Out-Migration of Second Generation Frontier Colonists and Population Redistribution in the Ecuadorian Amazon

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Abstract. Abstract. Since the 1970s, in-migration has driven swelling human presence and dramatic physical landscape changes in the Northern Ecuadorian Amazon frontier. Particularly in recent years, population growth and redistribution has engendered important consequences on deforestation and on the incipient, but increasing, urbanization in the frontier. This paper uses longitudinal and multi-scale data on settler colonists in the Northern Ecuadorian Amazon, between 1990 and 1999, to analyze the neglected importance of rural-rural and rural-urban migration of second-generation settler colonists from frontier areas in the Amazon. The results show important differentials between migrants in terms of personal characteristics, human capital endowments, farm household life cycle, access to community resources and infrastructure, and migration networks. The paper also identifies the distinct effects of policy-relevant variables on migrants' choices of rural versus urban destinations.

Keywords. Ecuadorian Amazon; rural-urban migration; rural-rural migration; agricultural colonization; development policies; frontier areas

Introduction

The Amazon is the largest tropical wilderness area in the world (Mittermeier et al. 2003; see also Myers et al. 2000). In particular, the Amazon region of Ecuador has experienced the highest rate of deforestation of any country's Amazon area (Food and Agricultural Organization 2001). In the study region in the Northern Ecuadorian Amazon (NEA), agricultural colonization 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, which has caused most of the forest loss. In addition to the principal deforestation on the original farms established in the 1970s and 1980s, a second wave of deforestation in the 1980s and 1990s is linked partly to the out-migration of people (mostly sons and daughters of the household head) 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 new pattern of population mobility within the Amazon: rural-urban migration.

Agricultural frontiers are often characterized initially by tremendous rates of in-migration, yet *out-migration* tends to dominate second-generation settler demographic dynamics (Laurian et al. 1998; Walker et al. 2002), as sons and daughters of pioneer settlers reach the early adult stage of their life cycle and sometimes set off on their own. While this can be a "rite of passage" (Laurian et al. 1998), the out-migration of one or more household members can also be a means of minimizing risk and maximizing household welfare and income. Given the increasing importance of internal migration as a main factor in population growth and changing population distribution in the various Amazonian countries (Bilsborrow 2003; Perz 2003), it is surprising that studies of the determinants of population mobility *within* the Amazon scarcely exist. 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). It is important to conduct studies based on

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household data since households are the main agents of decisions in rural areas, including frontier areas (Marquette and Bilsborrow 1999; Wood 2002). It is also important to understand better how households make migration decisions within a nested scale of multiple influences (see, for example, Zhu 1998 on China; Ezra 2003 and Henry 2004 on Africa; and VanWey 2003 on Thailand).

This paper uses a multi-scale approach to analyze how both temporal and contextual factors affect recent out-migration from rural areas in the Ecuadorian Amazon. The analysis focuses on the determinants of out-migration *at the place of origin*, that is, from migrant settler households. While the ideal analysis would draw upon data from households in *both* areas of origin and areas of destination (Bilsborrow et al. 1984; Bilsborrow et al. 1997), it is extremely rare to encounter data from linked origin-destination surveys since they are difficult and costly to implement. The decision about whether to focus the analysis on the origin or destination depends on the research questions and varies with the disciplinary orientation of the investigator (Bettrel and Hollifield 2000). Undertaking a study based only on data from the place of origin is the appropriate strategy for studying the *determinants* of *out-migration* (Bilsborrow et al. 1984; Skeldon 1990). This is particularly important in frontier areas of less developed countries, where factors such as low levels of education, poor access to communications, and scarce transportation resources hamper interaction with the outside world, creating inefficiencies in migrant networks or other mechanisms through which potential benefits from places of destination may be communicated. Finally, this paper considers urban and rural destinations of migrants separately to investigate how factors differentially affect the choice of destination. How migrant characteristics and other factors affect the choice of rural versus urban destination is also little understood but is of crucial importance for understanding future population mobility and distribution, which is in turn critical for development planning and environmental conservation policies.

Background and hypotheses

The scarcity of empirical studies on the determinants of population mobility in frontier areas of Latin America reflects the high cost of collecting data from households in these areas as well as the complexity of the migration process, beginning with its definition and extending to its causes. Nevertheless, certain factors have been cited frequently as possible determinants of out-migration from households in frontier areas: These include the 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, stage of the life cycle, and migration networks; and the larger context within which migration decisions are made, such as the characteristics of local communities.

Personal attributes, such as gender and age, and *human capital* endowments, such as education and occupational background or work experience, often play key roles in influencing migration decisions. The fact that migration is concentrated at younger ages is widely discussed in the literature, dating back to the origins of the field in Ravenstein 1889 and reiterated in Lee 1966, and is also consistent with the human capital approach (Sjaastad 1962). 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 in press).

The *human capital theory* of migration posits that individuals migrate to maximize utility, based on comparing the utility or personal satisfaction of staying versus moving (Milne 1991). Differences in the relative utility of places are ultimately explained by factors such as education and occupational background (Sjaastad 1962; Vanderkamp 1971; DeJong and Fawcett 1981; DaVanzo 1981; Milne 1991). Education has intrinsic value for people in the labour force (as it is linked to wage levels) but also influences attitudes, aspirations, and access to information, all of which tend to positively affect decisions to migrate, whether to urban or rural areas. Human capital factors also play important roles in influencing the decision as to *who* should migrate from the household. Thus, for example, farm households that adopt out-migration as a strategy of risk diversification are likely to allocate individuals to migration who have previous employment experience, better education, or both, since their expected earnings and therefore hopes for remittances are higher.

While not directly part of migration theory, *household life cycle* approaches may provide a link between household demographic factors and land use, which can ultimately affect migration. We examine these influences by drawing upon Chayanov's theory of the peasant household (Thorner et al. 1986; Ellis 1988), as adapted by several authors to the Amazonian context (for example, Walker and Homma 1996; Marquette 1998; Perz 2001; McCracken et al. 2002; Walker et al. 2002; Moran et al. 2003). The main argument of the household life cycle approach is that changes in household size and composition affect land use and farm household labour allocation, and that evidently out-migration directly affects household size and composition. In periods of low household labour availability (for example, early in the family life cycle when couples have young children, as well as later after adult children marry and move away), households tend to adopt agricultural practices suitable to the relatively low availability of household labour, such as clearing forest mainly to grow annual food crops in the first case, or switching land use to cattle in the second. The effect of the number of adults in the household on out-migration of a member can be positive or negative, depending, for example, on the amount of farm land available. A small amount of land will tend to lead to 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, so the returns to labour may remain high even with the addition of a new adult or the reaching of adulthood of a child in the household.

As households accumulate capital and labour (such as from young children becoming teenage children or young adults), *land use* tends to shift from annual crops to cash crops and pasture. When young adults leave the household as a rite of passage or to take advantage of employment opportunities elsewhere, farmers may switch to less labour-intensive forms of land use such as pasture. However, to the extent that such a process is under way autonomously, that is, farmers are seeking to acquire cattle for other reasons, this may free up labour, facilitating out-migration. Remittances from migrants to the origin household , in turn, may be invested on the farm in cattle, which has low labour requirements compared to crops.

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." 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). Previous out-migration from the household may also lead to further out-migration to the extent that it affects tastes and aspirations for a better or different life.

It is important to mention here how these hypotheses regarding the effects of *household life-cycle factors* on out-migration are addressed by the New Economics of Labor Migration (NELM) or risk diversification theory (Stark and Bloom 1985; Stark and Taylor 1989, 1991). The NELM posits that a household adopts a collective strategy of joint resource accumulation (maximize income and welfare) and risk minimization to ensure its subsistence. One or more household members will thus be allocated to either permanent out-migration or temporary labour migration to diversify sources of household income. The household member chosen to out-migrate is usually the one with higher human capital (such as education or previous off-farm working experience), since the expected income flow to the household in the form of remittances is higher. Younger household members are also expected to provide a longer period of income flows to the household than older ones. In particular, young women are often more likely to find employment in urban areas in Latin America, such as in domestic service, restaurants, and retail employment, and are also considered more reliable sources of remittances due to stronger affective ties to the origin household, and perhaps a higher level of submission to the male household head (Guest 1993).

Regarding *community effects* on migration, transportation access is an important community factor affecting migration decisions (see examples in Rudel 1983; 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 both seeking employment and purchasing consumer goods and services. The proximity of major destinations lowers transportation costs and facilitates temporary mobility (e.g., commuting), while longer

distances to towns increases such costs and tend to 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 1996; 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 1987; Findley 1987; Wood 2002). For example, better community infrastructure, such as 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 shape aspirations for a different way of life elsewhere, with higher income. However, there have been very few previous efforts to empirically investigate the influence of context on out-migration, although the effects on fertility and contraceptive use have received considerable attention (e.g., Entwisle and Mason 1985; Hirschman and Guest 1990; Entwisle et al. 1997).

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 landscapes in the country. The study area is located in the Northern Ecuadorian Amazon (NEA) (Figure 1).

FIGURE 1 HERE

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 1990's 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 100 per cent at the time of settlement to 59 per cent by 1990, and then further to 45 per cent in 1999. Urbanization is also an increasing, but still 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. 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, for example, 1,787 in 1990 and 1,324 in 1999. A separate community-level survey was also undertaken in 2000 and obtained retrospective information back to 1990 or earlier for the 43 rural communities linked to the 246 sample farms. A farm household is associated with a specific community if the Euclidean distance between the farm household and the central point in the community (such as the community center or school) is the shortest one, compared to other communities in the sample region.

A discrete-time multinomial hazard model is used to estimate the factors affecting out-migration from migrant settler households. 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:

$$\log\left(\frac{\pi_{\text{rit}}}{\pi_{\text{sit}}}\right) = \alpha_{rt} + \beta_{rA}\text{X}_{\text{ri}} + \beta_{rB}\text{X}_{\text{rit}} \qquad (1)$$

where $\log\left(\frac{\pi_{\text{rit}}}{\pi_{\text{sit}}}\right)$ represents the log-odds that individual *i* will out-migrate at time *t* (*t*=1990,…,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 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, matrices of vectors 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, and 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 1990 and the interview date in 1999. The definition embodies two important aspects. First, we cover only long-term, or "permanent," changes of residence and do not consider temporary migration, usually labour migration. Second, 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. 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 twelve years of age in 1990, which enters the 12-59 age interval during the 1990–99 decade, as well as others that attain their sixtieth 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 effects of one per cent change in a covariate X_{ri} or X_{rit} on the odds of out-migration can be estimated using the odds ratio e^{β} in the equation:

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

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. To avoid this, the model in equation (1) is estimated using Huber-White robust standard deviations (Allison 1999; Hox 2002).

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. Among those at risk, there are 398 out-migrants; 67 per cent chose rural areas, and 33 per cent chose urban areas (79 per cent move within the Amazon). Overall, 27 per cent of the population at risk living in colonist farm households in the Ecuadorian Amazon moved during the nine-year interval between 1990 and 1999. This is a highly dynamic, mobile population.

TABLE 1 HERE

Table 2 compares the means and standard deviations of independent variables according to migration status, that is, whether they chose rural or urban destinations or did not move. These variables are discussed here in the same order as in the section above on background and hypotheses. Table 3 compares the means in two book-end years of the analysis, 1990 and 1998.

TABLE 2 HERE

TABLE 3 HERE

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 (especially in the youngest age groups, 12-19). Men constitute most of the rural-rural migrants. Table 3 shows that out-migration becomes concentrated at older ages in the 12-34 age interval 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 between 1990 and 1999, these results partly reflect life-cycle factors related to the aging of household members. Most household heads and spouses of households came to the region in the 1970s and 1980s; thus, the typical female spouse was reaching the latter stages of reproductive life or even surpassed it in the 1990s. Correspondingly, the children of these women, the second generation, were often entering the ages of highest migration (age 20-34) during the 1990s.

Human capital. Table 2 shows virtually no difference in the education of the household head of rural-rural and rural-urban migrants, though those who do not move are more likely to have some secondary education. Over time, however, farm households with rural-urban migrants became more associated with household heads with at least secondary education (Table 3). Rural-rural migrants and those not moving are both more likely to have been engaged in farm work prior to migration than those moving to urban destinations, which is expected since previous farm work is relevant experience for continuing farm work but not for urban employment.

Farm size and composition and household life cycle factors. Farm size reduction over the decade reflects land subdivisions in the NEA. Land fragmentation and consolidation constitute key understudied issues in studies of demographic dynamics in frontier areas. Tables 2 and 3 show apparently only minor differences in farm area between households with out-migrants and those without out-migrants. (Note that means for household and community variables are weighted by person years; see footnote in Table 2). Thus households with rural-rural out-migrants had slightly less land than those with no out-migrants, while those with rural-urban out-migrants had slightly more. However, substantial changes in farm size occurred over time, with farm area decreasing by 17 per cent on average for households with rural-rural out-migrants between 1990 and 1999, by 20 per cent for those with rural-urban out-migrants, but by only 8 per cent for farm households without out-migrants. Thus, farms remaining practically intact in size are more associated with non-migrants, while subdivided farms are associated with migrants.

In Table 2 we also see that households with rural-rural migrants have considerably more adults and children than the other two groups, indicating a link between larger households and 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 the evolution of the farm household—the spouse of the male household head reaching the twilight of her reproductive window or surpassing it 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.

Tables 2 shows that farm households have more land in pasture than in crops and perennials throughout the period. (Outliers explain the much higher amount of land in pasture for households with rural out-migrants in 1990.) Table 3 shows a reduction in land uses over time, which does not mean declining areas overall, only the effects of the weight by persons for a declining household size.

Migration networks. As observed in Tables 2 and 3, households with out-migrants (especially rural-urban migrants) have more out-migrants in previous years, and the mean number of previous out-migrants increases over time for all out-migration status households, which is expected since it represents a cumulative measure of out-migrants from a farm household starting with its establishment in the study area. These increases are greater for the two groups of households with out-migrants compared with the group without out-migrants, as is to be expected. These data suggest that

migration networks may be more important for those migrating to urban areas than for those migrating to other rural 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 4 mentioned earlier, of Lago Agrio, Coca, Shushufindi and Joya de los Sachas) of 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 seemed to have out-migrants first, so by the end of the period, it is farm households farther from major towns that rural-rural migration. It is appropriate that the distance of households with no out-migrants did not increase in the 1990s, and continues to be less than those 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 both secondary schools and health facilities are much likely to be found in communities with farm households engaging in rural-rural out-migration than those with no out-migrants or out-migrants to urban destinations. As observed in Table 3, rural communities throughout the region acquired more health and education services over time, which may result in an improvement in living standards, but the differences across households observed in Table 2 continue to hold throughout the period.

Determinants of out-migration

Table 4 presents the model results. Model 1 estimates the determinants of migrating vs. not migrating, without taking into account out-migrants' places of destination, while Models 2a, 2b, and 2c distinguish, respectively, between rural-rural migrants and non-migrants, rural-urban migrants compared to non-migrants, and rural-rural migrants compared to rural-urban migrants. Table 5 compares the per cent changes in the odds ratio of out-migration for the statistically significant variables in Table 4.

TABLE 4 HERE

TABLE 5 HERE

Personal attributes. Table 5 shows that the odds of male out-migrants choosing an urban area are 28 per cent smaller than those of female out-migrants, reflecting a female preference for rural-urban migration. Women, especially the daughters of the head of the household, tend to have a secondary role in farm work, so females are more likely than males to move to towns, probably mainly to take up domestic work and service sector jobs. Age effects are quite strong: the per cent change in the odds that an individual in the two younger age groups will move is much higher than that of the age group 35 years and older (Model 1). Furthermore, the odds of persons below 35 years of age moving to urban areas are much higher than those of moving to a rural area.

Human capital. The household head's education is a measure of household human capital. If it has positive effects on migration, that could indicate the influence of the (almost always male in this population) household head's education on obtaining and transmiting information about employment opportunities elsewhere to his children, as well as effects on children's aspirations (see examples in VanWey 2003; Barbieri and Carr in press). However, Table 4 shows that household's head education is not significant in Models 1, 2a and 2c, and is only marginally significant (10%) for those choosing rural compared to urban destinations.

In contrast to the weak or non-existent effects of the head's education, previous work experience of the person at risk has a strong effect on out-migration. Tables 4 and 5 show that having only farm work experience is a significant predictor of rural-rural migration: it increases the odds of out-migration by 52 per cent. In addition, among movers (Model 2c), the odds of out-migrating to a rural area instead of an urban area are 151 per cent higher for those fully involved in farm work. These two results for on-farm employment experience show a lack of articulation between rural employment background and urban employment. This may reflect an "early mobility transition stage" (Zelinsky 1971), in which urbanization in the Ecuadorian Amazon region is only incipient and thus unable to rupture rural traditions and employment strategies away from traditional rural-rural migration for most rural households.

Farm size and composition and household life cycle. Prima facie, farm area in hectares is not easily interpreted in Table 4, since cubic and logarithm transformations were found useful to best capture the nonlinearity between farm size and out-migration. However, these effects can be interpreted from plotting an analysis of the predicted probabilities that an individual will out-migrate. (From equation (2), the predicted probabilities are estimated as: $P_{rit} = 1 / (1 + e^{- \alpha rt - \beta rAXri - \beta rBXrit})$.) Figure 2 shows that the probability of out-migrating decreases as the amount of farmland increases, until a point (25 hectares) beyond which there is virtually no difference between rural-rural and rural-urban migration, and the probabilities tend to stabilize at a low level. Nevertheless, for small farms, increasing farm size is associated with a decline in the likelihood of out-migration, as one would expect from theory and previous studies; this also is true for the finding that having fewer hectares of farmland is likely to have a bigger effect on leading to out-migration to urban areas compared to rural areas.

FIGURE 2 HERE

In terms of farm household life-cycle factors, Table 4 shows that the number of adults living in the farm household is positively associated with rural-rural migration: one additional adult increases the odds of out-migration by 4 per cent. Among movers, the odds of out-migrating to a rural area instead of an urban area are 11.5 per cent higher for each additional adult living in the farm household. 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 labour (since farm area is controlled for), engendering a demand for land outside the farm (hence rural-rural migration). On the other hand, an additional child living in the farm household decreases by 5 per cent the odds of out-migration in general and by 16 per cent the odds of rural-urban migration. The odds of out-migrating to a rural area instead of an urban area are 24 per cent higher for each additional child in the household. These results probably reflect the primary role of women (both mothers and older daughters) in child care, with their typical mobility to urban areas constrained by children.

Tables 4 and 5 show that farms with more land in pasture are likely to have a lower likelihood of out-migration in general, and of rural-rural vs. rural-urban out-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 cent per hectare of additional land in pasture in the initial year; thus for ten more hectares, the odds increase by a meaningful 6.2 per cent. The odds of out-migrating to a rural instead of an urban area are 50 per cent smaller for a one-hectare increase in farmland in pasture in 1990, indicating some effect of pasture on retaining rural labour. However, the effects of more land in crops are much greater on retaining the rural labour on farm households: thus for each additional hectare of land in 1990, the odds of out-migrating later decrease by 2.2 per cent, or by almost ten times the effects of an additional hectare of land in pasture. This is expected given the much higher labour intensity of growing crops than raising cattle.

The results for pastureland may suggest interesting possible feedback effects, with rural-urban migrants being younger and earning more cash income, and thus more likely to contribute to the original farm (the first-generation farm colonists) through remittances, which may well be invested in cattle, compared to rural-rural migrants, who probably earn and remit much less. Such a link between strategies of capital accumulation, via rural-urban migration of a farm household member coupled with remittances received and invested in cattle, has also been observed in the Brazilian Amazon (Browder and Godfrey 1997). Life cycle factors also may play a key role, since the aging of the initial first generation of colonists may require changing land-use strategies, such as replacing crops and perennials with cattle ranching, which requires much less labour and, consequently, fewer adults living on the farm.

Migration networks. Tables 4 and 5 show that previous out-migrants have a powerful impact on new out-migration, in Models 1, 2a and 2b. Having an additional previous out-migrant increases the odds of migration vs. no migration and both rural-rural migration and rural-urban migration vs. no migration by 20 per cent. These results reflect an important influence of migration networks on stimulating further out-migration from rural areas, perhaps as a reflection of its effects on reducing the costs of migration (providing temporary lodging, food) and as a source of information about job possibilities and social support in places of destination, as suggested in the previous literature (e.g., Massey 1990; Massey et al. 1993; Palloni et al. 2001).

Community factors. The results in Table 4 show that there is a strong statistically significant and positive association, as hypothesized, between out-migration in general and distance to the nearest important town (Model 1). But the results of Models 2a, 2b and 2c show that this is due to the strong effect of distance on contributing to rural-urban migration: not only is there no effect of distance on rural-rural vs. no migration, as anticipated from Table 2 above, but there is a strong impetus to rural-urban vs. rural-rural migration (Model 2c). The results in Table 5 show that an additional kilometer between the local community and the nearest major town increases the overall odds of out-migration by almost 1 per cent (Model 1), but that all of this effect is on rural-urban migration where an additional kilometer from the community to the closest town increases the odds by 1.5 per cent. This is probably because closeness of the local community to a major nearby town facilitates alternative forms of (temporary) mobility, such as commuting and temporary labour migration, which do not require a change of residence, whereas out-migration becomes more likely at higher distances due to the increasing transportation costs of commuting.

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 migration (by almost half), while the odds of out-migration to rural areas instead of urban areas are lower by 69 per cent. This may suggest that individuals are less likely to out-migrate to other rural areas, where such a facility is often not available. However, the same statistical results are not seen for secondary schools, another form of modern infrastructure available in some but not all rural communities. There is, in fact, no significant association between having a secondary school in the local community and overall out-migration. While this may be thought to be related to collinearity with the health facility variable, this correlation was low. The lack of any relationship may suggest, as discussed by Taylor (1986), that formal education opportunities in less developed countries do not provide significant economic returns and incentives to move to urban areas where that education is not sufficiently valued by prospective employers. Furthermore, traditional secondary education in Ecuador provides few practical skills useful to a rural-rural migrant. Still, we believe the lack of a general effect of secondary education is mostly due to counteracting effects: having access to secondary schools is a deterrent to out-migration (especially for education), on the one hand, but also tends to change tastes and increase access to information, which would 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.

Time. 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. The effects of time on out-migration are illustrated in Figure 3. Each year is a dichotomous variable, α_{rt}, in equation (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 five 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 Figure 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. Although no empirical evidence is available, it is likely that the fall of coffee prices (the main crop in the study area) and the political instability led to more out-migration over the decade (Bilsborrow et al., 2004). In general, rural-rural migrants have a higher likelihood of migrating away from their farm household compared to rural-urban migrants, as is consistent with Table 2. Since the "stock" of individuals at high risk of out-migration is reduced over time precisely as some persons out-migrate each year, the increase in the likelihood of migrating tends to stabilize and eventually declines. Furthermore, as farm households adjust their risk-diversifying strategies, such as allocating a member to local off-farm employment instead of out-migration or investing in land intensification, further out-migration from the original 1990 sample of farm households must become less likely.

FIGURE 3

Conclusions and policy implications

This paper contributes to the empirical literature on the determinants of migration by studying the migration of second-generation settler colonists in the Amazon frontier. It relies on multi-scale data investigating the effects of individual, farm household, and community characteristics on decisions to migrate over time. There has been little research on the determinants of migration flows within frontier areas of developing countries, and that which exists does not incorporate intergenerational characteristics associated with family succession, nor the effects of context on migration. Migration becomes increasingly the dominant demographic factor in frontier regions over time, and is now becoming important in the Ecuador Amazon study region. It should become even more important in future years as the second generation of settlers continue to reach adulthood and seeks more land or jobs, combined with the declining capacity of farms to sustain members due to population growth and decreasing soil quality with use over time, and therefore declining agricultural yields.

This paper presents empirical results for an area in the Northern Ecuadorian Amazon to identify key factors affecting out-migration from rural farm households on the agricultural frontier. The results should be useful to policymakers concerned about the effects of population mobility and redistribution in the Amazon. Multinomial models can unveil factors differentially motivating out-migration to particular destinations. Indeed, some variables which were not statistically significant in the binomial model (migrate or not) were significant in explaining out-migration to particular places of destination: engagement in farm work, education of household head, and health facility availability in the community.

Successful socioeconomic development and environmental sustainability in the Amazon will be influenced to a major degree by how governments react to these increasingly important migration dynamics. For example, our results show that *farm household life cycle* factors are key determinants of demographic dynamics, particularly of the out-migration of younger household members. This will increase pressure on natural resources of the region, especially rural-rural migration which usually results in further deforestation, and rural-urban migration which puts increasing 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. It is important to understand the implications of population momentum which results from past (and present) high fertility, which has major implications for the future labor supply and consumption demands in urban and rural areas. But there is also momentum in migration flows. Development policies in the Amazon should consider the "inertia" in population mobility due to the strong effects of *migration networks* following a history of previous out-migration from farm households. The results indicate a significant and positive effect of the resulting migration networks on further out-migration.

An important policy implication is thus 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 the anticipation of second-generation effects of past high fertility on patterns of land fragmentation, land use, and living standards. Another policy implication is the desirability of promoting land intensification through credit and technical assistance to improve productivity and returns to labor, which would tend to retain more rural labor.

This paper also identifies key *personal attributes* and *human capital* factors affecting out-migration. The "gender dimension" in rural-urban migration indicates the value of urban policies favoring the absorption and improvement of wages and working conditions of women and more accurate information about urban employment opportunities. While improving women's access to farm resources and land titles could perhaps reduce the out-migration of girls and women, in fact there are no institutionalized (only social custom) barriers to women's ownership of farmland.

Finally, this paper identifies certain effects of *community factors* on out-migration from the NEA frontier, which has important policy implications. While some policies—for example, those fostering urban employment or the expansion of oil activities—may induce rural-urban migration, 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 macro issue, being vigorously debated in Ecuador currently, about whether new roads should be

allowed for oil extraction in national parks and indigenous lands, the results here indicate that better road access to towns from rural communities favors rural out-migration.

Policy strategies to improve living conditions in rural communities—for example, through the construction of secondary schools or health centers—should also anticipate likely future impacts on rural out-migration. On the one hand, health facilities appear to reduce out-migration from rural areas in general, and especially to other rural areas that may not have such facilities. But on the other hand, more schools can have drawbacks related to the selective nature of migration, 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 to the degree that secondary schools stimulate out-migration, especially to urban areas, their widespread creation may not be the best use of scarce public resources, and may deleteriously impact rural production systems due to the loss of the more educated labor. Nevertheless, the results here on the effects of contextual or community-level effects must be considered highly provisional. There has been almost no empirical multivariate multi-level research on this important topic in frontier areas. Further factors need to be examined in this Ecuadorian Amazon and in other contexts, and further models explored, before definitive conclusions can be adduced. But meanwhile, the approach here seems a promising path to take.

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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*	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

* 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

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

	Rural-rural migrants		Rural-urban migrants		Non-migrants	
Variable	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+ (1=at least some secondary)	0.34	0.47	0.33	0.47	0.41	0.49
Farm area						
Farm area (ha)	42.2	15.7	44.4	23.3	43.7	27.1
Farm household life cycle						
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)+	7.27	5.73	7.47	6.11	8.76	6.41
Land in pasture in 1990 (ha)+	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)+	22.8	16.8	26.6	19.4	23.0	17.9
Health facility in the community (1=yes)	0.19	0.39	0.35	0.48	0.27	0.44
Secondary school in the community (1=yes)	0.24	0.43	0.38	0.49	0.33	0.47

+ time-invariant independent variables

* 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.

Table 3. Means of independent variables in 1990 and 1999, according to out-migration status, study area in the Northern Ecuadorian Amazon*.

	Rural-rural migrants		Rural-urban migrants		Non migrants	
Variable	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	0.29	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+ (1=at least some secondary)	0.35	0.35	0.35	0.41	0.40	0.41
Farm area						
Farm area (ha)	43.8	37.7	46.4	36.9	46.1	42.2
Farm household life cycle						
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)+	7.51	7.01	7.81	7.14	8.53	8.92
Land in pasture in 1990 (ha)+	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)+	22.2	27.1	25.6	26.5	23.3	22.8
Health facility in the community (1=yes)	0.16	0.21	0.30	0.41	0.20	0.31
Secondary school in the community (1=yes)	0.16	0.27	0.33	0.47	0.21	0.36

+ time-invariant independent variables

* See Table 2 footnote.

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 vs. no out-migration	Model 2a rural-rural migration vs. no out-migration	Model 2b rural-urban migration vs. no out-migration	Model 2c rural-rural migration vs. rural-urban migration
Personal attributes				
Gender (ref.=female)+	-0.3225***	-0.1923	-0.5988***	0.1755
	(0.1141)	(0.1342)	(0.1998)	(0.2786)
Age group 12-19	1.2566***	0.9990***	2.1251***	-0.7439
(reference group: 35+)	(0.2037)	(0.2256)	(0.4831)	(0.5540)
Age group 20-34	2.0494***	1.8187***	2.8726***	-0.8035
(reference group: 35+)	(0.1967)	(0.2137)	(0.4706)	(0.5229)
Human capital				
Engagement in farm work	0.1878	0.4160**	-0.2070	0.9205***
(ref.=not engaged)+	(0.1321)	(0.1655)	(0.2176)	(0.2925)
Household's head education	-0.0140	0.0566	-0.1584	0.4557*
(ref.=less than secondary)+	(0.1226)	(0.1475)	(0.2033)	(0.2708)
Farm area				
Farm area (ha)	-0.0095**	-0.0359***	-0.0336	-0.0505***
	(0.0050)	(0.0113)	(0.0223)	(0.0165)
Logarithm of farm area	0.2494	1.0338***	-	1.4625***
	(0.1757)	(0.3294)	-	(0.4613)
Squared farm area (ha)	-	-	0.00066*	-
	-	-	(0.0004)	-
Cubic farm area (ha)	-	-	-0.000003*	-
	-	-	(0.0000)	-
Farm household life cycle				
Number of adults in the farm household	0.0319**	0.0365**	-0.0023	0.069500
	(0.0169)	(0.0189)	(0.0281)	(0.0567)
Number of children in the farm household	-0.0539**	-0.0263	-0.1713***	0.2154**
	(0.0296)	(0.0325)	(0.0590)	(0.0850)
Farmland in crops and perennials in 1990 (ha)+	-0.0237**	-0.0222*	-0.0228	-0.0099
	(0.0100)	(0.0120)	(0.0154)	(0.0228)
Farmland in pasture in 1990 (ha)	-0.0026***	-0.0044	0.0062***	-0.0084***
	(0.0010)	(0.0046)	(0.0013)	(0.0028)
Migration Networks				
Number of previous out-migrants from the household	0.1888***	0.1839***	0.1807***	-0.0612
	(0.0199)	(0.0214)	(0.0296)	(0.0469)
Community factors				
Distance from community to nearest town/market (km)+	0.0078**	0.0017	0.0153***	-0.0203***
	(0.0033)	(0.0039)	(0.0053)	(0.0069)
Health facility in the community	-0.3122	-0.5912**	0.5087	-1.1642**
(ref.=no health facility)	(0.2374)	(0.2741)	(0.4589)	(0.5641)
Secondary school	0.2516	0.3783	-0.2542	0.6067
(ref.=no secondary school)	(0.2242)	(0.2534)	(0.4462)	(0.5422)
Intercept	-6.9289***	-9.0330***	-6.7566***	-2.9212**
	(0.5971)	(1.0315)	(0.8071)	(1.4682)
Log-likelihood	-1515.79	-1105.15	-619.15	-212.22

+ time-invariant independent variables

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

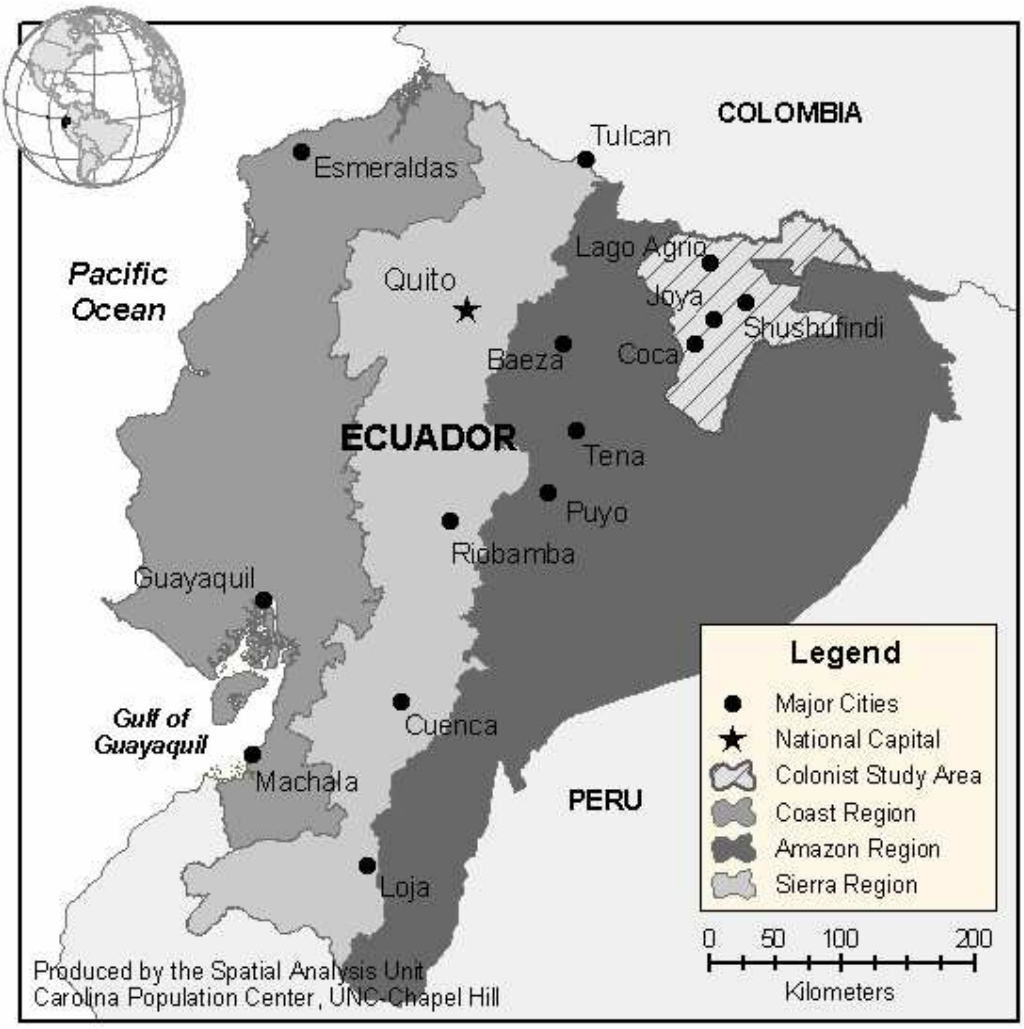
The coefficients representing the variable "year" (one dichotomous variable for each year between 1990 and 1998, with 1999 as contrast) are discussed in the text in relation to Figure 3. These variables are omited from this table.

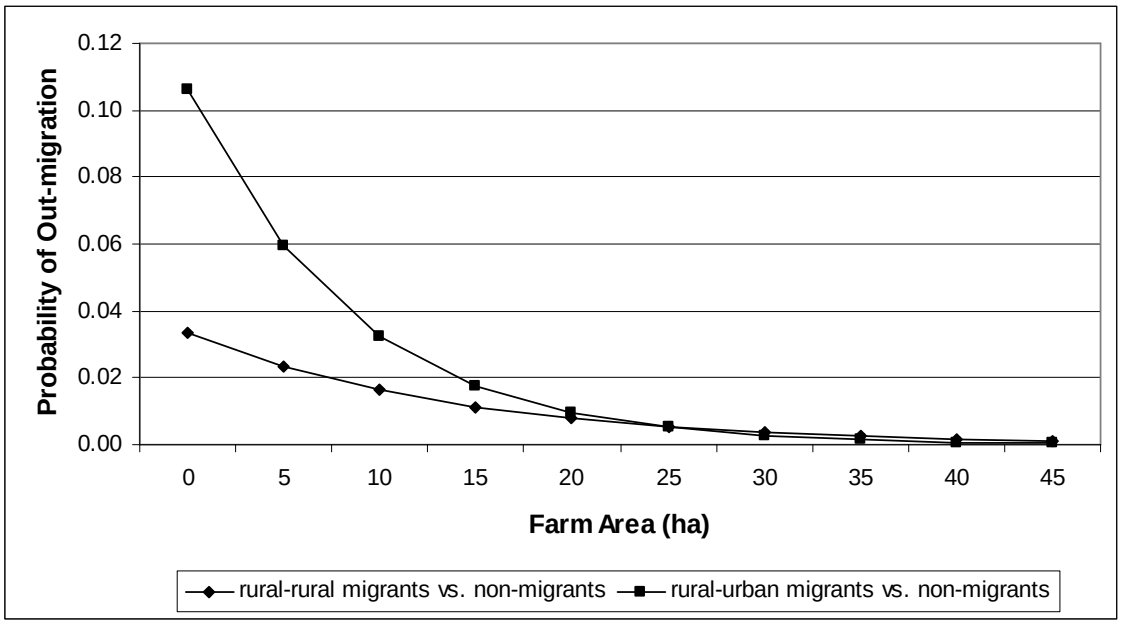
Table 5. Per cent change in the odds of rural out-migration from the Ecuadorian Amazon between 1990 and 1999, according to place of destination.

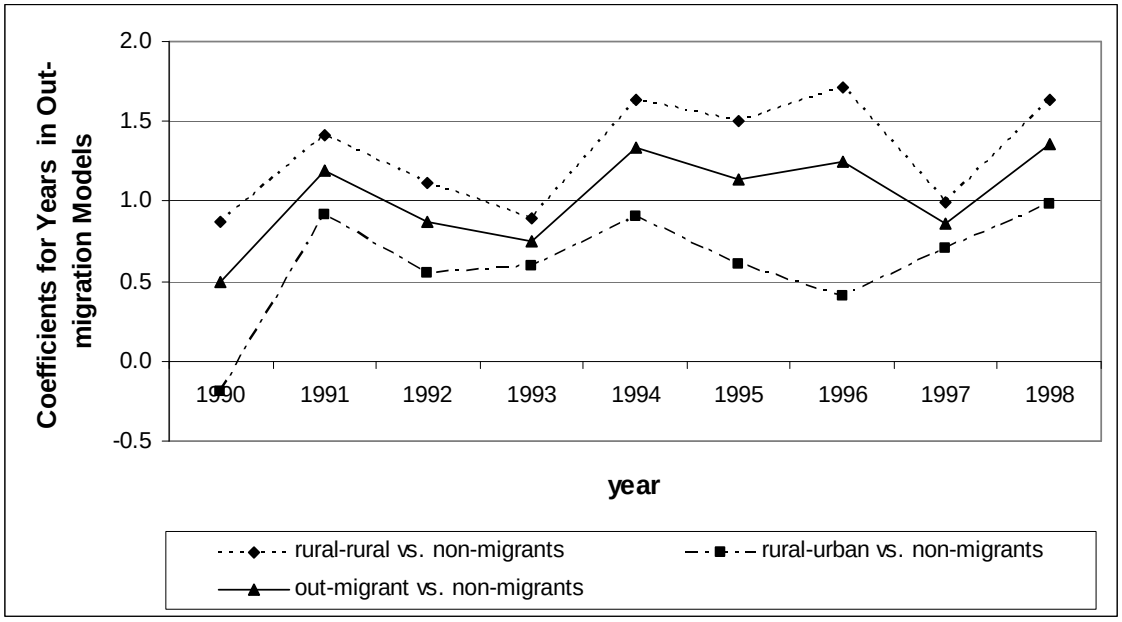
Variable	Percent Change in Odds Ratio*			
	migration vs. no migration	rural-rural migration vs. no out-migration	rural-urban migration vs. no out-migration	rural-rural migration vs. rural-urban migration
Male	-27.57	-	-45.05	-
Age 12-19	251.35	171.56	737.37	-
Age 20-34	676.32	516.38	1668.29	-
Engagement 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	-	-44.63	-	-68.78

*Considering only the significant variables in Table 4 ($p<0.05$), except "farm size" (analyzed in Figure 2).

Illustrations


COLOMBIA
Tulcan
Esmeraldas
Lago Agrio
Pacific
Ocean
Quito
Joya
Shushufindi
Baeza
Coca
ECUADOR
Tena
Puyo
Riobamba
Guayaquil
Legend
Major Cities
National Capital
Colonist Study Area
Coast Region
Amazon Region
Sierra Region
Gulf of
Guayaquil
Cuenca
Machala
PERU
Loja
0 50 100 200
Kilometers
Produced by the Spatial Analysis Unit
Carolina Population Center, UNC-Chapel Hill


Probability of Out-migration
0.12
0.10
0.08
0.06
0.04
0.02
0.00
0
5
10
15
20
25
30
35
40
45
Farm Area (ha)
rural-rural migrants vs. non-migrants
rural-urban migrants vs. non-migrants


Coefficients for Years in Out-migration Models
2.0
1.5
1.0
0.5
0.0
-0.5
1990
1991
1992
1993
1994
1995
1996
1997
1998
year
rural-rural vs. non-migrants
rural-urban vs. non-migrants
out-migrant vs. non-migrants