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Migration Within the Frontier: The Second Generation Colonization in the Ecuadorian Amazon

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Abstract Since the 1970s, migration to the Amazon has led to a growing human presence and resulting dramatic changes in the physical landscape of the Northern Ecuadorian Amazon frontier, including considerable deforestation. Over time, a second demographic phenomenon has emerged with the children of the original migrants leaving settler farms to set out on their own. The vast majority have remained in the Amazon region, some contributing to further changes in land use via rural–rural migration to establish new farms and others to incipient urbanization. This paper uses longitudinal, multi-scale data on settler colonists between 1990 and 1999 to analyze rural–rural and rural–urban migration among second-generation colonists within the region. Following a description of migrants and settlers in terms of their individual, household and community characteristics, a multinomial discrete-time hazard model is used to estimate the determinants of out-migration of the second generation settlers to both urban and rural areas. We find significant differences in the determinants of migration to the two types of destinations in personal characteristics, human capital endowments, stage of farm and household lifecycles, migration networks, and access to community resources and infrastructure. The

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paper concludes with a discussion of policy implications of migrants' choice of rural versus urban destinations.

Keywords Ecuadorian Amazon · Rural–urban migration · Rural–rural migration · Agricultural colonization · Farm/household lifecycle · Multinomial model

Introduction

The Amazon is the largest and most biodiverse tropical wilderness in the world (Mittermeier et al. 2003; see also Myers et al. 2000 on "ecological hotspots"). The rate of deforestation in Ecuador's Amazon has exceeded that of any other Amazonian nation's tropical forest (Food and Agricultural Organization 2001). In the study region in the Northern Ecuadorian Amazon (NEA), agricultural colonization has occurred along roads built by oil companies to lay pipelines, following the discovery of large oil fields in 1967 near the town of Lago Agrio. This colonization by small farmers initially settling 50 ha plots (Pichon and Bilsborrow 1999) has caused the majority of forest loss. In addition to the well-documented deforestation on the original farms established in the 1970s and 1980s, a second, less researched, wave of deforestation in the 1980s and 1990s is linked partly to the out-migration of people (mostly sons and daughters of household heads) from migrant settler households to other rural areas of the Ecuadorian Amazon. The rapid growth of Amazonian towns has also attracted migrants from rural households both inside and outside the region, reflecting an evolving pattern of population mobility within the Amazon: rural–urban migration.

Frontier areas are important locations for the study of migration, given their important differences, vis-à-vis long-settled areas, especially in terms of the association between household lifecycles and labor allocation (including via out-migration). Agricultural frontiers are characterized initially by high rates of in-migration, yet *out-migration* tends to dominate *second-generation* settler household demographic dynamics (Laurian et al. 1998; Walker et al. 2002; Carr et al. 2006a), as sons and daughters of pioneer settlers reach the early adult stage of their lifecycle and sometimes set off on their own. While this can be a "rite of passage" (Piore 1980; Laurian et al. 1998), the out-migration of one or more household members can also be a means of reducing risk by diversifying sources of household income. Given the increasing importance of internal migration in local population growth and changing population distribution as fertility declines in the Amazon-basin countries (Bilsborrow 2003; Mena et al. 2006), it is surprising the scarcity of studies of population mobility based on data from origin areas anywhere in the developing world (Carr 2008) and the dearth of research on migration *within* the Amazon (Barbieri and Carr 2005). Further, existing empirical studies on migration in the region have been based primarily on macro-level data instead of household-level data, and none has used longitudinal data (Marquette and Bilsborrow 1999; Wood 2002). It is desirable to understand how individuals and households make migration decisions within a nested scale of multiple influences (for example, Bilsborrow et al. 1984; Bilsborrow 1998; Zhu 1998 on China; Ezra 2003 and Henry et al. 2004 on Africa; VanWey 2003 on Thailand).

This paper examines how both temporal and contextual factors affect recent out-migration of second generation family members of colonist households from rural areas in the Ecuadorian Amazon. It significantly extends and clarifies previous studies of household lifecycles in frontier areas by focusing on the second generation and adding a multi-scale temporal and contextual approach. We analyze the determinants of out-migration based on data on households at the place of origin, taking into account the characteristics of the migrants themselves, their households and migration networks, and the community context in which they live. We study only long-term or "permanent" migrants, who leave the household to change their place of residence.

The ideal analysis would draw upon data from households in areas of *both* origin and destination (Bilsborrow et al. 1984, 1997). However, as is almost always the case in migration studies since they are difficult and costly to collect, such data are not available. The decision about whether to focus the analysis on the origin or destination also depends on the research question, and tends to vary with the discipline of the investigator (Bettrel and Hollifield 2000). A study based on data from the place of origin only is sufficient for studying the *determinants of out-migration* (Bilsborrow et al. 1984; Skeldon 1990). Another aspect of this paper of particular interest is our analysis of the how the determinants of migration differ to urban and rural destinations and hence on how factors differentially affect the *choice of destination*. This is little understood but of crucial importance for understanding population mobility and redistribution, and hence critical for development planning and environmental conservation policies.

Theoretical Background

This paper constructs an empirical model of determinants of out-migration that combines elements of individual and household lifecycle theories with other key elements of migration theories focusing at three distinct levels of analysis—individuals, households, and communities or regions. Such a model focuses on income maximization and risk diversification, such as personal attributes of the person, which may raise or lower the returns of migration and affect its perceived risk, including age and human capital; household factors, such as household composition, land and other assets, the household lifecycle, and migration networks; and the larger context within which migration decisions are made, such as the characteristics of local communities and labor markets. There is, however, a scarcity of empirical studies on the determinants of population mobility in frontier areas of Latin America, which reflects, at least in part, the high cost of collecting data from households in these areas as well as the complexity of the migration process, including its definition and causes. In this sense, we identified within major theoretical traditions the key determinants or variables explaining population mobility in rural settings of the developing world; we use these to test their importance in explaining rural out-migration in the Northern Ecuadorian Amazon.

We organize this present section according to the main groups of determinants of migration in frontier settings, drawing on the empirical literature and how these groups of determinants are discussed by different theoretical traditions. Within each group of determinants, the variables which will be tested in the empirical model are italicized. Consistent with this approach, the presentation of empirical results is also organized according to these main groups of determinants.

Farm Size and Composition and Household Lifecycle Factors

Household lifecycle approaches have focused on the interactions between land use and household demographics (size and composition). The consequence of this interaction is the formulation, at the household level, of strategies of income or consumption maximization and risk diversification. In this regard, household lifecycle theories, while not yet part of migration theory, may provide a link between household demographic factors and land use, which can ultimately affect migration, by focusing on migration theories which are also about income maximization and risk diversification.

The justification for studying the effects of household demographic factors and land use on migration draws upon Chayanov's theory of the peasant household (Thorner et al. 1986; Ellis 1988), as 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; Moran et al. 2003; Barbieri et al. 2005). The main argument is that changes in household size and composition affect land use and farm household labour allocation, and that out-migration directly affects household size and composition (Carr et al. 2006b). In periods of low household labor availability (e.g., early in the family lifecycle, when couples have young children, as well as later in the cycle after the children reach adulthood, marry and move away), households tend to adopt agricultural practices suitable for the relatively low availability of household labor, clearing a small area of forest to grow annual food crops in the first case, or switching land use from perennials to cattle in the second. Household age structure therefore affects out-migration: in later stages of the lifecycle, when the second generation members become adults, marry and seek land or work, is when out-migration is most likely, as noted in the Brazilian Amazon (McCracken et al. 2002; Perz and Walker 2002).

Although people are more likely to migrate from large households, the effects of household size are much better addressed by disaggregating according to the *numbers of adults and children* since that reflects the proportion of productive to non-productive members and consequently the likelihood of surplus labor. The effect of the number of adults in the household on the out-migration of a member can be positive or negative, depending on the *amount of farm land* available. A small amount of land is associated with decreasing returns to labour as household size increases, favoring out-migration. On the other hand, a large farm will mean a high ratio of land to labour even with many household members; thus the returns to labour may remain high despite the addition of a new adult or the attainment of adulthood by a child in the household.

As households accumulate capital and labor over time (such as from young children becoming teenage children or young adults), farmers tend to shift from *land in annual crops* to cash crops and ultimately increasingly to *land in pasture*. When young adults leave the household as a rite of passage or to take advantage of employment opportunities elsewhere, farm managers may switch to less labor-intensive forms of land use, such as pasture. Thus, as the children grow older and the number of working age adults and adolescents expands, in the absence of more land clearing (which is controlled for statistically anyway) returns to labor on their farm fall, and out-migration tends to increase. However, such a process of declining demand for labor on the farm may also occur autonomously, e.g., farmers seek to acquire cattle for other reasons, such as status or to serve as a walking bank account, this frees up labor, facilitating out-migration. If subsequent remittances are subsequently received from out-migrants, they may be invested in cattle, which have low labor requirements compared to crops.[1]

The effects of household life-cycle factors on out-migration can be linked to the New Economics of Labor Migration (NELM) (Stark and Bloom 1985; Stark and Taylor 1989, 1991). Household age structure influences risk-aversion and out-migration strategies—a key tenet of the NELM. Thus a household adopts a strategy of joint resource accumulation (maximize income and welfare) and risk minimization to ensure its subsistence. Thus, the household (and not the individual) is seen as the *locus* of out-migration decisions. One or more household members may thus be allocated to permanent out-migration and/or temporary labor migration to diversify sources of household income. Theories of risk minimization and income diversification are compatible with household strategies to allocate one or more members to out-migration to the extent they expect to receive remittances later, and also to the degree that out-migration alleviates pressures on scarce household resources, such as land and housing space.

Personal Attributes

Certain personal attributes of household members directly influence the propensity to out-migrate, varying across cultures and time (e.g., male versus female migration with gender roles). Such attributes include gender, age, and human capital endowments, such as education, occupation and work experience. *Younger household members* are more likely to migrate since they have a longer period of time to realize the gain of higher earnings from migration. From a household perspective, they may also be seen as more desirable out-migrants since they can provide remittances over a longer period of time. The fact that migration is

[1] A key question in the analysis of the association between land use and out-migration is to determine the direction of causality—that is, if it is change in land use that determines out-migration, or it is out-migration that determines land use (via remittances or reducing the supply of farm labor). Thus, endogeneity problems may arise since the direction of causality between land use and out-migration is unclear. It is not always possible, in these cases, to employ causal statements involving land use variables and population mobility; instead, analyses should discuss potential *associations* between land use and population mobility. Nonetheless, in longitudinal studies, it is possible to analyze how the initial “stock” of land in particular uses (that is, land use in the first year of analysis) affects out-migration in the following years.

concentrated at younger ages is widely discussed in the literature, dating back to the origins of the field in Ravenstein (1889), reiterated in Lee (1966) and consistent with the human capital approach (Sjaastad 1962). *Gender* is also important as young women are often more able than young men to find employment in urban areas in Latin America, such as in domestic service, restaurants, and retail employment; they are also often seen as more reliable sources of remittances due to stronger affective ties to the origin household (Guest 1993). Previous studies based on earlier data in the same Northern Ecuadorian Amazon found age and gender differences important in migration decisions, with women more likely than men to leave their parents' household, to leave at younger ages, and to choose urban destinations (Laurian et al. 1998; Barbieri and Carr 2005).

The Human Capital Approach

The household member chosen to out-migrate is the one expected to earn the most in another destination compared to what he or she would produce on the farm. This often but not always is the person with higher human capital, based on *education* or *previous off-farm working experience*. According to the Human Capital approach, individuals migrate to maximize earnings, based on comparing the discounted earnings stream perceived to be available at alternative destinations with that at the place of origin (Sjaastad 1962; Vanderkamp 1971; De Jong and Fawcett 1981; Da Vanzo 1981; Milne 1991). Education also influences attitudes, aspirations, and access to information, which tend to positively affect decisions to migrate, especially to urban destinations. Off-farm working experience and education also interact with certain personal attributes, particularly age, to maximize income earnings.

Migration Networks

Migrant networks have been found to be important factors influencing migration in many studies. They are defined by Massey (1990, p. 7) as "sets of interpersonal ties that link migrants, former migrants, and non-migrants in origin and destination areas by ties of kinship, friendship, and shared community origin; having friends, relatives, or other members of one's personal community at a destination dramatically increases the probability of migrating there." In sum, it relates diffusion of out-migration in a community, households or smaller units, to kin networks. Migrant networks act as a social structure to facilitate migration by reducing its costs—transportation, labour search, and psychological stress from leaving family and community (Bilsborrow et al. 1984; Curran and Fuentes 2003). *Previous out-migration from the household* may also lead to further out-migration to the extent that it affects tastes and aspirations of remaining household members for a better or different life.

Migration networks may assume distinct meanings if measured at the household or at the community levels. The latter may be more suitable to evaluate the effects of networks on the reduction in costs of moving and networks based on kinship ties (assuming that the community does not present the same structure of kinship ties), while the former may be more useful to measure the overall perceptions of the effects of out-migration on income and welfare levels in the community, shaping a sense of "relative deprivation" and engendering imitative behavior among potential movers.

Community Factors

The interaction between contextual or community characteristics (e.g., at the community level) and individuals and farm households in a given place engenders conditions influencing both land use and migration (affecting the cost of migration, access to information, and formation of migration networks). For example, access to transportation is important (e.g., see examples in Rudel 1983; Bilsborrow et al. 1984; Southgate et al. 1991; Nelson and Hellerstein 1997; Rudel and Roper 1997). The *distance from the local community to the nearest significant town* is a measure of transportation accessibility to local markets, for seeking employment, selling farm products, and purchasing consumer goods and services. Proximity to major towns lowers transportation costs and facilitates temporary mobility (e.g., commuting to work), while longer distances to towns increase those costs and hence may increase out-migration. The link between transportation accessibility and urbanization in turn shapes the rural–urban migration behavior of second-generation settler colonists. For instance, von Thunen (Hall 1966; see also Walker and Homma 1996) suggests that the expansion of the agricultural frontier and out-migration to new agricultural areas both depend on the growth of an urban nucleus, which provides a market for agricultural products and opportunities for off-farm employment.

Other aspects of the broader community context where the farm household is located are also likely to play key roles in out-migration (Bilsborrow et al. 1984; Bilsborrow 1987; Findley 1987; Wood 2002). For example, better *community infrastructure*, such as *schools*, *health facilities* and government services, indicates a higher overall level of development and probably better living conditions, which alleviates pressures on households to send members away. On the other hand, some aspects of local infrastructure may have the opposite effect: better educational facilities may stimulate out-migration by improving access to and capacity to assimilate information about opportunities elsewhere, and change aspirations towards a different way of life. It is striking that despite the strong theoretical basis for examining the effects of contextual factors on migration decisions, there have been few previous studies on migration developing countries which take into account contextual factors, although the effects of context on fertility behavior and contraceptive use have received considerable attention (e.g., Entwisle and Mason 1985; Hirschman and Guest 1990; Entwisle et al. 1997).

Period Effects

An important feature of the household lifecycle approach discussed above is its highlighting the importance of distinguishing cohort from *period effects on land use*

(McCracken et al. 2002; Moran et al. 2003; see also Mulder 1993). Regarding *period effects*, all the individuals and households analyzed at the same point in time in the Amazon are subject to the same period experience, such as current market and credit conditions and other contextual changes in the national economy. Cohort effects refer to cohorts of settler colonists who share similar experiences over time and which can result in different strategies in agricultural land use and off-farm labor allocation. Since period effects may represent an important influence on land use decisions, some authors (Barbieri et al. 2005; Barbieri 2006) have suggested that land use changes mainly not because of household lifecycles but instead due to *farm lifecycles* (vis., the age of the farm).

The Study Area

The Ecuadorian Amazon is located in the western Amazon rainforest and, together with the Coastal region and the Highlands ("Sierra"), is one of the three distinct regions in the country. The study area is located in the Northern Ecuadorian Amazon (NEA) (Fig. 1).

Agricultural settler families first came to occupy the study area in significant numbers following the discovery of oil in 1967, which led to the laying of pipelines and adjacent roads and the establishment of the town of Lago Agrio. Virtually all colonization in the Ecuadorian Amazon has been spontaneous, facilitated by the initial opening of roads by petro-dollars. From the mid-1970s to the present, oil extracted from the Ecuadorian Amazon has been responsible for half or more of both foreign exchange earnings and government revenues. Despite coming to be extensively occupied by agricultural settlers, the region is still attracting migrants in the 1990s from other parts of Ecuador, especially the Sierra. For an examination of ultimate drivers, however, one has to explore what it is that leads large numbers of people to leave their places of origin. Though this has not been quantitatively demonstrated, it seems likely that lack of land and rural poverty, linked directly to the high concentration of landholdings in the Sierra, must be major factors in impelling out-migration.

As a consequence of colonization and oil extraction, the NEA has experienced high rates of deforestation, with forest cover on sample farms falling from nearly 100% at the time of initial settlement to 59% by 1990, and then further to 45% in 1999. Urbanization in the region is also an increasing rapidly, but is still an incipient, process; there are now four main towns in the study area: Lago Agrio (the largest with 34,000 people, according to the 2001 Ecuadorian census), followed by Francisco de Orellana (Coca), Shushufindi, and Joya de los Sachas.

Data and Methods

This study uses panel data from 246 farm households in the study area who were interviewed in a household survey in *both* 1990 and 1999. Farm households in 1990 were selected using a two-stage cluster sample in the following manner. Based on

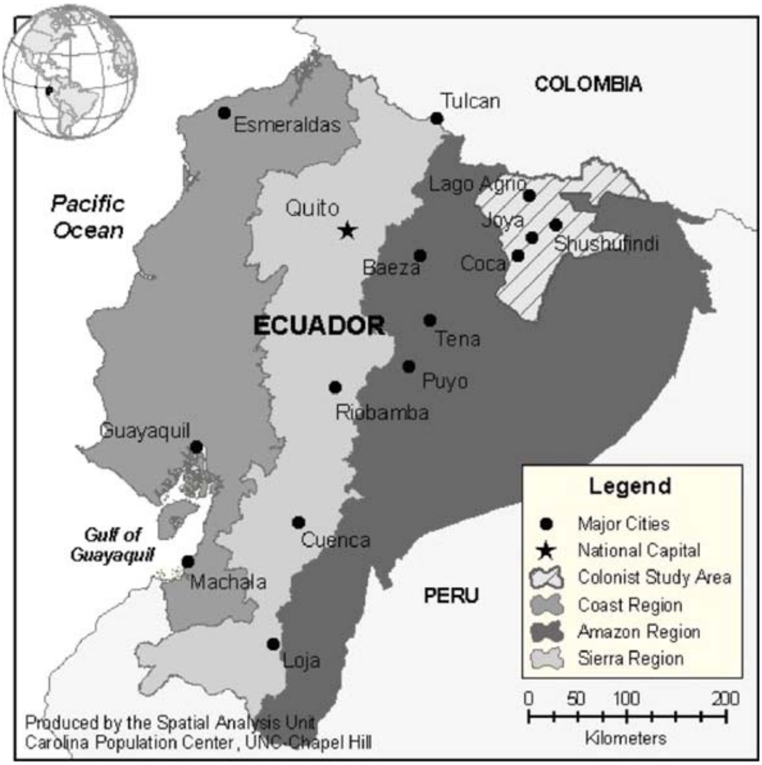

Fig. 1 Study area in the Northern Ecuadorian Amazon

crude maps and lists of approved settlement areas in the northeast Amazon, it was obtained a sample frame of sectors (settlement areas), with each sector comprising a number of farm households. The sampling frame contained the total number of farm households for all sectors, and was used to select systematically a sample of 64 sectors from the nearly 300 in the region. In the second stage, a cluster of 5–10 contiguous farm households was randomly selected from each of the selected sectors, based on the size of the sector, to achieve a Probabilities Proportional to Size (PPS) probability sample. Through this process, 418 farm households were selected and interviewed completely in 1990. This represented a 5.9% sample of the rural population of the entire Northeastern Ecuadorian Amazon study region, the area of most intense colonization in the country from 1970 to the present. From the original sample of 418 farm households, 246 were re- interviewed in a separate household survey in 1999, and had the same head or spouse of the head in both years.

The population living on each sample farm in every year between 1990 and 1999 was then computed using methods of family reconstruction based on annual data on births, deaths, and in- and out-migration. The total population living on the 246 farms was 1,787 in 1990 and 1,324 in 1999. Data for 1999 (when the second survey was undertaken) was not included in some of the analyses on out-migration in this paper (Table 3 and Fig. 2), and 1998 was used instead. This is because, due to the fact that data was collected during the first semester of 1999, the data does not include all out-migrants in this year (from January 1 to December 31).

A separate community-level survey was also undertaken in 2000 and obtained retrospective information back to 1990 or earlier for the 43 reference communities linked to the 246 sample farms.

A discrete-time multinomial hazard model is used to estimate the factors affecting out-migration from migrant settler households. The results are presented as a set of binary logit equations, which can be derived from the multinomial model and which also correspond to comparisons between (any) two of the categories of the dependent variable in the multinomial estimation model. The multinomial model corresponds to a population-averaged model, in which each regression coefficient is interpreted as measuring the expected effect of a one-unit increase in its predictor on the outcome variable, controlling for other explanatory factors in the model except for random effects. The hazard is the risk of out-migration to an alternative destination for each person for each year, that is, individuals living in a farm household between 1990 and 1999 who are at risk of out-migration until they move or die:

$$\log\left(\frac{\pi_{rit}}{\pi_{sit}}\right) = \alpha_{rt} + \beta_{rA}X_{\mathrm{ri}} + \beta_{rB}X_{rit} \quad (1)$$

where $\log\left(\frac{\pi_{rit}}{\pi_{sit}}\right)$ represents the log-odds that individual i will out-migrate at time t ($t = 1990,\ldots,1999$) to a destination of type r ($r = 1$ represents out-migration to a rural area and $r = 2$ out-migration to an urban area), rather than an event of type s, the reference category ($s = r = 0$, the decision of not moving). The baseline hazard, α_{rt}, estimates the effect of time on the log-odds of out-migrating. X_{ri} is a matrix of time-invariant covariates (such as completed education), and X_{rit} is a matrix of time-varying covariates (such as age of person, number of adults and children in the household, and land size). β_{rA} and β_{rB} represent, respectively, estimates of the average effect of X_{ri} and X_{rit} on the log-odds of out-migration each year between 1990 and 1999.

The risk of out-migration is estimated for individuals aged 12–59 years, with out-migrants defined as those who left their usual place of residence in a farm household to live elsewhere in a given year between the first survey in 1990 and the second interview in 1999. Out-migrants include those going to live in a new residence which may be in the place of destination (a) within the community or outside the community, and (b) rural or urban, allowing the specification of the spatial displacement as rural–rural or rural–urban. The age limits used assure that we deal only with persons old enough to be directly involved in the out-migration decision, such as whether to pursue employment or educational opportunities elsewhere, but not so old as to be migrating due to declining health or retirement. Furthermore, an individual can enter and leave exposure to the risk of migration if they age into or out of the target age during the period of analysis. Out-migration was measured through a retrospective question in the 1999 woman's questionnaire, which obtains the year in which a former household member moved away to another place in the

Amazon between 1990 and 1999, as well as his/her characteristics at the time of migration (age, education, marital status). As a quality check, given recall and memory problems from the use of retrospective questions, the 1990 survey data were used to check the information on individuals.

From the discussion on theoretical background, we use the 1990 and 1999 surveys to identify key independent variables related to farm and household lifecycles, and individual, household and community attributes. Aggregate measures of household size and composition, such as measures of the number of adults and children, take into account births to household members and deaths of household members in each year. This therefore takes into consideration the population below 12 years of age in 1990, which enters the 12–59 age interval during the 1990–1999 decade, as well as others that attain their 60th birthday during the interval and hence transition out of the study population from that point onward. Finally, since the analysis is on out-migration of individuals when the decision to move is conditioned by household characteristics, households with only one member in any year in the 1990s are excluded in all years.

The percentage change in the odds of out-migration brought by an unitary increase in a covariate X_{ri} or X_{rit} can be estimated using the odds ratio e^{β} calculated from:

$$\%\ \text{change} = 100 \times \left(e^{\beta} - 1\right) \tag{2}$$

Given the clustered nature of the data, with individuals of the same farm household and living in the same community tending to be more homogeneous in their characteristics (covariates) than those living in other farm households or communities, the assumption of independence of observations is likely to be violated, leading to underestimates of standard errors and thus exaggeration of the statistical significance of results. In order to avoid this problem and correct for the clustered nature of the data, the multinomial models provide consistent estimators of standard errors (decreasing or eliminating estimation biases), and thus produces efficient estimates of coefficients (with smaller sampling variability).

Descriptive Results

Table 1 shows the number and percentage of out-migrants between 1990 and 1999, according to place of destination. Two population subgroups are considered: all persons in the sample and persons between the ages of 12 and 59 (the group at risk of migration in the modeling strategy). There are virtually no differences between the two subgroups, showing no significant age selectivity in the extreme age groups (0–11 and above 59). Among those at risk, there are 398 out-migrants; 67% to rural areas, and 33% to urban destinations (79% move within the Amazon). Overall, 27% of the population at risk living in colonist farm households in the Ecuadorian Amazon moved during the 9-year interval between 1990 and 1999. This is a highly dynamic, mobile population.

Table 2 compares the means and standard deviations of independent variables according to migration status, that is, whether they chose rural or urban destinations

Table 1 Out-migrants from the study area in the Ecuadorian Amazon between 1990 and 1999, according to place of destination

	Total		Rural		Urban	
	Out-migrants N	% Of total population[a]	Out-migrants N	Out-migrants % of total	Out-migrants N	Out-migrants % of total
All persons	466	26.3	316	67.8	150	32.2
12–59 years	398	27.3	266	66.8	132	33.2

[a] Considering total population (migrants over the decade plus non-migrants in 1999): 1,458 individuals aged 12–59, and 1,771 individuals of all ages

or did not move. (Note that means for household and community variables are weighted by person years; see footnote in Table 2). Table 3 compares the means in the two end years of the analysis, 1990 and 1998. In this session, Tables 2 and 3 are discussed according to group of variables.

Farm Size and Composition and Household Lifecycle Factors

The significant reduction in farm size over the decade reflects the widespread process of land subdivisions in the NEA mentioned above, with land fragmentation and consolidation constituting key understudied issues in studies of demographic dynamics in frontier areas. Tables 2 and 3 show substantial changes in farm size occurred over time, with farm area decreasing by 17% on average for households with rural–rural out-migrants between 1990 and 1998, by 20% for those with rural–urban out-migrants, but by only 8% for farm households without out-migrants. Thus, farms remaining nearly intact in size are more associated with non-migrants, while subdivided farms are associated with migrants.

In Table 2 we see that rural–rural migrants come from households with considerably more adults and children than the other two groups, indicating a link between larger households and a preference for rural destinations. Table 3 presents data showing a sharply decreasing number of children over time in all three groups of these maturing settler households, which is consonant with previous findings of dramatically reduced fertility (Carr et al. 2006b) and with the evolution of those households there in 1990—the spouse of the male household head reaching the twilight of her reproductive window during the 1990s. The decreasing number of adults also reflects the corresponding out-migration of children of the head, and, to a much smaller extent, deaths over the decade.

Table 2 shows that migrants tend to come from households with less land in crops. This is to be expected since growing crops requires much more labor than raising cattle. Over time, the difference between the amount of land in crops of migrant and non-migrant households becomes even larger, with land in crops actually rising for non-migrant households, while it declines for migrant households, the latter being consistent with the overall decline in farm size over the period due to subdivisions. Rural–rural out-migrants come from farms with larger areas in pasture than either of the other two groups, but compared to non-

Table 2 Means and standard deviations of independent variables, according to out-migration status, study area in the Northern Ecuadorian Amazon, 1990–1999[b]

Variable	Rural–rural migrants		Rural–urban migrants		Non-migrants	
	Mean	St. dev.	Mean	St. dev.	Mean	St. dev.
Personal attributes						
Gender (1 = men)	0.62	0.48	0.49	0.50	0.57	0.50
Age group 12–19	0.45	0.50	0.57	0.50	0.33	0.47
Age group 20–34	0.46	0.50	0.40	0.49	0.29	0.45
Age group 35+	0.09	0.28	0.03	0.18	0.38	0.49
Human capital						
Engagement in farm work (1 = engaged, 0 = not engaged)	0.80	0.40	0.66	0.47	0.70	0.46
Education of head[a] (1 = at least some secondary)	0.34	0.47	0.33	0.47	0.41	0.49
Farm size						
Farm size (ha)	42.2	15.7	44.4	23.3	43.7	27.1
Farm and household lifecycles						
Number of adults	7.15	3.22	6.11	1.92	6.09	3.22
Number of children	2.33	2.49	1.82	1.58	1.79	1.98
Land in crops and perennials in 1990 (ha)[a]	7.27	5.73	7.47	6.11	8.76	6.41
Land in pasture in 1990 (ha)[a]	19.3	65.8	7.6	9.3	9.3	15.4
Migration networks						
Number of previous out-migrants from household	1.77	2.28	2.00	2.39	1.68	2.38
Community factors						
Distance from community to nearest town (km)[a]	22.8	16.8	26.6	19.4	23.0	17.9
Health facility in community (1 = yes)	0.19	0.39	0.35	0.48	0.27	0.44
Secondary school in community (1 = yes)	0.24	0.43	0.38	0.49	0.33	0.47

[a] Time-invariant independent variables

[b] Means and standard deviations for households and communities are weighted by person-years. That is, they are a function of the number of people between 12 and 59 years in each year, t, living in a farm household and community. For example, if four individuals in household X are exposed to the risk of out-migration at time t, but only three are exposed at $t + 1$ (because one individual died, out-migrated, or reached age 60), farm household X will have a weight 4 at t and 3 at $t + 1$. Since farm households can have different numbers of members exposed to the risk of out-migration each year, the weighted means for time-invariant household and community variables can differ each year

migrant households this is the case only in the first year. Moreover, outliers explain the much higher amount of land in pasture for households with rural out-migrants in 1990. Table 3 shows a reduction in the areas of land in both crops and pasture over time, which is due to the overall decline in farm sizes.

Personal Attributes

Tables 2 indicates that, on average, men migrate away from farm households more than women, but women out-migrate proportionately more to urban areas than men

Table 3 Means of independent variables in 1990 and 1998, according to out-migration status, study area in the Northern Ecuadorian Amazon[b]

Variable	Rural–rural migrants		Rural–urban migrants		Non migrants	
	1990	1998	1990	1998	1990	1998
Personal attributes						
Gender (1 = male)	0.61	0.62	0.50	0.56	0.56	0.57
Age group 12–19	0.53	0.33	0.61	0.32	0.26	0.36
Age group 20–34	0.38	0.54	0.35	0.65	0.31	0.29
Age group 35+	0.08	0.14	0.04	0.03	0.43	0.35
Human capital						
Engagement in farm work (1 = engaged, 0 = not engaged)	0.80	0.81	0.62	0.65	0.78	0.63
Education of head[a] (1 = at least some secondary)	0.35	0.35	0.35	0.41	0.40	0.41
Farm size						
Farm size (ha)	43.8	37.7	46.4	36.9	46.1	42.2
Farm and household lifecycles						
Number of adults	6.78	6.09	5.83	6.24	5.52	6.41
Number of children	2.66	0.50	3.27	0.85	3.09	0.93
Land in crops and perennials in 1990 (ha)[a]	7.51	7.01	7.81	7.14	8.53	8.92
Land in pasture in 1990 (ha)[a]	18.64	8.73	7.87	6.20	9.42	9.05
Migration networks						
Number of previous out-migrants from household	0.84	3.62	1.09	3.5	0.71	2.41
Community factors						
Distance from community to nearest town (km)[a]	22.2	27.1	25.6	26.5	23.3	22.8
Health facility in community (1 = yes)	0.16	0.21	0.30	0.41	0.20	0.31
Secondary school in community (1 = yes)	0.16	0.27	0.33	0.47	0.21	0.36

[a] Time-invariant independent variables

[b] See Table 2 footnote

(especially in the youngest age groups, 12–19). Men constitute most of the rural–rural migrants.

Table 2 indicates that migrants tend to be quite young, with 91% of rural–rural migrants under age 35 and up to 97% of those going to urban destinations under age 35. There is little difference in out-migration by gender in the time period, but a significant difference in destinations, with males mainly going to rural destinations and females to urban ones, especially among the youngest age group, 12–19. Men constitute the majority of rural–rural migrants, but the dominance of females among rural–urban migrants observed up to 1990 ended in the 1990s, as is clear from the gender distribution of rural–urban migrants being the same as that of non-migrants.

Table 3 shows that the concentration of migrants in the youngest age category up to 1990 became far less over time between 1990 and 1998, as shown by the considerable decrease in the proportions of migrants 12–19 and the increases for those 20–34 and 35+, among both rural–rural and rural–urban migrants. Since the analysis considers the same farm households and their inhabitants over the decade, these results partly reflect life-cycle factors related to the aging of the 1990 households. Thus 1990 household heads and spouses came to the region in the 1970s and 1980, so their children were often entering the usual ages of highest migration (20–34) during the 1990s.

Human Capital

Table 2 shows there is little difference in the education of the household head of rural–rural and rural–urban migrants, with those who do *not* move more likely to have some secondary education. Over time, however, rural–urban migrants tended to come more from households with heads with secondary education, perhaps because that helped them compete in urban labor markets (Table 3). “Engagement in farm work” measures if an individual who lived in the farm household was engaged, not engaged, or partially engaged in farm work in the previous 12 months. Rural–urban migrants are much less likely to have been engaged in farm work prior to migration than those moving to rural destinations and those not moving, which is expected since previous farm work provides relevant experience for continuing farm work but not for urban employment.

Migration Networks

The variable “Number of Previous Out-migrants from the Household” measures the cumulative number of out-migrants who left without returning up to the year of interview. It is created through taking into account household composition through reconstruction of the household size and composition for each year plus taking into account the out-migration of any member during the period. The variable is updated for each household during the time interval according to whether someone left or not in the previous year. As observed in Tables 2 and 3, out-migrants over the decade (especially rural–urban migrants) tend to come from households which had out-migrants in previous years. The number of previous out-migrants from a household is higher for both rural–urban and rural–urban migrants than for those who do not out-migrate. This is expected since previous migrants can provide information and assistance in housing and seeking work. As a result, the mean number of out-migrants from households tends to increase over time (whenever there are various siblings, mainly young adults, exposed to the risk of migration). Note that the importance of networks is especially important for migrants moving to urban areas.

Community Factors

Table 2 shows that there is little difference in the distance from the local community to the nearest significant town (chosen from among the four mentioned earlier-Lago Agrio, Coca, Shushufindi and Joya de los Sachas) among households with no migrants and those with rural-rural migrants, although rural–urban migrants come from communities farther from the nearest town. However, during the 1990s households with rural–rural migrants came to be associated with farm households located at longer distances from towns, and became essentially the same as those with rural–urban out-migrants (Table 3). This is probably due to the selectivity of previous rural–rural migration, as those less far from roads out-migrated first, so that by the end of the period, rural–rural migrants tended to come preferentially from households farther from major towns, the deterring effects of which appear to be countered by the effects of being more likely to have previous out-migrants from the household. It is appropriate that the mean distance of households with no out-migrants did not increase in the 1990s, and continues to be less than that for households with out-migrants to either destination.

With respect to the other community variables in the final model, we see in Table 2 that out-migrants to urban destinations are more likely to come from households in communities with both secondary schools and health facilities than are rural–rural migrants or non-migrants. (Non migrants are also associated with communities with both secondary schools and health facilities). Table 3 simply shows that rural communities throughout the region acquired more health and education services over time, which tends to improve living standards, but the differences across migrants observed in Table 2 continued throughout the period and areas of rural–rural migration lagged behind other communities in these key development indicators.

Determinants of Out-migration

The results of the statistical estimation for several variations of the model are shown in Table 4. Model 1 (a binomial logit model) shows the results for comparing the determinants of migrating versus not migrating, without taking into account place of destination, while Models 2a–c (see Eq. 1) distinguish, respectively, the results for contrasting the determinants of rural–rural migration and non-migration, rural–urban migration and non-migration, and rural–rural migration and rural–urban migration. Table 5 compares the odds ratios for the statistically significant variables in Table 4. Variables are discussed by type of variable in the same sequence as they were discussed above in connection with Tables 2 and 3.

Farm Size and Composition and Household Lifecycle

Prima facie, the effects of farm area on out-migration are not easily interpreted from Table 4, since cubic and logarithm transformations were both found useful to capture the nonlinear relationship. However, these effects can be interpreted by

Table 4 Estimates from the discrete-time hazard models for the probability of an individual out-migrating from the study area in the Ecuadorian Amazon between 1990 and 1999

Variable	Model 1 Out-migration versus no out-migration	Model 2a Rural–rural migration versus no out-migration	Model 2b Rural–urban migration versus no out-migration	Model 2c Rural–rural migration versus rural–urban migration
Personal attributes				
Gender (ref. = female)[a]	−0.323*** (0.114)	−0.192 (0.134)	−0.599*** (0.200)	0.176 (0.279)
Age group 12–19 (reference group: 35+)	1.257*** (0.204)	0.999*** (0.226)	2.125*** (0.483)	−0.744 (0.554)
Age group 20–34 (reference group: 35+)	2.049*** (0.197)	1.819*** (0.214)	2.873*** (0.471)	−0.8035 (0.523)
Human capital				
Engagement in farm work (ref. = not engaged)[a]	0.188 (0.132)	0.416** (0.166)	−0.207 (0.218)	0.921*** (0.293)
Household's education of head (ref. = less than secondary)[a]	−0.014 (0.123)	0.057 (0.148)	−0.158 (0.203)	0.456* (0.271)
Farm size				
Farm size (ha)	−0.010** (0.005)	−0.036*** (0.011)	−0.034 (0.022)	−0.051*** (0.017)
Logarithm of farm area	0.249 (0.176)	1.034*** (0.329)	–	1.463*** (0.461)
Squared farm area (ha)	–	–	0.00066* (0.0004)	–
Cubic farm area (ha)	–	–	−0.000003* (0.0000)	–
Farm and household lifecycles				
Number of adults in the farm household	0.032** (0.017)	0.037** (0.019)	−0.002 (0.028)	0.070 (0.057)
Number of children in the farm household	−0.054** (0.030)	−0.026 (0.033)	−0.171*** (0.059)	0.215** (0.085)
Land in crops and perennials in 1990 (ha)[a]	−0.024** (0.010)	−0.022* (0.012)	−0.023 (0.015)	−0.010 (0.029)
Land in pasture in 1990 (ha)	−0.003*** (0.001)	−0.004 (0.005)	0.006*** (0.001)	−0.008*** (0.003)
Migration networks				
Number of previous out-migrants from the household	0.189*** (0.020)	0.184*** (0.021)	0.181*** (0.030)	−0.061 (0.047)

Table 4 continued

Variable	Model 1 Out-migration versus no out-migration	Model 2a Rural–rural migration versus no out-migration	Model 2b Rural–urban migration versus no out-migration	Model 2c Rural–rural migration versus rural–urban migration
Community factors				
Distance from community to nearest town/market (km)[a]	0.008** (0.003)	0.002 (0.004)	0.015*** (0.005)	−0.020*** (0.007)
Health facility in community (ref. = no health facility)	−0.312 (0.237)	−0.591** (0.274)	0.509 (0.459)	−1.1642** (0.564)
Secondary school (ref. = no secondary school)	0.252 (0.224)	0.3783 (0.253)	−0.254 (0.446)	0.607 (0.542)
Intercept	−6.929*** (0.597)	−9.033*** (1.032)	−6.757*** (0.807)	−2.921** (1.468)
Log-likelihood	−1515.79	−4779.67[b]	−4779.67[b]	−4779.67[b]

[a] Time-invariant independent variables

[b] The binary logit models (2a–c) do not generate the correct log-likelihood since the sample size (n) is not the same for the three models. The solution here was to estimate simultaneously the contrasts in each model using a multinomial model, and thus obtaining the joint log-likelihood for Models 2a–c

Significance levels: * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$ (two-tailed test)

The coefficients representing the variable "year" (one dichotomous variable for each year between 1990 and 1998, with 1999 as contrast) are discussed in the text in relation to Fig. 3. These variables are omitted from this table plotting the predicted probabilities that an individual will out-migrate. (From Eq. 2, the predicted probabilities are estimated as:

$$P_{rit} = \frac{1}{\left(1 + e^{-\alpha_{rt} - \beta_{rA} X_{ri} - \beta_{rB} X_{rit}}\right)} \tag{3}$$

with mean values assigned to the covariates). Figure 2 shows that the probability of out-migrating decreases with farm size up to 25 ha, beyond which there is virtually no additional effect. Note that for small farms, increasing farm size is associated with a steep decline in the likelihood of out-migration, as one would expect from theory and previous studies (see, e.g., Bilsborrow et al. 1987). Nevertheless, for small farms, increasing farm size is associated with a decline in the likelihood of out-migration. There is also no significant effect of farm size on rural–urban migration, which is not surprising since those children who seek a new type of life in urban areas are not likely to be deterred by coming from a larger farm, and it is also possible that such a farm would be associated with household members with more access to information and initial economic support that may not be fully captured by other variables in the estimation equations (such as head's education and migration networks).

Table 4 shows that larger households are more likely to have out-migrants in general, with the number of adults living in the farm household positively linked to both overall migration and rural–rural migration, although the effect is small: one additional adult increases the odds of out-migration by 3–4% (Table 5). Moreover, among movers, the odds of out-migrating to a rural area instead of to an urban area are 11.5% higher for each additional adult living in the farm household—a much stronger effect. This may indicate that as men are more associated with farm work, an increasing number of producers (adults) in the household implies smaller returns to labor (since farm area is controlled for), engendering a demand for land *outside* the farm (hence rural–rural migration).

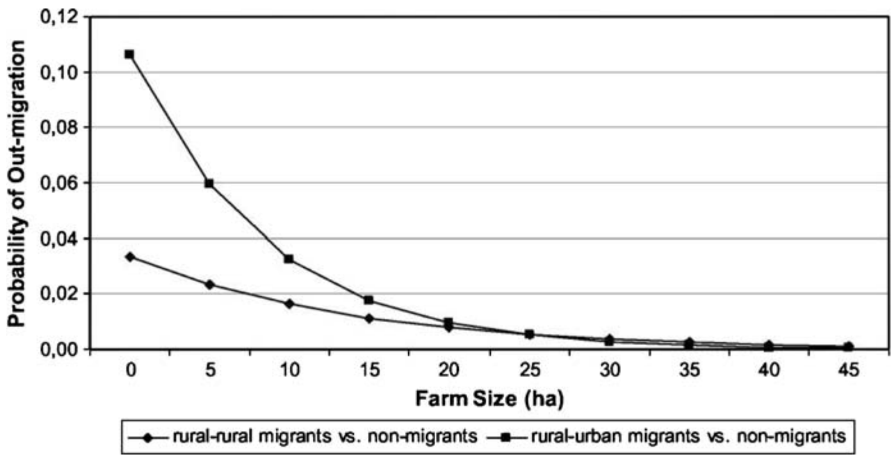

Fig. 2 Predicted probability of out-migration from a farm household in the Ecuadorian Amazon between 1990 and 1998, according to farm size (hectares)

Table 5 Per cent change in the odds of rural out-migration from the Ecuadorian Amazon between 1990 and 1999, according to type of destination

Variable	Percent change in odds[a]			
	Migration versus no migration	Rural–rural migration versus no out-migration	Rural–urban migration versus no out-migration	Rural–rural migration versus rural–urban migration
Male	−27.57	–	−45.05	–
Age 12–19	251.35	171.56	737.37	–
Age 20–34	676.32	516.38	1668.29	–
Engagement in farm work	–	51.59	–	151.05
Adults	3.24	3.72	–	11.46
Children	−5.25	–	−15.74	24.04
Land in crops in 1990	−2.34	–	–	
Land in pasture in 1990	−0.26	–	0.62	−49.83
Previous out-migrants	20.78	20.19	19.81	–
Distance from community to nearest town	0.78	–	1.54	−2.01
Health facility in community	–	−44.63	–	−68.78

[a] Considering only the significant variables in Table 4 ($p < 0.05$), except "farm size" (analyzed in Fig. 2)

It is striking that the effects of children in the household on migration are, overall, very different, with migrants more likely to come from households with fewer children, especially migrants to urban destinations. At the same time, migrants to rural areas are far more likely to migrate than those to urban areas when there are more children in the household. Overall, the odds of out-migration fall by 5% for each child, and by 16% for migrating to an urban destination. At the same time (Table 5), the odds of out-migrating to a rural area instead of an urban area are 24% higher for each additional child in the household, a powerful effect. These results may well reflect the primary role of women (both mothers and older daughters) in child care, so that the typical mobility to urban areas (mainly females) is constrained by more children in the household. At the same time, the positive effect of more children as well as more adults on the selectivity of migrants for rural versus urban destinations may be due to the need for more land to produce income to feed the family.

Tables 4 and 5 show that farms with more land in pasture in the beginning year of analysis are somewhat less likely to have out-migrants in general, and rural–rural migrants, in particular. Thus, migrants are less likely to come from households with more land in pasture overall, though the quantitative significance of the effect is trivial (coefficient one-ninth that of the coefficient for land in crops). Rural–rural migrants are also less likely than rural–urban migrants to come from households with more land in pasture at the beginning of the observation period. These households may have aged into the latter years of the household lifecycle in which labor investments are exchanged for capital investments in cattle, which would enable urban migration. On the other hand, there is a positive association between land in pasture in 1990 and subsequent rural–urban migration, with the odds of out-migrating to an urban area increasing by 0.62% per hectare of additional land in pasture in the initial year (Table 5); thus a farm with 10 more hectares has the odds or out-migration to urban destinations versus no migration increase by a meaningful 6.2%. The odds of out-migrating to a rural instead of an urban area are 50% smaller for a 1-ha increase.

However, the odds ratios, like the coefficients noted above, indicate that the effects of land in crops are far greater on retaining labor on farm households, with each additional hectare of land in crops in 1990 decreasing the odds of out-migration by 2.3% compared to 0.26% for each additional hectare of land in pasture. This is exactly what is expected given the much higher labor intensity involved in growing crops compared to raising cattle.

The results for land in pasture may suggest an interesting possible feedback effect, with more land in pasture leading to more rural–urban migrants, who being younger and hence more likely also to be single, may be more likely to contribute income to the original farm household through remittances, which may then be invested in purchasing more cattle and clearing further pasture. Such a process was observed in the Brazilian Amazon by Browder and Godfrey (1997). Household lifecycle factors may also play a key role, along with the farm lifecycle, since the aging of the initial first generation of colonists and the out-migration of their children as they reach adulthood may require changing land-use strategies over time, viz., replacing annual crops and aging perennials with cattle, since it requires much less labor (Barbieri et al. 2005).

Personal Attributes

Table 4 shows that women are significantly more likely than men to leave their farm households in the Ecuadorian Amazon, overall (Model 1), and that this is due to their much greater tendency to leave for urban destinations, seen in Model 2b (we know from information on their location that this is mainly towns in the Amazon, not the major cities elsewhere in the country). The results of Models 2a and c show that there is no significant gender difference in comparing the determinants of migration to rural destinations versus non-migration or in comparing rural–rural and rural–urban movements. Table 5 shows that the odds of male out-migrants choosing an urban area are 45% smaller than those of female out-migrants. Women, especially the daughters of the head of the household (the main female migrants), tend to have a secondary role in farm work, so females are both more likely than males to leave the family farm and to move to towns, where there are growing opportunities for employment in domestic work and other service sector jobs.

As seen in Table 4, age effects are also quite strong, with young person's 12–19 and 20–34 both much more likely to migrate overall than those over age 35, to either urban or rural destinations (Models 1 and 2b). Table 5 adds that the odds that someone 12–19 or 20–34 migrates are 2–17 times as high as those for 35 years and older (Model 1), with this age effect being far stronger for those moving to urban areas.

Human Capital

As noted earlier, the household head's education is a measure of household human capital. If it has positive effects on migration, it could indicate an effect of the household head's education on obtaining and transmitting information about employment opportunities elsewhere to his children and/or an effect on children's aspirations (for examples, see, e.g., VanWey 2003). However, Table 4 shows that the migrants are in fact no more likely than non-migrants to come from households where the head has some secondary education (Models 1, 2a and c). There is a marginally significant ($p < 10\%$) tendency for migrants choosing rural compared to urban destinations to come from households where the head has more education, which is contrary to expectations, but since the effect is so marginal, we do not elaborate further.

In contrast to head's education, previous work experience of the person at risk has a strong effect on out-migration, being linked to the likelihood of rural–rural migration (versus no migration) and to rural–urban versus rural–urban migration (Table 4). Table 5 shows that having farm work experience increases the odds of rural–rural out-migration by 52% and of out-migrating to a rural area instead of an urban area by one and a half times. These results show a lack of articulation between farm work and urbanward migration.

Migration Networks

The results in Tables 4 and 5 show that previous out-migrants have a powerful impact on new out-migration from a household (cf. Models 1, 2a and b). Having an additional previous out-migrant increases the odds of migration versus no migration as well as of both rural–rural migration and rural–urban migration versus no migration by 20%. These consistent, strong results point to the important influence of migration networks on stimulating further out-migration from farms, likely reflecting its effects on reducing the costs of migration (providing temporary lodging, food) and as a source of information about job possibilities in places of destination, as hypothesized above and found in previous literature (e.g., Massey 1990, 1993; Palloni et al. 2001).

Community Factors

Finally, the results in Table 4 show that there is a strong statistically significant and positive association, as hypothesized, between the likelihood of out-migration and distance to the nearest important town (Model 1). The results of Models 2a–c clarify that this is solely due to the strong effects of distance on contributing to *rural–urban* migration: not only is there no effect of distance on rural–rural versus no migration, as anticipated from Table 2 above, but greater distance provides a strong impetus for rural–urban versus rural–rural migration (Model 2c), within the context of stimulating overall migration. The results in Table 5 show that an additional kilometer between the household's local community and the nearest major town increases the overall odds of out-migration by almost 1% (Model 1), but that all of this effect is on rural–urban migration, as an additional kilometer from the community to the closest town increases the odds of rural–urban versus no migration by 1.5%. This is likely because if the household's local community is close to a major town, off-farm work is convenient via commuting and temporary labour migration, which do not require a change of residence, whereas when the distance is greater, out-migration is necessary due to the increasing time and transportation costs of commuting (see Barbieri 2006).

The results in Tables 4 and 5 show that having a health facility in the community is an important factor in reducing the odds of rural–rural out-migration (by almost half), and of out-migration to rural versus urban areas by as much as 69%. This is a powerful effect. On the other hand, the same results are not seen for secondary schools, another form of modern infrastructure available in less than half of the study communities. We initially thought this may be due to collinearity with the health facility variable, but that correlation was low. Another possibility, discussed by Taylor (1986), is that formal education opportunities in less developed countries do not provide sufficient economic returns and incentives for their existence in communities to retain rural populations. We believe the lack of a general effect of secondary education is due to *counteracting effects*: on the one hand, having access to secondary schools is a deterrent to out-migration (for those desiring an education), but on the other hand it also increases urban wage prospects, may alter tastes and motivations, and increases capacity to access information, all of which tend to increase out-migration.

While we only show the results for these two community variables reflecting local infrastructure, we did examine a number of other community variables which were not statistically significant in any model. These include electricity, the presence of a bank or other credit facility, of technical assistance agencies, or a church.

Period Effects

We examined whether there was a significant effect of year on out-migration, which could capture the effects of external factors that change over time, such as prices of major commodities, political changes, weather, etc. This procedure allows us to verify potential period effects affecting out-migration, albeit not specifying which specific factors (e.g., commodity prices) impact out-migration. We thus included nine dummy variables for the year of migration to capture these effects, as illustrated in Fig. 3. Each year is a dichotomous variable, α_{rt}, in Eq. 1 (coefficient estimates for years are not provided in Table 4). The reference year is 1999, for which out-migration data refer only to the first 5 months, as fieldwork was undertaken mainly between February and July. Thus, almost all coefficients for any year between 1990 and 1998 are higher than that for 1999. Figure 3 shows that out-migration jumped in 1991, 1994, 1996 and 1998, and tended to rise over time slightly (corroborated by constructing polynomial trend lines representing each curve, not shown in Fig. 2). There is little difference in rural–rural and rural–urban out-migration in most years, with the exceptions of 1996 and 1997, when the time coefficient moved in the opposite direction. It is likely that the fall in coffee prices

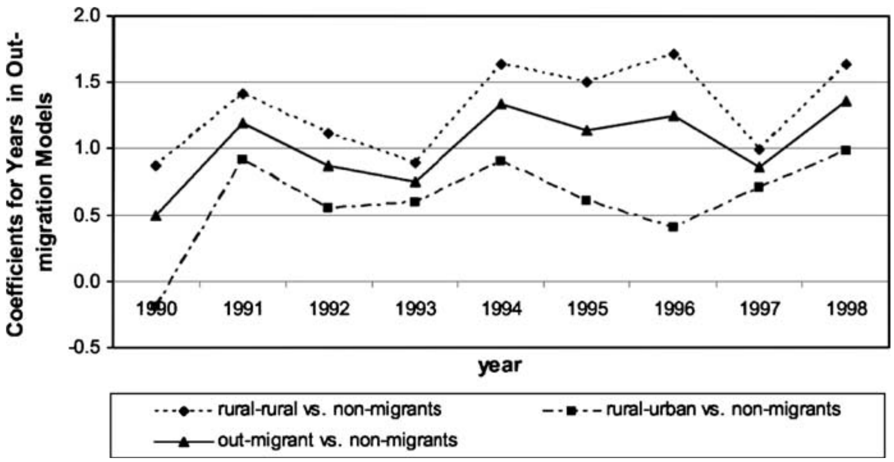

Fig. 3 Coefficient estimates of the effects of years on out-migration from the Ecuadorian Amazon between 1990 and 1998, taking 1999 as the reference year

(the main crop in the study area) and increasing political instability led to more out-migration over the decade (Bilsborrow et al. 2004).

During the decade of the 1990s, one of rapid population growth in towns but also continuing rapid growth in rural areas, more persons left farm households in the Ecuadorian Amazon for rural than urban destinations (Tables 1 and 2). Since the "stock" of individuals at high risk of out-migration (defined by age, etc.) is gradually reduced over time as the number of persons who out-migrate each year from the panel is greater than the number entering the pool from new births and aging of children already born, the likelihood of out-migration tends to stabilize and eventually decline. Farm households also adjust their risk-diversifying strategies in other ways over time, notably allocating a member to local off-farm employment or intensifying land use, which would also reduce the tendency for the original sample of households to have further out-migrants over time.

Conclusions

This paper contributes to the empirical literature on the determinants of migration by studying the migration of second-generation settler colonists in a rainforest frontier setting. There has been much research on such settings recently, but mostly on the ecological consequences, rather than on what happens to the migrant colonists once they have moved. While their economic welfare is of enormous importance and must be considered in crafting policies if they are to have any chance of being sustainable, the question of what happens to the migrant families, particularly children, once they have moved, is also important for the same reason. Thus, do they tend to remain on the farm or to themselves migrate elsewhere, and to establish further farms continuing the cycle of deforestation, or to urban destinations?

The results suggest that migration is becoming an increasingly important demographic factor in the NEA. Nevertheless, there has been little research on the determinants of migration flows *within* frontier areas of developing countries, and that which exists has not incorporated intergenerational characteristics associated with the evolution of farm land use over time. As fertility levels decline in frontier areas (following national declines), migration becomes increasingly the dominant demographic factor. This has already occurred in the Brazilian Amazon and is beginning in the Ecuadorian Amazon as well, and will become even more predominant in the future as second generation settlers reach adulthood and seek land or jobs, catalyzed by the declining capacity of farms to sustain members due to decreasing soil quality and therefore declining agricultural yields over time. It is in this context that this paper investigates the factors that motivate migration of second-generation settler colonists in the Amazon frontier and their choice of destination. We use a multi-scale perspective to investigate the effects of individual, farm household, and community characteristics on decisions to leave farm households over time.

The results indicate links between intergenerational aspects of family succession, land use change, and out-migration, and the need to understand the importance of the farm lifecycle relative to the household lifecycle in explaining out-migration. The multinomial models also reveal factors differentially motivating out-migration to urban versus rural destinations. Indeed, some variables not statistically important in the binomial model (to migrate or not) were found relevant for explaining the choice of destination, viz., experience working on the farm, education of the household head, and whether there is a health facility in the community. The analysis of the time coefficients also suggests period effects acting upon out-migration decisions. This shows that it is important to control for those effects, to avoid misspecification and get more reliable results for other included variables. This also suggests that the vast majority of previous research on migration, not only in frontier settings but any setting, which does not take into account temporal factors, is likely to lead to misspecified models and incorrect parameter estimates of variables. In the situation here, period effects are only controlled for implicitly (through time dummy coefficients) rather than explicitly (e.g., through independent variables actually measuring specific period effects, such as changes in coffee prices). If such variables could be identified and measured, it could be possible in future work to attempt to control for those effects as well as cohort effects in studying the relationships between household demographic factors, particularly out-migration, and land use.

The results here are also useful to inform policymaking in the NEA, given that the development of the Amazon region and its environmental sustainability are both influenced by these intra-regional migration processes. The fact that over a quarter of the members of those households that remained in the region over the decade migrated away in the short 9 year period, two-thirds to other rural destinations in the region (see Table 1), suggests that pressures continue to be strong towards further deforestation and environmental loss. At the same time, the growing rural–urban migration adds to demands on urban infrastructure and budgets. The former has implications for the need to develop appropriate long-term land use settlement and agricultural policies, while the latter needs to be taken into account in urban planning. In addition, development policies in the Amazon and in Ecuador as a whole should take into account the powerful "inertia" in these population mobility processes due to the strong effects of *migration networks* (from *previous* out-migration from migrant settler households) on likely future migration decisions and destinations within the region.

In addition, the findings underline the importance of adopting a long-term planning perspective, incorporating policies such as family planning to reduce unwanted births, which would lead to smaller household sizes (and less pressures for out-migration from farm households). This research also suggests that promoting more intensive patterns of land use, through credit and technical assistance, for example, could improve land and labor productivity and hence the retention of labor on farm households.

Finally, this paper identifies effects of the *community context* on out-migration decisions from farm households, which have important policy implications. While many policies—e.g., those fostering improvements in urban employment or infrastructure, or the expansion of oil activities—tend to induce rural–urban migration, that migration as well as rural–rural migration is also influenced by *where* new oil extraction is allowed and hence where new roads and colonization occur. Vigorous debate is ongoing in Ecuador on whether oil extraction and new roads should be allowed in national parks (especially the Yasuni Park) and indigenous lands. The results here indicate that better road access to towns facilitates more out-migration from farm households, especially rural–urban migration. However, it also facilitates more off-farm employment in nearby towns. Thus, further expansion of the road network tends to reduce rural poverty, but can destroy vital natural ecosystems. Taking into account this trade-off is necessary for developing well informed policies for the sustainable development of the region. The results here are only one useful input into that larger process which must take into account population–environment interrelationships on a larger scale, taking into account farm and household lifecycle dynamics, migration, land use change, and infrastructure expansion.

Policies to improve living conditions in rural communities through infrastructure such as secondary schools or health centers should take into account the likely impacts on rural out-migration. On the one hand, having a health facility in the rural community appears to reduce out-migration, especially to other rural areas. But on the other hand, despite the bivariate data in Tables 2 and 3 suggesting there might be tendencies for people in communities with a secondary school to migrate to urban areas and those with none to migrate to rural destinations or not migrate, these results were not observed in the multivariate model, which found no overall effects. This is likely due to the counteracting effects of secondary schools, hypothesized above, with the more educated and younger persons tending to be the most mobile (not shown in this study, but see Laurian et al. 1998 on results from the 1990 NEA survey data). Thus secondary schools in rural communities are not likely to reduce (or increase) out-migration, though they might channel migrants who leave disproportionately to urban destinations.

The results on the effects of contextual or community-level factors on migration here must be considered provisional, given they are not very strong and given the lack of previous empirical findings in the literature. As far as we know, there has been no research on contextual effects on migration within frontier areas using appropriate multi-level estimation approaches. Further research is thus needed on this topic in the Ecuadorian Amazon and other contexts before definitive conclusions can be adduced. Since community-level variables often, as is the case here, reflect policy decisions (Bilsborrow et al. 1984; Barbieri 2006), such research can be most valuable for policy-makers interested in affecting rural–urban migration and other aspects of development in frontier regions. The model used here provides one such useful estimation approach.

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