypotheses can be defined about key determinants of OFE at three levels: individuals, farm households, and communities⁵. These hypotheses will be tested further in this paper through a multilevel model. In Figure 1, straight arrows represent the direct, independent effects of variables at the individual, farm household and community levels on OFE. Testing the hypotheses refers mainly to these effects, which are derived from the literature on population mobility. The dashed arrows indicate that factors at a lower level of aggregation are likely to be influenced by factors at higher levels. For example, community variables act through individual and farm household variables, in which case the dotted arrows means that community factors affecting mobility are “filtered” down at the farm household and individual levels. Since individuals are nested within households and households are nested within communities, information at a lower level is not independent, and the conceptual model indicates that the effects of clustered information should be accounted for when analyzing the effects of independent variables on OFE.

At the **individual level**, a group of variables measures the effects of *personal attributes* on the selectivity of OFE. Following virtually all studies on migration selectivity since Ravenstein (1889) and Lee (1966), OFE is associated with stages in individual life cycles characterized by *younger ages*. *Gender* also tends to be a significant personal characteristic affecting mobility, with women moving proportionately more to urban areas compared with men. Closely related to age and gender but measuring a distinct concept, *marital status* is expected to be a significant predictor of mobility. Singles tend to move proportionally more than married couples; singles also move more to urban areas, while married couples move proportionally more to rural areas.

Another group of variables measures the effects of *human capital* on OFE. Individuals with *farm work experience only* tend to move more to rural areas or do not move; those without

⁵Farm households in the Northern Ecuadorian Amazon can be associated with a reference community consisting of a population center (centro poblado) where some basic infrastructure and services can be found. Farm households are usually located near the centro poblado and secondary roads crossing the community, though most are dispersed given the large size of plots and the fact that farmers usually live on their plots, not in the centro poblado. There is a high variability in community size and characteristics, with some presenting only minimal infrastructure and services while others have diversified infrastructure and services, such as Lago Agrio—the largest town in the region.

farm work experience tend to move to urban areas. Finally, it can be expected that farm households, particularly in urban areas, tend to select individuals with *higher education* and previous off-farm experience for OFE, since expected income returns are higher.

At the **farm household level**, some hypotheses measure the effects of *household composition and life cycle* on OFE. *Age of household head* indicates how a particular living experience in the settled area influences household decisions to allocate a member on OFE or not. Older age of the household head may imply less mobility because it implies a position in the life cycle where older individuals usually have a smaller insertion in off-farm labor markets. *Number of adults and adolescents at working ages* and *number of children* test the relationship between producers and consumers and OFE from the farm households. It is hypothesized that a higher number of producers (adults or working-age adolescents) reduces returns to labor at the farm and thus incentivizes mobility, while a larger number of children can imply a situation of labor scarcity and thus higher returns to labor, which decreases incentives to move.

Among *land use* hypotheses, a high proportion of *land in crops or perennials* demands more labor, thus negatively impacting mobility; a higher proportion of *land on pasture* also has a negative impact on OFE but to a smaller extent compared with crops and perennials, since it usually demands less labor.

Among *land management hypotheses*, land extensification as indicated by a *larger farm area* tends to reduce OFE. This relationship is predicated in our knowledge about patterns of land use in the study area, where land extensification is linked to farmland consolidation (particularly for cattle ranching) and several constrains in terms of labor and technology supply. Thus adding farmland is usually not linked to increases in the ratio labor / land output or adding capital. Land intensification as indicated by the use of *chemical inputs*, tends to reduce OFE, due to higher farm yields and productivity and thus reducing the necessity of supplemental off-farm income (see, e.g., Bilsborrow et al., 1987). Furthermore, the hypothesis of a negative effect of intensification on OFE is predicted on a specificity of household life cycles: land intensification requires more capital which is possible only for households at later stages in the life cycle (when accumulation of capital is possible); more capital, combined with labor shortages due to the out-migration of adult sons and daughters as predicted by the theory, favors investment in intensification to compensate labor shortage and retain the (already smaller) farm labor pool.

Hired farm labor can be regarded as an indication of either land intensification, since it can reflect a higher labor input for a fixed amount of land, or land extensification, if the hired labor is for activities such as land clearing. Hired labor's effect on OFE is dubious. It can reflect labor shortages at the farm household level (e.g., a small household size with a scarcity of adult or adolescent labor, or a large household size but a high proportion of non-working children). Based on our knowledge on the study area, we may also suggest that hired labor reflects a more complex household strategy in which household labor is allocated for more profitable off-farm activities (particularly in urban areas) and cheap labor is hired in substitution. *Land title* suggests a degree of land security and consequently a settler's commitment to live, invest, and produce on their land, thus being negatively associated with

OFE. Finally, *credit or technical assistance* indicates the accessibility to resources that allows improvements in farm production and living conditions and an investment in land intensification or extensification, with a corresponding reduction in OFE.

Two additional hypotheses are tested at the farm household level. *Environmental contamination* measures if the farm had any form of environmental contamination (soil, air or water), thus damaging the prevailing stock of natural capital. It is expected that environmental contamination degrades farm resources and human health and thus impacts OFE positively. *Walking distance* indicates the distance, in kilometers, from the farm household to the nearest road and thus access to several types of markets. It is expected that the greater the walking distance, the less the mobility from farm households, especially for types of OFE which imply higher mobility—such as commuting.

Among **community level** hypotheses, *distance to the nearest town* measures the distance, in kilometers, from a reference point in the community (e.g., a school) to the closest town. It is assumed that a closer proximity to a town facilitates circulation of people and goods, increasing OFE, and decreasing out-migration. *Community size* refers to the population of the four towns and rural communities of origin of those engaged or not in OFE, and how their characteristics may act to retain labor. These communities may have basic infrastructure such as electricity; local markets (complementary to town markets); health, educational, religious and educational services; and roads linking to larger towns. Furthermore, they might increasingly acquire urban features as they grow, creating new employment opportunities, opportunities for social interaction, economies of scale for investments in infrastructure, political force, or facilitating labor fluxes between community residents and other places. Larger communities, in particular the four main towns, are associated with urban features and a pattern of social organization that can facilitate the retention of potential movers. Finally, two hypotheses test the effects of *labor markets* on OFE: communities with a larger *secondary sector*, and communities with a larger *tertiary sector* absorb surpluses of rural labor force in the community, increasing local mobility due to local OFE opportunities⁶.

THE NORTHERN ECUADORIAN AMAZON

The Ecuadorian Amazon, a region also known in Ecuador as the “Oriente”, is located in the western Amazon Rain Forest and together with the Coastal region and the Highlands (“Sierra”) represents three distinct landscapes in the country (Figure 1). The study area in the Northern Ecuadorian Amazon (NEA) encompasses the provinces of Sucumbios (which includes the towns of Lago Agrio and Shushufindi) and Orellana (which includes the towns of Coca and La Joya de Los Sachas). The NEA is a rural agricultural frontier, which is characterized by excess land, limited infrastructure, and low population density (thus scarce labor and capital).

⁶The tertiary sector included low paid, formal, and semi-formal activities in retail, transportation, commercialization, etc., as well as informal activities such as domestic service, which may constitute a broad source of employment for community population, and an alternative for the allocation of farm labor during some part of the year. The secondary sector refers mostly oil extraction, but also agricultural processing, such as coffee roasters, rice huskers and sawmills

While oil exploration in the NEA dates from 1940, the study area only began to be occupied by agricultural settler families after the discovery of extensive and commercially viable reserves of oil in 1967. This was followed by the laying of pipelines and a road network for the exploitation of oil and the establishment of the town of Lago Agrio. A consortium led by Texaco was responsible for constructing trunk roads from Quito east to Lago Agrio and Coca, in the NEA (Bromley, 1981). From the mid-1970s to the present, the oil exploited in the NEA has generally been responsible for producing half or more of both foreign exchange earnings and government revenues in Ecuador (Bilsborrow *et al.*, 2004).

Virtually all of the colonization in the NEA has been spontaneous by impoverished settlers who arrived without capital to invest in their plots and faced a lack of infrastructure or governmental assistance. Two of the main drivers of colonization were a) the opening of roads by oil companies which greatly improved physical accessibility, and b) the concentrated agrarian pressures in the Sierra.

DATA AND METHODS

Data are from a sample of 611 farm households in the NEA interviewed 1999. The sample was selected via a two-stage PPS (Probabilities Proportional to Size) selection of land plots in 1990 in which all farms located on the plots were included (see detailed description in Bilsborrow *et al.*, 2004). The total population living on the 611 farm households was 3,746, from which 2,216 were aged 12–59 y. A separate community-level survey was undertaken in 2001 and obtained information on 60 rural communities, 43 of which are linked to the 611 sample farms. A farm household is considered to be associated with a specific community if the road distance (in Km) between the farm household and the central point in the community (such as the community center or school) is the shortest one, compared with other communities in the sample region. The community dataset is complemented by information provided by the 2001 Ecuadorian Census on the community population and labor force by the sector of economic activity (primary, secondary, and tertiary sectors).

We use a generalized linear multilevel model to test the associations between individual, household and community level factors, and OFE⁷. A GLMM is specified by defining a link function, $g(\cdot)$, for the expected value of the outcome, μ , that is linearly related to a set of explanatory variables and random effects (Raudenbush and Bryk, 2002). Therefore, let y_{ijk} indicate whether individual i in farm household j and community k participated in OFE (=1) or not (=0); then we can write $\mu_{ijk} = E(y_{ijk} | u_{jk})$ and:

$$g(\mu_{ijk}) = \gamma_{000} + \sum_{i=1}^n (\gamma_i a_{ijk}) + \sum_{j=1}^p (\gamma_j x_{jk}) + \sum_{k=1}^q (\gamma_k w_k) + (u_{0jk} + u_{00k}) \quad (1)$$

⁷Overall, the great advantage of multilevel statistical models is to fully specify the distribution of the population by introducing a random coefficient which measures the extent to which the mobility of individuals in the same farm household or community resembles each other as compared with the mobility of individuals in different farm households and communities. The consequence is usually better estimates of fixed effects and more efficient estimates of variance.

where γ_{000} represents the intercept; $\sum_{i=1}^n (\gamma_i a_{ijk}) + \sum_{j=1}^p (\gamma_j x_{jk}) + \sum_{k=1}^q (\gamma_k w_k)$ represents $i=(1,2,\dots,n)$, $j=(1,2,\dots,611)$, and $k=(1,2,\dots,43)$ independent variables at the individual (a), household (x), community (w) levels, respectively; γ_i , γ_j and γ_k represent estimated effects of each independent variable at the individual, household or community levels, respectively; and the u terms are random effects representing unobserved factors operating at the household and community levels. The random effects are assumed to be normally distributed [$u \sim N(0, \sigma^2_u I)$]. When we consider the choice of OFE participation or not, we can use the logit link function, in which case model results are interpreted in terms of log-odds ratios. Further, when we consider the discrete choice of OFE by location (local community vs. another rural area vs. another urban area) vs. the choice of not participating in OFE, we can use the multinomial link function. The multinomial link function is written below along with the linear predictor, assuming that r refers to response categories 1, 2, or 3 and response category 4 is the choice not to participate in OFE:

$$g(\mu) = \log \left(\frac{\Pr(y_{ijk} = r | a, x, w)}{\Pr(y_{ijk} = 4 | a, x, w)} \right) = \gamma_{000} + \sum_{i=1}^n (\gamma_{ir} a_{ijk}) + \sum_{j=1}^p (\gamma_{jr} x_{jk}) + \sum_{k=1}^q (\gamma_{kr} w_k) + (\gamma_{0jk} + \gamma_{00k}).$$

The coefficients γ_{ir} , γ_{jr} , γ_{kr} represent the log-odds of OFE in location r versus no OFE (the baseline).

The risk of OFE is estimated for individuals aged 12–59 y, thus assuring age limits that deal only with persons old enough to be directly involved in OFE, but not so old as to not move due to declining health or retirement.

RESULTS

Descriptive results

Table 1 shows the percentages and standard deviations for **individual-level explanatory variables** included in the model of the determinants of OFE, according to place of destination (1998–1999)⁸. Individuals engaged in OFE were mostly in the older age groups (> 24 y). Considering the young age pattern of marriage, common in frontier areas, this may suggest that OFE was predominantly a household strategy of income generation and risk diversification involving older farm household members, especially the head, his wife or older sons or daughters—probably in periods when demand for farm labor was low (e.g., between planting and harvesting seasons). Finally, the results showed a younger age composition of the farm labor force (i.e., those not engaged in OFE).

Among variables measuring *personal attributes*, compared to men, women were mostly associated with greater mobility to urban areas, or remaining in the farm and having little

⁸Barbieri (2006) shows that: 23% of the entire sample population was engaged in OFE in the twelve months preceding the survey interview in 1999 (507 individuals of the 2,216 at risk population). Agricultural labor was by far the most common type of OFE, involving 13% of the total sample population and 57% of all OFE. Most of the agricultural OFE labor was in the community (78%). “Services” were the second most common type of OFE, especially in urban areas (44% of workers in this type of employment) and in the community (30%). “Professional/technical” and “Other” employment opportunities were mostly concentrated in urban areas (54% and 56%, respectively), while manual work in oil companies was mostly in rural areas (71%). “Self-employment” occurred mostly in urban areas or within the community.

insertion in the local community or rural OFE. Table 1 also shows virtually no difference between movers regarding marital status; the majority of those looking for community, rural, or urban employment were married or in other forms of consensual union, with equal numbers of singles and married not engaged in off-farm work.

Among *human capital variables*, there was little difference between education level of those involved in short-range employment mobility (OFE in the local community) and those not engaged in OFE. However, the difference was much greater for those working in other urban or rural areas (longer range mobility) that had considerably higher educational attainment. In particular, those engaged in urban OFE had more education, which was expected, given the requirements of higher education for many urban jobs. Overall, the results suggest that those with more education were more likely to take advantage of employment opportunities farther from their farms, due for example, to more access to information as well as access to labor markets where higher education was required.

Table 1 shows little difference across groups engaged in farm work except for those working in urban areas. In this case, engagement in farm work and urban employment had a smaller association. There was a higher association between those engaged in farm work and those involved in OFE in the community. Obviously this reflects, as expected, the fact that being a short distance from employment opportunities in the community facilitated commuting.

Table 2 shows the percentages and standard deviations for **farm household-level explanatory variables** included in the model of the determinants of OFE, according to place of destination (1998–1999). Among *farm household composition and life cycle* variables, there are small differences between the ages of the household head across places of OFE. The slightly lower mean age for those choosing urban destinations could indicate an association between earlier positions at the farm household life cycle and urban employment, but also the effects of weighting household variables by person-weight (see footnote in Table 2). Those not engaged in OFE had the oldest age of household head, indicating that older cohorts of colonists may have had less access, or desire, to engage in OFE.

The results show an association between large household size (numbers of adults and children) and OFE outside the local community—specifically in the case for other rural areas—and non-engagement in off-farm work. This suggests that larger households may allocate family labor in traditional rural activities within the farm or elsewhere, with the largest also having enough members to allocate to rural work. On the other hand, those in which someone engaged in urban work were much smaller in terms of both numbers of adults and children in the household.

Urban OFE was associated with a smaller number of children. The smaller number of children and a smaller farm size may facilitate urban work; urban work is the most incompatible with child care and a small farm size (see farm area below) means that there is less need for farm labor, freeing up labor. However, the most important factor in urban OFE was probably the much higher education of this group, as discussed previously.

Among *land use* variables, Table 2 shows that that most land in the NEA farms was in pasture rather than crops/perennials. Farms with less land in crops/perennials and in pasture were more likely to have people involved in OFE. Considering places of OFE, farms with more land in pasture were more likely to have people working in other urban areas. This may indicate an important association with strategies of allocating labor to urban areas and investment in pasture and cattle. Individuals not engaged in OFE usually had more land in crops/perennials and pasture (as well as larger farms), suggesting, other things equal, a strategy of income generation based on farm production using household labor.

Among *land management* variables, as expected, having more land was associated with a less likely engagement in OFE. Among those in OFE, farms with more land were associated with people involved in rural off-farm work. Smaller farms tended to be associated with OFE in the community or in urban areas. Table 2 also shows that lack of land security was more associated with OFE, especially within the local community (that is, short-range mobility). Thus, land insecurity may have limited job search to the immediate community. Farm households with less use of credit and technical assistance were more likely to have members engaged in OFE, especially in urban areas, perhaps because they did not seek such assistance, or lacking it, were not as successful in their farm work, so they sought urban work.

Two variables measured land intensification: chemical inputs and hired labor. Less use of chemical inputs was linked to people more likely to be engaged in OFE, especially in the community or other urban areas. The higher land productivity, if associated with land intensification, may have helped retain farm labor. The other relevant variable available was hired labor, which may refer mainly to land intensification. Hired labor was much higher for farm households with individuals engaged in either rural or urban employment away from the local community, as expected. This may suggest a substitution of farm labor for hired labor; in particular, since women tended to be proportionally more engaged in urban employment than men, this may reflect farm labor allocation decisions in which female farm labor was replaced by hired (usually male) farm labor.

Table 2 shows that a higher proportion of individuals living in farms with *environmental contamination* (particularly oil spills) were associated with OFE in other rural areas. This may indicate limitations in farm production due to the contamination of natural resources, with farm households looking more for off-farm supplemental sources of income. Finally, shorter walking distances to the nearest road seemed to be a facilitator of urban OFE. There evidently was a powerful effect of walking access to the farms on the ability to engage in urban employment. This was particularly relevant for women, due to their proportionally higher insertion in urban labor markets.

Table 3 shows the percentages and standard deviations for **community-level explanatory variables** included in the model of the determinants of OFE, according to place of destination (1998–1999). *Distance from the community* center (more specifically, from a geo-referenced landmark in the center of the community, such as a local school, a road intersection, or community center) to the nearest town shows small differences between urban off-farm work, other places of OFE, or no engagement in OFE. Again, it shows that

farms closer to towns were more likely to have people in OFE overall, especially in urban areas.

Farm households located in *larger communities* were more likely to have individuals working in urban markets. Larger communities had infrastructure and other characteristics, such as higher education and an “urban-like life style”, and offered more possibilities for urban employment. At the other extreme, smaller communities were more associated with local community OFE. Finally, there were virtually no differences between those engaging in OFE and those not moving, in terms of the proportion of labor force in the *secondary sector*. This was because employment in the secondary sector was low, and tended to be similar between smaller and larger towns. On the other hand, farms near communities with a larger *tertiary sector* were more likely to have people engaged in urban areas OFE. This may be explained by the broad composition of activities in the tertiary sector.

Results of the multilevel model⁹

Four models are estimated. Model 1 estimates the determinants of OFE vs. not OFE, without taking into places of destination, while alternatives a, b and c of Model 2 distinguish, respectively, between OFE in the local community, in other rural areas, or in other urban areas vs. not OFE. Model fit was good, with the BIC statistic indicating improved model fit with each model (BIC statistics were X1, X2, X3, and X4 for Models 1, 2a, 2b, and 2c, respectively). For ease of presentation, the results are divided in three parts, each with a table showing the coefficient estimates followed by a table showing the estimates of percent change in the odds ratio: a) the results for individual effects, b) the results for household effects, and c) the results for community effects. Albeit presented separately, the regression results for individual, household and community effects are from a single model as discussed in the “Data and Methods” section.

Individual level—Table 4 shows coefficient estimates and the percent change in the odds ratio of individual-level variables in the multilevel models of OFE. An individual in the intermediate age groups (18–24 and 25–34) in Model 1, had lower odds to be engaged in OFE than an individual in the age group 12–17. In fact, for an individual between 18 and 24, the odds of working away were almost 100% less compared with an individual in the age group 12–17 (Models 2a, 2b and 2c); and an individual aged 25–34 was also less likely to move away, albeit the odds were less. The youngest were most likely to engage in temporary (rather than permanent mobility such as out-migration) forms of mobility due to their age, lack of experience in working for pay, and higher bonds to the farm household (e.g., cultural or social norms which made it difficult to move away from the farm at a young age) (Barbieri and Carr, 2005). The only exception in Table 5 was for those in the age group 35–59 engaged in urban work; the odds of OFE were 20.5% *higher* than in the reference group (12–17). A person in this age group who engaged in urban OFE was probably the household head or his spouse.

⁹Collinearity tests between the variables were used in order to fit the Models 1 to 2.

The coefficient estimates and odds ratios show that women were much less likely to engage in OFE than men. Women tended to be more engaged in urban activities, as shown in Table 1; even though, the odds of OFE were still considerably higher for males (122%), contrary to expectations. It is likely here that gendered characteristics of OFE were different from out-migration (permanent change of residence), in which case women had higher odds to move to urban areas when compared with men (Laurian *et al.*, 1998; Barbieri and Carr, 2005). The effect of being single was significant only for community OFE; the odds of being in OFE decreased by 36% when compared with a married individual. However, the statistical significance is low ($5\% < p < 10\%$). This is probably related to the older age pattern involved in this type of mobility, with movers usually being the head of household, as suggested in Table 1.

Education was not significant in the overall model of OFE (vs. not in the OFE; Model 1), but had a distinct effect when community or urban OFE was considered. Regarding urban work destinations, the results confirmed the hypothesis, showing a highly significant effect of human capital on urban employment; having at least some secondary education increased the odds that an individual would engage in urban OFE—by almost 300%. Individuals with higher education were more likely to work in urban areas for at least some time during the year, both as a strategy to maximize income, but perhaps also due to the motivation of engagement in an “urban life style”. On the other hand, having more education implied 40% less odds of being engaged in local community off-farm work. This explains the small expected returns, both in terms of income and personal satisfaction offered by employment in the local community.

An individual with previous experience in farm work had only 36% lower odds of engagement in OFE in general (Model 1). This shows that previous farm work contributed to farm labor retention. The effects of previous farm work on OFE had, however, a distinct direction when considering OFE by place of work. While engagement in farm work increased the odds of community OFE by 70%, it decreased the odds of urban OFE by 66%. In the first case, it suggests that temporary work, for example, land clearing in other farms of the community, may have been compatible with the labor demands on the farm household. In the second case, the “opportunity cost” of urban OFE might have been high for those also involved in farm work, for example, due to transportation time costs to urban areas or the demands of specific tasks in the farm household, such as women nurturing small children. Perhaps most important, however, was the lack of occupational backgrounds in other activities since farming offers few skills useful for urban activities.

Farm household level¹⁰—Table 5 shows that one additional adult living in the farm household slightly increased the odds that an individual would engage in overall OFE (Model 1), but the result was only marginally significant. Among destinations, the data

¹⁰The random effects at the farm household level (results not shown) were statistically significant in all models except Model 2c (urban OFE), indicating that, after controlling for all fixed effects (independent variables) at the farm household-level, there was still unexplained farm household variation in the models. An implication is that, in Models 1, 2a and 2b, individuals within the same farm households had mobility behavior more alike than that of individuals in other farm households because they shared unmeasured characteristics. On the other hand, the fixed effects variables were sufficient to explain OFE in urban areas, as shown by the non-significant random effect. There was not a significant unexplained variance in the model for urban OFE

showed that the main significant effect was on increasing the local community OFE; one additional adult increased the odds by almost half. As expected, given decreasing returns to farm labor, households with larger numbers of adults appeared more likely to allocate adult labor in the local community OFE during some part of the year.

An additional child in the farm household had no effects on overall OFE (Model 1) but did significantly increase the odds of OFE in each locus of work or OFE, contrary to expectations. The highest effect was for rural OFE, with the odds increasing 38% for each additional child. The smaller percent changes in odds ratios occurred for urban OFE (20%) and in community OFE (28%). These results showed that, rather than an incentive to retain farm labor, households allocated farm labor more to a variety of off-farm activities to meet the higher subsistence or welfare needs of an increasing number of consumers.

Finally, the age of the household head was significant and had an inverse relationship in all models in Table 5, as expected. The largest effects occurred for work in the local community or urban employment; one additional year in the age of the household head decreased the odds of OFE by 6%. The age effect on rural OFE (2%) was smaller than on urban OFE.

Table 5 shows that land use variables had an inverse relationship with OFE in all models. Overall, the results suggested a strong association between land use and labor on the farm¹¹. Model 1, for example, showed that one additional hectare of land in crop or perennials was associated with 12% smaller odds that an individual would engage in OFE, while the association is only 2.5% in the case of land used as pasture. (Remembering that since land size is controlled for, the variables reflected land use share). These are strong results, consistent with theoretical expectations. When considering the place of off-farm work, the effects of land use that were significant for a specific land use were not always significant for the other; thus, one additional hectare of land in pasture was associated with a decrease in the odds that an individual would engage in community OFE by 8%, but one additional hectare in crops or perennials was associated with a decrease in the odds by twice as much for rural OFE (16%), and by 14% for urban OFE.

As expected, more farmland reduces OFE overall, but the effect was marginal except for decreasing the odds of work in the local community. These results were expected since they implied higher resources available to support the household, other things being equal. One additional hectare of farmland decreased the odds of community and urban OFE by 4.4% and 2%, respectively.

Having a land title had little effect, only slightly increasing urban OFE, in a direction contrary to expectations; a farm with land title increased the odds that one of its members would engage in OFE by 81%. If farm households in a better socioeconomic position were more likely to have land titles and if urban employment was associated with higher human

¹¹The presence of problems of endogeneity between land use variables and OFE is possible. Land use in crops/perennials and pasture, which were assumed to cause OFE, may also have been a consequence, for example, of OFE which generates income to invest in cattle, or even be jointly determined. Some control of this problem was assured in this paper by the use of lagged variables (land in pasture and crops/perennials in the year preceding the survey in 1999). Nevertheless, the analysis here avoids strong causal statements involving land use variables and OFE, focusing instead on the associations between land use and OFE.

capital (and probably higher wages), it was reasonable to observe a significant but not causal association between urban OFE and farm land title.

There was no overall effect of credit or technical assistance on overall OFE (Model 1). However, farms which received credit or technical assistance were more likely to have someone engaged in local community or rural OFE, contrary to expectations; it increased the odds by 153% in the first case and by 134% in the second case. It may be that in these cases farm households saw OFE as a way to acquire income to amortize or pay off credit or loans, while still working closer to the farm.

The use of chemical inputs had no overall effect, but farms where they were used were much less likely to have someone working away, especially in either community or urban OFE, as expected. In both cases, the odds that an individual worked away were negative and approximately 50%. It can thus be inferred that land intensification tends to increase returns to farm labor, reducing the necessity of seeking supplemental sources of income via OFE. Farms where labor was hired tended to have someone working away in urban areas. Farms which hired labor had 136% higher odds of having someone engaging in urban OFE. As suggested by the descriptive results in Table 2, it is likely here that some “substitution” of hired labor was used for on-farm household labor.

The results in Table 5 provide support for the hypothesis that environmental contamination increased population mobility in the form of OFE. The results are marginally significant for Model 1. Environmental contamination increased the odds that an individual would engage in local community and rural OFE by 172% and 188%, respectively. Given that it increased local OFE, the results imply that the contamination was not a widespread local phenomenon, and the effects might be on reducing farm production and productivity. Thus, OFE appears to be a way to supplement farm income when it is impacted by pollution.

As expected, the walking distance from the farm to the nearest road reduced OFE in general. Each additional kilometer decreased the odds of local community OFE by 13%, and urban OFE by 32%. The much higher effect for urban OFE was fully expected since distance complicated commuting to work. This result confirmed the orthodoxy in the population mobility literature about the negative effects of physical barriers on the movement of people in general (see, e.g., Ravenstein, 1889; Lee, 1966).

Community level¹²—Road distance from the local community to the nearest town was generally linked to less OFE, as expected. The results in Table 6 thus show that longer distances tended to decrease OFE. One additional kilometer decreased the odds that an individual would engage in local community OFE or in rural OFE by 4–5%. This is reasonable, since larger distances increased the costs of temporary labor mobility, especially commuting, and increased the viability of a definitive residential change (see Barbieri, 2006; Barbieri and Carr, 2005). Due to better transportation access to urban areas (e.g., regular bus

¹²The community-level random effects (not shown here) were not significant in any model; they were, in fact, close to zero in all models except Model 2a (where the effect was still too small to be significant). This suggests that the community variables in the fixed parts of the model—community size, distance to the nearest town, labor force in secondary and tertiary sectors—were sufficient to explain the community effects on OFE.

services linking communities to nearest towns), road distance was not a significant factor decreasing OFE to urban areas.

The coefficient estimate for community size is scaled in 100s (that is, the percent change in the odds of OFE refers to the effect of an additional 100 persons in the community). After controlling by community size in the multilevel model, there were no significant additional effects of variables measuring the presence of health facilities or secondary schools (which were tested, but not included in the model due to high correlation with community size). Community size was, in this case, a broad proxy for the availability of services in the community, but added the desirability of analyzing the effects of “urbanization” (in a strict sense of population growth) on OFE. The effects were marginally significant and negative, as expected, for all models of OFE, suggesting that the larger the community, the lower the probability of OFE. Considering Model 1 for example, if a community had about 100 inhabitants more, the odds that farms would have someone engaged in OFE decreased by about 2%. As communities grew, they acquired more infrastructure, services, and sources of support for settler colonists (e.g., social contacts, consumer markets) that reduced OFE opportunities.

More employment in the secondary sector in the community decreased the odds that a farm had anyone engaging in rural or urban OFE. The effects were small but in the direction expected. Thus, a larger secondary sector had some effect on retaining the labor which otherwise would have looked for employment in the secondary sector or elsewhere. On the other hand, a 10% increase in tertiary sector employment increased rural OFE by 175%, and urban OFE by 525%. Considering that an important proportion of this sector corresponded to transportation and commercialization activities, a higher articulation with urban areas was likely to increase urban OFE. Since the effects on local community OFE were not significant (though one would expect them to be significant and negative, thus offering local jobs), it is likely that the tertiary sector in local towns rarely reached a stage typical of countries at more advanced urbanization and “modernization” processes, in which the tertiary sector is a significant “pull factor” in retaining rural labor.

CONCLUSIONS AND POLICY IMPLICATIONS

At the individual level, the results show how personal attributes have strong impacts on mobility decisions. Younger individuals are much more likely to move than older ones; men tend to predominate in OFE; and married people tend to engage in OFE locally. Cultural factors may be critical in this case, substantiating mobility as a “rite de passage” (Piore, 1979) of individuals in particular life stages.

While corroborating the importance of individual factors on decisions to move, farm household and community factors have important effects on OFE decisions. Farm household factors indicate that more adults in the household stimulate OFE in local communities; OFE is higher as the number of children in the household increases; and the age of the household head effects indicate that older farm households (assuming an association between age of the head and age of the farm household) engage less in OFE. Thus, it is likely that farm household life cycle factors are key determinants of the mobility of younger household

members, which will increase (a) pressure on natural resources of the region and (b) demands on urban infrastructure and budgets. However, the former can be ameliorated by appropriate settlement and agricultural policies, and the latter by appropriate urban planning.

Overall, policies to promote socioeconomic development and environmental sustainability in the Amazon will be influenced to a major degree by how governments react to the increasingly important OFE. An important policy implication is the need to adopt a long-term planning perspective, incorporating policies such as family planning to reduce unwanted births and therefore high population growth, and thus reducing second-generation effects of past high fertility on patterns of land fragmentation, land use, and living standards. Understanding these implications of population momentum that results from past (and present) high fertility is a key factor to adequately address the future labor supply and consumption demands in urban and rural areas.

Higher shares of land in crops and perennials are an important factor because of their effects on farm labor needs. Among land management variables, having more land decreases OFE, whether in the local community or urban employment. Two land intensification variables were measured, and showed distinct effects: (1) the use of chemical inputs is linked to less OFE, while (2) having hired labor is associated with urban OFE (probably indicating a substitution of farm labor by hired labor). Land titles have little effect, and farms receiving credit and technical assistance are more likely to have members involved in OFE in the local areas (a typical strategy in the study area, of diversifying income sources to amortize or pay off credit or loans and meet consuming demands, while working closer and partially on the farm). This suggests that the search for off-farm income may be complementary to farm investments, or that the same households engage in both to increase their welfare.

The variable measuring environmental contamination shows a negative effect on the farm natural resource base and stimulates a search for off-farm income via community or rural OFE. Walking distance is negatively associated with OFE to local communities and urban areas, confirming the important role of physical barriers as constrain to population mobility.

The multilevel approach is useful to isolate the effects of policy-relevant contextual variables from individual and household factors. Community factors may reflect policies at the local level (or formulated at higher levels and “filtered down” to the local level) and indicate the context in which individual and farm household mobility decisions are taken. There are some important policy implications from community effects on OFE, albeit the results are generally weaker than those for farm household and individual variables. The size of the community is negatively associated with OFE, which may indicate that characteristics of larger urban agglomerations (e.g., better infrastructure, services, and consumer markets for farm products) seem to facilitate farm labor retention. It is important to note one potential limitation, which is that the models were fit using PQL, which might lead to inefficient standard error estimates. Gaussian adaptive quadrature would provide more efficient estimates, but the mean (fixed effect) estimates would still be unbiased. We were not concerned by this potential limitation given that prior research with these data did not find significant differences in standard error estimates for different estimation techniques (Pan et al., 2007; Pan et al., 2010).

While this paper focuses on community size as a determinant of OFE *at the origin*, it may be speculated that larger communities at places of *destination* are also a powerful mechanism to attract rural labor. This is based on the literature which suggests that the typical “urban bias” in policies in developing countries acts as a major mechanism to attract population to leave rural areas and move to urban ones (Lipton, 1977; Bilsborrow, 1998, 2002). The existing practice therefore—including in Ecuador—of channeling most public investments to urban areas in the forms of better infrastructure, public sector employment, new factories, etc, induces population mobility to urban areas (Bilsborrow, 2002).

Policies to increase the proportion of the labor force in the secondary sector in the communities of the NEA (e.g., expand oil activities and mining, small-scale industries such as food processing, etc) would seem likely to help retain rural population and reduce urban growth or land extensification and deforestation. A larger secondary sector in the community means not only more employment opportunities, but also a larger consumer market for farm products. Policies to improve farm income and reduce population mobility (particularly to urban areas) could involve incentives to invest in facilities such as coffee driers and rice huskers. On the other hand, the results indicate that policies to increase the tertiary sector will have little effect on retaining rural labor, since a large tertiary sector in the local community may be more articulated with other larger communities, improving information flows and hence leading to more OFE.

Another key issue is better planning of investments in “social overhead” of frontier areas, particularly road openings. Due to the role of oil companies in opening roads, and the indirect effect on spontaneous colonization (without previous investments in socioeconomic infrastructure), the occupation of the Ecuadorian Amazon did not involve significant public investment. While some policies fostering urban employment or the expansion of oil activities may induce rural-urban mobility, rural-rural migration to other areas of the Amazon can also be influenced by *where* new oil extraction is permitted and (not unrelated) where new roads and colonization are permitted. Apart from the macroeconomic issue (i.e., whether new roads should be allowed for oil extraction in national parks and indigenous lands) the results indicate that better road access to towns from rural communities favors OFE. Policymakers should promote technologies and methods of oil exploitation which do not imply opening roads in the middle of the Amazon forest in order to limit the extension of the road network in the NEA to areas with ongoing processes of colonization and to forbid, or at least to limit, its extension into areas of high cultural and species biodiversity, such as protected areas and indigenous lands.

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Figure 1.
Theoretical framework of Off-Farm Employment (OFE) in the Northern Ecuadorian Amazon (NEA)

Figure 2.
Study area in the Northern Ecuadorean Amazon (NEA)

Table 1

Percentages and standard deviations of independent variables, according to off-farm employment status and individual-level independent variables – Northern Ecuadorian Amazon, 1999^a

Independent variable	Place of Off-farm Employment							
	Local Community		Other Rural		Other Urban		Not in off-farm employment	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
<i>Personal attributes</i>								
Age group 12–17	0.11	0.31	0.05	0.21	0.07	0.26	0.32	0.47
Age group 18–24	0.28	0.45	0.23	0.42	0.28	0.45	0.21	0.40
Age group 25–34	0.26	0.44	0.43	0.50	0.33	0.47	0.17	0.37
Age group 35–59	0.35	0.48	0.30	0.46	0.31	0.47	0.30	0.46
Gender (0=female, 1=male)+	0.88	0.32	0.92	0.27	0.62	0.49	0.48	0.50
Marital status (0=married/in union, 1=single/not in union)	0.39	0.49	0.39	0.49	0.37	0.49	0.50	0.50
<i>Human capital</i>								
Education (1=at least some secondary)	0.49	0.50	0.58	0.49	0.74	0.44	0.52	0.50
Engagement in farm work (1=yes, 0=no)+	0.90	0.30	0.84	0.37	0.68	0.47	0.84	0.37

^aFor persons in the ages 12–59

⁺The interpretation of the percentages for age groups considers the columns; thus, 11% of people who work in a Local Community are aged 12–17, 28% are aged 18–24, 26% are aged 25–34, and 35% are aged 35–39.

Table 2

Percentages and standard deviations of independent variables according to off-farm employment status and farm household-level independent variables – Northern Ecuadorian Amazon, 1999^a

Independent variable	Place of Off-farm Employment						Not in off-farm employment	
	Local Community		Other Rural		Other Urban			
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
<i>Household life cycle</i>								
Age of household head	43.21	13.50	43.83	13.43	42.02	12.78	45.99	12.14
Number of adults	4.57	2.97	4.92	2.61	4.09	2.07	4.68	2.48
Number of children	2.63	2.14	2.70	2.03	2.14	1.54	2.72	2.13
<i>Land use</i>								
Land in crops/perennials (ha)	2.87	2.52	3.12	3.51	2.56	3.18	4.00	3.67
Land in pasture (ha)	4.13	6.82	4.54	8.28	6.23	9.84	6.66	9.56
<i>Environmental conditions</i>								
Environmental contamination (0=no, 1=yes)	0.42	0.50	0.51	0.50	0.43	0.50	0.43	0.49
<i>Land management</i>								
Farm area (ha)	21.32	18.22	28.45	25.64	24.44	20.56	30.47	26.07
Land title (1=has title)	0.33	0.47	0.41	0.49	0.41	0.50	0.44	0.50
Use of inputs (0=no, 1=yes)	0.29	0.45	0.37	0.48	0.28	0.45	0.34	0.47
Hired farm labor (0=no, 1=yes)	0.35	0.48	0.55	0.50	0.57	0.50	0.44	0.50
Credit or technical assistance (0=no, 1=yes)	0.23	0.42	0.25	0.43	0.20	0.40	0.26	0.44
<i>Transportation accessibility</i>								
Walking distance to nearest road (Km)	1.03	1.58	1.18	1.76	0.55	1.06	1.12	1.75
Road distance to nearest town (Km)	17.47	12.51	18.66	15.38	14.77	12.84	17.89	13.47

^aFor persons in the ages 12–59

Means and standard deviations are weighted by person-weights, that is, the number of individuals exposed to the risk of out-migration in the farm household in 1999. For example, a farm household with 5 individuals will have a weight 5 (and consequently household-level characteristics for this household are multiplied by five), while another household with two members will have weight two. Weighting by person-weights allows distinguishing farm household variables according to the household's composition (those engaged in community, rural or urban off-farm employment, and those not engaged in off-farm employment).

Table 3

Percentages and standard deviations of independent variables according to off-farm employment status and community-level independent variables – Northern Ecuadorian Amazon, 1999^a

Independent variable	Place of Off-farm Employment							
	Local Community		Other Rural		Other Urban		Not in off-farm employment	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
<i>Transportation accessibility</i>								
Distance to nearest town (Km)	18.55	16.00	21.02	18.01	18.54	15.82	20.60	16.14
<i>Community size</i>								
Population size	2064.11	4950.77	2816.02	5933.34	4578.59	85.14	2692.00	5506.35
<i>Labor market</i>								
Proportion of labor force in secondary sector	0.08	0.08	0.07	0.07	0.08	0.07	0.08	0.07
Proportion of labor force in tertiary sector	0.29	0.26	0.35	0.28	0.42	0.31	0.34	0.27

^aFor persons in the ages 12–59

Means and standard deviations are weighted by person-weights, that is, the number of individuals exposed to the risk of off-farm employment in a community in 1999.

Table 4

Coefficient estimates of independent individual-level variables, and percent change in the odds-ratio of being engaged in off-farm employment in 1999 for significant individual-level variables, multilevel model of off-farm employment – Northern Ecuadorian Amazon, 1999

Independent variable	Model 1: Engaged in off-farm employment vs. not in off-farm employment			Model 2a: Local Community			Place of Off-farm Employment (versus not in off-farm employment)			Model 2c: Other Urban		
	Coefficient	St. error ^a	% Change OR	Coefficient	St. error ^a	% Change OR	Coefficient	St. error ^a	% Change OR	Coefficient	St. error ^a	% Change OR
Constant	-1,416	0.407 **		-1,286	0.641		-3,147	0.749 ***		0.708	0.804	
<i>Personal attributes</i>												
Age group 18–24 (ref.:age group 12–17)	-0.303	0.176 **	-26,1	-3.834	0.351 ***	-97,8	-3,511	0.460 ***	-97,013	-3,727	0.481 ***	-97,6
Age group 25–34 (ref.:age group 12–17)	-2,410	0.256 ***	-91,0	-0,632	0.254 **	-46,8	-0,272	0.297	-23,815	-1,147	0.351 ***	-68,2
Age group above 35 (ref.:age group 12–17)	-0,393	0.190 **	-32,5	0,218	0.232	-	1,25	0.278 ***	-	0,186	0,323	20,4
Gender (ref.: 0 = female)	2,316	0.158 ***	913,5	2,417	0.211	-	2,522	0.332 ***	1145,348	0,799	0,252 ***	122,3
Marital status (ref.: 0 = married/in union)	0,075	0.188	-	-0,449	0.239 *	-36,2	-	-	-	-	-	-
<i>Human capital</i>												
Education (ref.: 0 = less than secondary education)	0,256	0.165	-	-0,513	0.232 **	-40,1	-	-	-	1,381	0,288 ***	297,9
Engagement in farm work (ref.: 0 = not engaged)	-0,450	0.196 **	-36,2	0,531	0.284 *	70,1	-	-	-	-1,093	0,301 ***	-66,5

^a significance level:

* p<0.10,

** p<0.05,

*** p<0.01 (two-tailed test)

Table 5

Coefficient estimates of independent farm household-level variables, and percent change in the odds-ratio of being engaged in off-farm employment in 1999 for significant farm household-level variables, multilevel model of off-farm employment – Northern Ecuadorian Amazon, 1999

Independent variable	Model 1: Engaged in off-farm employment vs. not in off-farm employment			Place of Off-farm Employment (versus not in off-farm employment)					
				Model 2a: Local Community			Model 2b: Other Rural		
	Coefficient	St. error ^a	% Change OR	Coefficient	St. error ^a	% Change OR	Coefficient	St. error ^a	% Change OR
<i>Household life cycle</i>									
Age of household head	−0.018	0.008**	−1.8	−0.061	0.012***	−5.9	−0.024	0.012**	−2.4
Number of adults	0.078	0.042*	8.1	0.389	0.066***	47.6	-	-	-
Number of children	−0.027	0.040	-	0.246	0.060***	27.9	0.325	0.074***	38.4
<i>Land use</i>									
Land in crops/perennials (ha)	−0.124	0.027***	−11.7	-	-	-	−0.172	0.050***	−15.8
Land in pasture (ha)	−0.026	0.011**	−2.6	−0.081	0.019***	−7.8	-	-	-
<i>Environmental conditions</i>									
Environmental contamination (ref.: 0 = no contamination)	0.274	0.155*	31.5	1.002	0.235***	172.4	1.057	0.293***	187.8
<i>Land management</i>									
Farm area (ha)	−0.007	0.004*	−0.7	−0.045	0.007***	−4.4	-	-	-
Land title (ref.: 0 = no title)	−0.155	0.187	-	-	-	-	-	-	-
Use of inputs (ref.: 0 = no use)	−0.160	0.165	-	−0.740	0.245***	−52.3	-	-	-
Hired farm labor (ref.: 0 = did not hire)	0.223	0.162	-	-	-	-	-	-	-
Credit or technical assistance (ref.:0=no credit or assistance)	0.019	0.191	-	0.927	0.281***	152.7	0.851	0.345**	134.2
<i>Transportation accessibility</i>									
Walking distance to nearest road (Km)	−0.087	0.048*	−8.3	−0.144	0.072**	−13.4	-	-	-

^a significance level:

* p<0.10,

** p<0.05,

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Table 6

Coefficient estimates of independent community-level variables, and percent change in the odds-ratio of being engaged in off-farm employment in 1999 for significant community-level variables, multilevel model of off-farm employment – Northern Ecuadorian Amazon, 1999

Independent variable	Model 1: Engaged in off-farm employment vs. not in off-farm employment				Place of Off-farm Employment (versus not in off-farm employment)										
	Model 2a: Local Community				Model 2b: Other Rural				Model 2c: Other Urban						
	Coefficient	St. error ^a	% Change OR		Coefficient	St. error ^a	% Change OR		Coefficient	St. error ^a	% Change OR				
<i>Transportation accessibility</i>															
Distance to nearest town (Km)	−0,028	0.017 *	−2,8		−0,048	0.023 **	−4,7		−0,043	0.026 **	−4,2		-	-	-
Squared distance to nearest town	0,000	0.000 *			0,001	0.000 *			0,001	0.000 *			-	-	-
<i>Community size</i>															
Population size	−0,018	0.011 *	−1,8		−0,006	0.003 **	−0,6		−0,007	0.003 **	−0,7		−0,004	0.002 *	−0,4
Squared population size	0,000	0.000			-	-			-	-			-	-	
Cubic population size	0,000	0.000			-	-			-	-			-	-	
<i>Labor market</i>															
Proportion of labor force in secondary sector	−0,365	1,073	-		-	-	-		−3,585	2.134 *	−97,2		−2,483	2,062	-
Proportion of labor force in tertiary sector	0,077	0,418	-		-	-	-		1,013	0.615 *	175,4		1,832	0.582 ***	524,6

^a significance level:

* p<0.10,

** p<0.05,

*** p<0.01 (two-tailed test)