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Environment, Land, and Rural Out-migration in the Southern Ecuadorian Andes

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Summary. — Out-migration, environmental degradation, and changes in land distribution are all key processes of rural transformation in the developing world, but few quantitative studies have investigated their interactions in migrant origin areas. This study uses survey data from the southern Ecuadorian Andes and an event history model to investigate the effects of land ownership and environmental conditions on out-migration to local, internal, and international destinations. The results indicate that the effects of land ownership and other factors differ strongly across migration streams. Also, negative environmental conditions and landlessness do not consistently increase out-migration as commonly assumed in the literature.

Key words — rural out-migration, access to land, environmental refugees, destination choice, Andes, Ecuador

1. INTRODUCTION

The departure of people from rural areas (i.e., rural out-migration) represents one of the primary forms of human population redistribution over the past century, with profound impacts on urban, frontier, and international destinations as well as on rural origin areas. In attempting to understand the causes of these and other migration flows, quantitative studies have focused on and demonstrated the importance of a series of demographic, social, and economic factors including age, gender, education, migrant networks, and wage rates (White & Lindstrom, 2005). Paralleling these advances in migration studies, ecologists and human–environment researchers have drawn attention to the rapid rate of environmental change in many rural areas, including soil degradation, deforestation, and climate change and the related displacement of potentially large numbers of "environmental refugees" (Bates, 2002; Myers, 2002). The importance of environmental change and other processes of rural transformation such as land fragmentation are widely recognized within development studies (e.g., Rigg, 2006), but few quantitative studies of migration have focused on the effects of these changes or on other elements of the agrarian and development context (Beauchemin & Schoumaker, 2005; De Haan & Rogaly, 2002).

Fortunately, the development of new theoretical and empirical approaches to migration, incorporating factors at household and community-levels, provides an opportunity to convincingly address the effects of land ownership and environmental factors on out-migration. Household-centered theoretical frameworks such as the new economics of labor migration (NELM) (Stark & Bloom, 1985) and the sustainable livelihoods framework (Ellis, 2000) can accommodate the effects of land and environmental factors, and multilevel longitudinal data collection (Axinn, Barber, & Ghimire, 1997; Massey & Zenteno, 2000) supplemented by Geographic Information Systems can provide the necessary social and environmental data. Recently, a small number of quantitative studies have used these and similar methods to investigate agrarian and environmental effects on migration. These studies have found nonlinear effects of land ownership on migration that differ by destination type (Barbieri, 2005; Mendola, 2008; VanWey, 2005) and relatively weak environmental effects that are not consistent with predictions regarding environmental refugees (Henry, Schoumaker, & Beauchemin, 2004; Massey, Axinn, & Ghimire, 2007).

This study investigates the effects of land ownership and environmental factors on out-migration from a rural study area in the southern Ecuadorian Andes to local, internal, and international destinations. The study draws on retrospective survey data collected from 397 households from 36 rural communities in Ecuador's Loja Province, a region of rapid out-migration and environmental conditions marginal for agricultural production. I investigate the influences on out-migration to the three destination types using a multinomial event history model, including the effects of access to land, land quality, fluctuations in agricultural harvests, and a large set of controls. Control factors have effects that are largely consistent with previous studies, and indicate that determinants of out-migration differ strongly by destination type. The results for land area reveal that local and internal migration are most likely from land-poor households, whereas international migration is most likely from land-rich households. The results also indicate that environmental factors are most important for local and internal migration, and that negative environmental conditions do not necessarily increase migration as predicted by the literature on environmental refugees.

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2. ENVIRONMENTAL INFLUENCES ON OUT-MIGRATION

(a) *The environment and land in theories of migration*

Consistent with the paucity of empirical studies, commonly invoked theories of migration do not explicitly include environmental factors, but several theories can accommodate them. Overall, migration theories share the core idea that migrants compare opportunities between the origin area and the potential destinations, and that their decisions are influenced by personal characteristics and experiences, household assets and constraints, contextual characteristics of the origin and destination, and connections to potential destinations such as migrant networks (Massey *et al.*, 1993; Massey & Espinosa, 1997; White & Lindstrom, 2005). Environmental factors enter here as elements of the household or community context, and might include natural disasters such as flooding or earthquakes, incremental environmental changes such as soil degradation and deforestation, and static environmental conditions such as elevation and topography (Bates, 2002). Potentially relevant environmental factors thus range over multiple spatial and temporal scales and across multiple resource domains (e.g., climate, soils, and land cover). The overall importance of these factors to agricultural activities, other natural-resource-dependent activities such as fuelwood collection, and household decision-making is supported by large literatures in cultural ecology and agricultural economics (e.g., Reardon & Taylor, 1996; Sandor & Furbee, 1996).

Straightforward interpretations of commonly cited theories of migration do not lead to consistent predictions regarding the expected direction of environmental effects on out-migration. In Petersen's (1958) general typology of migration, negative environmental qualities such as soil degradation could be considered to be "push factors," and in the neoclassical microeconomic approach (DaVanzo, 1981) they could be considered to be location-specific disamenities (Hunter, 2005). In this view, the perception of a degraded environment or of the consequently lowered productivity of agricultural or of other natural-resource-dependent activities would encourage the individuals to migrate. Conversely, access to environmentally valuable lands would discourage out-migration. These formulations are consistent with the literature on environmental refugees in predicting that negative environmental conditions will promote out-migration, and I refer to this prediction as the *environmental-amenity hypothesis*.

Household-centered theories such as the new economics of labor migration (NELM) and the sustainable livelihoods framework provide two additional hypotheses for the potential effects of environmental factors. NELM considers migration to be a household strategy for income diversification in the face of production risks and lack of credit in the origin area (Stark & Bloom, 1985; Taylor, 1999). The sustainable livelihoods framework similarly focuses on household livelihood diversification, emphasizing the role of human, social, and natural capital in enabling diversification (Ellis, 2000). The livelihoods framework has not commonly been applied in studies of the determinants of migration, but alone among these approaches it explicitly includes both contextual and environmental factors.

One element of these theories is that migration can serve as a form of diversification against economic risk (Rosenzweig & Stark, 1989), which could be extended to include the risk of environmental degradation (e.g., soil degradation) or environmental fluctuations (e.g., drought) and associated declines in agricultural production. In this view, environmental conditions indicating exposure to risk should lead to increased migration as a form of diversification. I refer to this prediction as the *environmental-risk hypothesis*. As environmental variation could also be viewed as a disamenity, this hypothesis is closely related to the environmental-amenity hypothesis. These theories also identify access to capital, potentially including natural capital, as a factor facilitating investment in income diversification, including migration. In this view, households might be able to draw on natural capital to facilitate costly migrations, either through increased productivity of agriculture or by using high quality lands as collateral for a loan. I refer to this prediction as the *environmental-capital hypothesis*.

These arguments also apply in part to the effects on migration of access to land. In the previous studies, land has primarily been treated as a proxy for household wealth, and migration has been assumed to decrease with land ownership (e.g., Potts, 2006; Shaw, 1974). However, as discussed by VanWey (2005), land can also serve as a source of employment, an opportunity for investment of migrant remittances, and an indicator of social status. Where land is primarily a source of employment then it should serve as an amenity, discouraging out-migration, but where it is primarily a form of capital then it should facilitate out-migration. Given large differences in the costs of different types of migration, land ownership is likely to increase out-migration to more costly international destinations relative to less costly internal destinations.

(b) *Previous studies of land, the environment, and migration*

A large number of previous studies have included land ownership as a predictor of migration behavior (e.g., Shaw, 1974). Consistent with the amenity hypothesis, land ownership tends to have a negative effect on out-migration, but studies controlling for community-level migrant networks have also found positive effects (VanWey, 2005). A subset of these studies has examined the effects of land ownership more carefully by allowing for nonlinear effects of land area and for differences across migration streams. VanWey (2005) found that internal and international out-migration decreased with household land area in Mexico, but that internal out-migration in Thailand was least likely at intermediate values of land area. In contrast, Davis, Stecklov, and Winters (2002) found that ownership of rainfed land had positive but diminishing effects on out-migration from Mexico to the US and that ownership of irrigated land had similar effects on out-migration to internal destinations for agricultural work. In that study, land holdings had no effect on internal out-migration for non-agricultural work. Mendola (2008) showed that temporary and internal out-migration decreased with household land area in Bangladesh but that international out-migration increased. Finally, in a study from the Ecuadorian Amazon, Barbieri (2005) showed that out-migration to both rural and urban destinations decreased with household land ownership. Overall, these studies confirm that negative effects of land assets on out-migration are most common, but they also reveal that effects are commonly nonlinear and are likely to differ across migration streams and between origin areas.

Several studies, both quantitative and qualitative, have investigated the effects of land ownership on migration specifically in the Ecuadorian Andes. Qualitative studies by Jokisch (1997) and Pribilsky (2007) revealed that the lack of access to land was an important direct and indirect contributor to international out-migration from the provinces of Azuay and Cañar. Among quantitative studies, Bilsborrow, McDevitt, Kossoudji, and Fuller (1987) used household survey data from a sample of highland cantons to show that rural–urban migra-

tion of men increased with land area for land-poor households and decreased with land area for land-rich households, though these effects were mitigated by distance from the primary urban destination. In that study, land had no effect on the out-migration of women. Laurian and Bilsborrow (2000) used data from a similar household survey to show that rural–urban migration of men decreased with land area, but that land had no effect on women's out-migration. Brown, Brea, and Goetz (1988) combined individual-level census data from the highlands with indices created from canton-level variables to show that out-migration increased with indices for long-standing settlement and modern socio-economic structure and decreased with indices for subsistence-oriented agriculture and large-sized farms. These studies confirm that land and agrarian structure are important influences on out-migration in the Ecuadorian Andes. The analysis described below extends these studies by comparing three different migration streams, allowing nonlinear effects of land area and including multiple measures of environmental conditions.

Many authors have discussed the potential for environmental degradation to displace "environmental refugees," with some estimating the number of those displaced in millions (e.g., Hugo, 1996; Myers, 2002; Westing, 1992). Human displacement associated with the construction of large-scale infrastructure projects such as the Three Gorges Dam (Heming & Rees, 2000) has clearly illustrated this phenomenon, but investigation of more pervasive environmental influences on migration has been hampered by lack of appropriate datasets and enduring disciplinary boundaries between migration studies and environmental studies. Thus, only a handful of previous multivariate studies have investigated these effects (see below), leading some authors to argue that such claims are largely unfounded (Black, 2001; Paul, 2005).

Previous quantitative studies of environmental effects on out-migration include two which investigated the effects of climate and two which focused on local environmental changes. Regarding the effects of climate, Henry *et al.* (2004) found rural–rural migration in Burkina Faso to increase with dry climates and rainfall variability in the origin but international migration to decrease. Gutmann, Deane, Lauster, and Peri (2005), using historical data from the 1930's US Great Plains, showed net migration to increase with fluctuations in precipitation in the origin but to decrease with fluctuations in temperature. Addressing local environmental changes, Massey *et al.* (2007) found that both local and longer-distance mobility increased with perceived declines in agricultural productivity in Nepal's Chitwan Valley, but that only local mobility responded to the time to collect firewood and to the vegetative cover of the community. Finally, Rindfuss, Kaneda, Chattopadyay, and Sethaput (2007) showed that individual and household out-migration increased with forest cover in Nang Rong Thailand, though this relationship may be partially explained by correlated differences in community accessibility. Overall, these previous studies do not consistently support the environmental-amenity and environmental-risk hypotheses implicit in the literature on environmental refugees. The analysis described below extends this approach by jointly considering the effects of several environmental characteristics on three migration streams.

3. STUDY AREA AND DATA COLLECTION

(a) *Study area*

Over the past fifty years, Ecuador has experienced large-scale rural–urban as well as rural–rural migrations which have contributed to rapid urbanization and advances of the agricultural frontier (Brown *et al.*, 1988; Brown & Sierra, 1994). During a period of economic crisis and political instability since 1990, over one million Ecuadorians (from a current population of 14 million) have emigrated to the United States, Spain, and other countries, many of them from rural areas (Gratton, 2007; Jokisch & Pribilsky, 2002). Migration to Spain peaked in 2001 following the height of the crisis in 2000 (Gratton, 2007; World Bank, 2004). Although international remittances from these migrants represented 6.4% of Ecuador's Gross Domestic Product in 2005 (IADB, 2006), the government recently proposed directing development assistance to discourage international migration (Associated Press, 2007).

Figure 1 displays the international out-migration propensity [2] from 1996 to 2001 for each Ecuadorian canton and also identifies the five-canton study area, [3] a high-propensity cluster in the far southern highlands. The study area is an isolated, poor, and predominantly rural region. Rural households are primarily dependent on smallholder agriculture, small-scale cattle ranching, and coffee-based agroforestry, and must cope with steep slopes, a poorly developed transportation network, and a highly seasonal temperate-to-subtropical climate with recurrent droughts. In these marginal conditions, agricultural yields are low relative to the Ecuadorian highlands as a whole (INEC, 2002). In addition to international migration, this region has a long history of sending migrants to the coastal and Amazonian lowlands and to the capital city of Quito in the northern highlands (Brown *et al.*, 1988; Brown & Sierra, 1994; Brownrigg, 1981). Many observers and local residents anecdotally link these movements to environmental factors such as drought (e.g., OAS, 1992).

(b) *Data collection*

To investigate the influences of land and environmental factors on migration in the region, I conducted a household and community survey in early 2006, beginning with a two-stage sampling procedure. From the five study cantons, 18 rural census sectors containing 36 communities were selected through systematic random sampling. In each community, a participative household listing was conducted with a group of community members to list all resident households and identify those which had sent one or more migrants to internal or international destinations since 1995. This list served as the frame to select a sample of households stratified by migrant status, with migrant-sending households selected at a higher probability.

In each sampled household, trained local interviewers implemented a household questionnaire with the household head or another knowledgeable adult, who also served as a proxy respondent for other adult household members and departed migrants. [4] This interview collected life histories for the period 1995–2006 for each adult member of the household and all adult out-migrants since 1995, [5] including annual information about primary place of residence and demographic characteristics. Limited information on places of residence and migrants departed was also collected for dates prior to 1995. Recall errors were limited by a format that allowed comparisons across related characteristics and across household members, by restricting data collection on migration to departures of six months, or longer, and by the twelve-year window of data collection, which is considerably shorter than many previous studies using life history methods (e.g., Massey & Espinosa, 1997). Proxy response errors were limited by the close relationships between proxy respondents and departed migrants (most often parent and child) and by the small number of variables

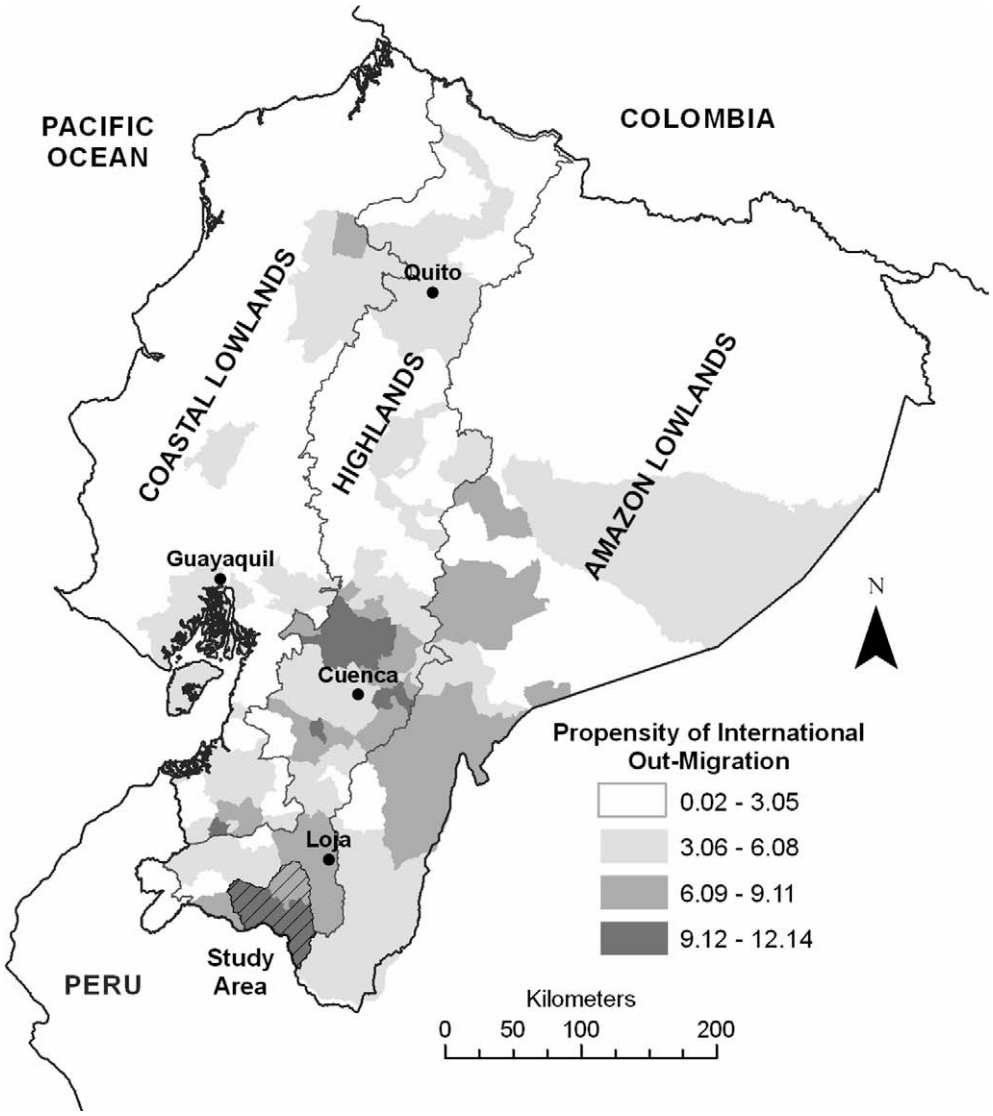

Figure 1. *Map of Ecuador showing the study area and canton-level international out-migration propensities for 1996–2001.*

that were collected for each year. Individual life histories were compiled to describe household composition in each year,[6] and a similar life history approach was used to collect annual information about characteristics of the household and of each agricultural parcel. The questionnaires were developed in collaboration with local staff to ensure that information was collected on the most relevant environmental characteristics and contextual factors. Overall, the survey collected complete information for 397 households with a 2.7% non-response rate for sampled households.

To provide information on the context of out-migration decisions, global positioning system (GPS) points were collected in each community and incorporated into a geographic information system (GIS). GPS points were collected in the center of each community and later were combined in a GIS with the following coverages: mean annual precipitation at 1 km resolution (Hijmans, Cameron, Parra, Jones, & Jarvis, 2005), a 30 m digital elevation model (Souris, 2006), and a vector layer of the road network (Universidad de Azuay, 2006). The GIS was used to extract distance from the community center to the closest paved road as well as mean slope and precipitation in a 1 km buffer surrounding the community center. The GIS, together with data aggregated from the household surveys, allowed the construction of time-varying contextual variables for the event history analysis.

4. ANALYSIS

(a) *The person–year dataset*

I used these data sources to construct a person–year dataset including migrants and non-migrants. The dataset contains time-varying and time-invariant variables at individual, household, and community-levels, and each case represents one year in the life of a person at risk for out-migration as defined below. Migration outcomes (from year t) are lagged one year after predictors (year $t-1$) to reduce the possibility of endogeneity with the migration decision; thus complete data are available for 1996–2006[7] (year t). Consistent with previous studies from Ecuador (Bilsborrow *et al.*, 1987; Laurian & Bilsborrow, 2000), household heads and spouses and all individuals over 50 years old in the year t were excluded from the analysis dataset as they had very low propensity for out-

migration. Households that had not yet formed, or taken residence in the community in 1995 (8% of sample households) were also excluded as the members had low propensities of out-migration and were not exposed to contextual variables measured in 1995. Following these exclusions, the analysis dataset included 279 households with 1005 adults at risk for out-migration during the study period. Children of the head and other non-head members of the household enter the dataset after 1995 when they are age 14 or older, and reside primarily in the community in the year $t-1$. Individuals leave the dataset when they out-migrate after 1995, turn 50 years old, or are censored at data collection in 2006. Return migrants re-enter the dataset in each year ($t-1$) that they reside primarily in the community.

(b) *The outcome*

Migration was defined as a departure from the origin household for six months or longer in the year t, with three destination categories defined by the first place of residence outside of the origin household. The four destination categories are local mobility (to a different household or community within the study area), internal migration (to a destination within Ecuador but outside the study area), and international migration (to another country). For the sake of brevity, I refer to these outcomes collectively as migration. Corresponding to these categories, the outcome variable is coded one to three for all person–years in which migration occurred, and in all other person–years is coded zero. The dataset contains 426 non-migrants (2378 person–years) and 579 migrants who departed their origin household one or more times [8] (2642 person years). Counting the multiple moves of 12 individuals who returned and departed their origin household a second time, the dataset contains 75 local movements, 387 internal migrations, and 129 international migrations. Primary destinations for internal migrants included the provincial and national capitals and rural areas of neighboring El Oro and Zamora provinces. Primary destinations for international migrants included Spain and the United States.

(c) *The predictors*

Definitions and mean person–year values for the predictors (i.e., independent variables) are presented in Table 1. Consistent with the livelihoods framework (Ellis, 2000) and previous studies of the determinants of migration (Massey *et al.*, 1993; White & Lindstrom, 2005), the model includes as control variables measures of demographic characteristics, human capital, social capital, and physical capital, in addition to measures of natural capital which are the focus of the study (see below). As described in Table 1, the predictors include both time-varying and stable characteristics at individual, household, and community-levels. Measures of demographic composition include the following: age, gender, marital status, and relationship to the household head of the individual; the age–sex composition of the household; and the population of the community. Human capital is measured by the educational attainment of the individual and the number of household members with secondary education. Social capital is measured by migration experience and migrant networks, including whether the individual had previously lived elsewhere in Ecuador outside the study area, [9] the number of adults with migration experience in the household and the community and the number of current migrants to internal, and international destinations who previously resided in the household and in the community. The level of physical capital is measured by ownership of the dwelling of residence, the accessibility of the dwelling to local roads, and of the community to paved roads.

To test the effects of agrarian and environmental conditions on migration, I also include as predictors measures of access to land, environmental land quality, and fluctuations in agricultural harvests. To test the effects of access to land, I include the area of land owned by the household in the year $t-1$, the square of area to allow for a nonlinear effect, and the total area of agricultural land in the community in 1995. Land ownership is the primary form of access to land in the study area, but renting and borrowing land are also important for land-poor households. With controls for community population and land quality included (see below), the total land area in the community captures the availability of additional land for renting or borrowing. Predictors testing the effects of land quality include household ownership of flat land [10] in the year $t-1$ as well as community-level measures of land slope and mean annual precipitation derived from the GIS. Topography and precipitation are key environmental variables in this mountainous and seasonally dry region, and community-level variables capture unmeasured characteristics of lands owned by the households as well as other lands that might be available for renting, borrowing, or future purchase. To test the effects of environmental variation over time and related agricultural shocks, I also include a dichotomous measure of whether the household experienced an unusually good or bad harvest in the year $t-1$. This specification was selected after observing in preliminary models that both good and bad harvests tended to have similar effects on migration. Given that respondents commonly attributed these unusual harvests to environmental causes such as precipitation or crop pests, this measure captures exposure to unexpected fluctuations in environmental and agrarian conditions. This is an appropriate measure of environmental variation over time given the relatively small temporal and spatial scale of the study, during which no large-scale natural disasters occurred.

(d) *The event history model*

I analyzed these data using a multinomial discrete-time event history model (Allison, 1984). This model is appropriate for exposure to a mutually exclusive set of competing risks over time (e.g., out-migration to alternative destinations), where time is measured in discrete units. In this model, the log odds of experiencing a migration event of type r relative to no mobility (event s) are given by

$$\log\left(\frac{\pi_{rit}}{\pi_{sit}}\right) = \alpha_{rt} + \beta_r X_{it-1},$$

where π_{rit} is the odds of mobility to destination type r for individual i in the year t, π_{sit} is the odds of no migration for individual i in the year t, α_{rt} is the baseline hazard of mobility to destination type r in the year t, X_{it-1} is a vector of predictor variables for individual i in the year $t-1$, and β_r is a vector of parameters for the effects of the independent variables on migration to destination type r.

In this model, the exponentiated form of the parameters (e^{β}), known as the odds ratio, can be interpreted as the multiplicative effect of a one unit increase of the predictor on the probability of that type of migration relative to the probability of no migration. A derivation of this equation can also be used to calculate the predicted probabilities of migration given the year and a set of values of the predictors. I estimate the model using Huber-White robust standard errors with clustering set at the level of the census sector, which corrects for the multilevel nature of the predictors and the clustering of person–

Table 1. *Definitions and weighted mean person–year values for the independent variables*

Variable	Unit	Level	Time-varying	Mean	Definition
Demographic characteristics					
Female	1/0	Indiv	No	0.44	Gender is female, reference is male.
Age	Years	Indiv	Yes	20.5	Age in years
Union	1/0	Indiv	Yes	0.11	Married or in a cohabitating union
Other relation to head	1/0	Indiv	Yes	0.11	Other relation to HH head, reference is child
Minors	#	HH	Yes	2.74	HH residents ages 0–14
Young women	#	HH	Yes	1.00	Male HH residents ages 15–29
Young men	#	HH	Yes	1.21	Female HH residents ages 15–29
Adult women	#	HH	Yes	1.09	Male HH residents ages 30+
Adult men	#	HH	Yes	1.12	Female HH residents ages 30+
Community population	Pop/10	Com	No	18.1	Population of community in 1995 divided by 10[a]
Human capital					
Primary education	1/0	Indiv	Yes	0.53	Complete primary education[b]
Secondary education	1/0	Indiv	Yes	0.36	Some or complete secondary education[b]
HH secondary education	#	HH	Yes	0.95	HH residents ages 15+ with secondary education
Social capital					
Migration experience	1/0	Indiv	Yes	0.08	Previous residence outside of the study area
HH migration experience	#	HH	Yes	0.35	Current HH members with migration experience
HH internal migrants	#	HH	Yes	1.78	Current internal migrants from the HH
HH international migrants	#	HH	Yes	0.48	Current international migrants from the HH
Com migration experience	#	Com	Yes	8.73	Current com residents with migration experience[a]
Com internal migrants	#	Com	Yes	48.3	Current internal migrants from the com[a]
Com international migrants	#	Com	Yes	11.6	Current international migrants from the com[a]
Physical capital					
Home ownership	1/0	HH	Yes	0.93	HH owns the dwelling of residence
Distance to road	km	HH	No	0.62	Distance from the home to the nearest road
Distance to highway	10 km	Com	No	13.8	Distance to the closest paved road from GIS
Access to land					
HH land area	ha	HH	Yes	4.96	Area of agricultural lands owned by HH members
Com land area	ha/10	Com	No	10.3	Total area of com agricultural lands in 1995 divided by 10[a]
Land quality					
Flat land	1/0	HH	Yes	0.23	HH owns flat agricultural land
Slope	Degrees	Com	No	32.3	Mean surface slope in 1 km buffer from GIS
Precipitation	cm/year	Com	No	101	Mean annual precipitation in 1 km buffer from GIS
Harvest fluctuations					
Unusual harvest	1/0	HH	Yes	0.13	Unusually good or bad harvest reported

Indiv: individual, HH: household, Com: community.
Note: Household and community measures exclude individuals who died before 2006.
[a] Estimated as a weighted sum from the household survey data, adjusted for whole departed households.
[b] Reference is less than primary education.

years within individuals, households, communities, and census sectors (Angeles, Guilkey, & Mroz, 2005). To account for unequal probabilities of selection across census sectors and households, I include household-level weights in the models, calculated as the inverse of the probability of selection. In fitting the model, I also tested for nonlinear effects by including squared terms for the continuous predictors.

(e) *Hypotheses*

Table 2 presents the hypotheses for the effects of access to land, land quality, and harvest fluctuations on out-migration to local, internal, and international destinations under the environmental-amenity, environmental-capital and environmental-risk hypotheses. The environmental-capital and amenity hypotheses are most relevant to relatively stable agrarian and environmental characteristics such as access to land and land quality. Under the environmental-amenity hypothesis positive agrarian and environmental characteristics such as household land area and ownership of flat land are expected to reduce out-migration, whereas negative environmental conditions such as the slope of community lands are expected to increase out-migration. Under the environmental-capital hypothesis the opposite effects are expected. The environmental-risk hypothesis relates to changing environmental conditions, and in this view migration should increase with harvest fluctuations as a measure of temporal environmental variation. Across all the three hypotheses, I also expect in most cases that environmental and agrarian effects will be most important for local mobility and least important for international migration, given that potential local and internal migrants are more likely to be poor, and thus more sensitive to threats to subsistence production. For the case of household land area, however, its role as a capital is likely to be the most

Table 2. *Hypotheses for the effects of access to land, land quality, and harvest fluctuations on out-migration to local, internal, and international destinations*

Predictor	Local	Internal	International
Environmental-amenity hypothesis			
HH land area	−	−	−
Com land area	?	−	−
Flat land	−	−	−
Slope	?	+	+
Precipitation	?	−	−
Environmental-capital hypothesis			
HH land area	+	+	+
Com land area	?	+	+
Flat land	+	+	+
Slope	?	−	−
Precipitation	?	+	+
Environmental-risk hypothesis			
Unusual harvest	+	+	+

Note: The size of plus and minus signs indicates the predicted strength of the effect, and question marks indicate no prediction.

important for international migration and least important for local mobility given the relative costs of these forms of migration. Also note that the effects of community-level environmental variables on local migration are difficult to predict given that local destinations include new residences within the same community as well as outside the community.

(f) *Potential sources of bias*

Models of migration such as this one can potentially be biased by endogeneity of the predictors or by the influence of unobserved characteristics (Mora & Taylor, 2005), but I argue that in this case both problems are likely to be of limited scope. Endogeneity could arise if past migration or remittances influenced land area or quality such as through investment of remittances in land purchases. To limit this problem, variables capturing decisions likely to be simultaneous with migration, including labor market participation, land use, and land rental, were excluded as predictors, along with measures of housing quality or manufactured goods likely to be affected by remittances. Land sales are relatively infrequent in the study area, and international migration with its sizable remittances only became widespread after the year 2000, limiting the possibilities for significant endogeneity in land area and quality. The effects of land and environmental conditions are also robust to the inclusion of measures of migrant networks and previous migration experience, again suggesting that land and environmental effects are not endogenous to migration. The potential scope of bias from unobserved characteristics is similarly small given the large number of control variables, which include the most important individual, household, and community-level factors that have been shown to influence migration and are relevant to the study area.

5. RESULTS

The results from the event history analysis are displayed in Table 3, including odds ratios and the results of significance tests. I briefly discuss below the effects of each of the control variables before discussing in depth the effects of land ownership and environmental conditions. The discussion focuses on the statistically significant ($p < 0.05$) and marginally significant effects ($p < 0.10$).

(a) *Control variables*

(i) *Demographic characteristics*

The effects of the control variables are largely consistent with the previous studies but also reveal important differences across the three migration streams. The effects of demographic factors, including individual, household, and community-level measures, were jointly significant for all the three streams but least important for internal migration. Relative to men, women were more likely to be local movers, equally likely to be internal migrants, and less likely to be international migrants, indicative of a relative gender equity in out-migration that is consistent with previous Ecuadorian studies (Barbieri, 2005; Jokisch & Pribilsky, 2002; Laurian & Bilsborrow, 2000). The effects of age were jointly significant for local mobility and international migration but not for internal migration. International migration peaked at age 25 and local mobility later in the lifecycle at age 30. Individuals in a union were more likely to migrate internationally, often likely in order to follow a previously departed spouse. Individuals who were not children of the head and presumably have less access to household resources were less likely to be local movers and internal migrants. At the household-level, age–sex composition of the household had complex effects: local mobility increased with minors in the household but decreased with the number of older adults, internal migration increased with the number of women, and international migration decreased with the number of minors and older women. These effects likely reflect new household formation by young families, the ability of older adults to support the household, and the consumption desires of women who rarely have access to wage labor in the origin area. Finally, local mobility increased and internal migration marginally decreased with community population, likely reflecting increased opportunities for new household formation in larger communities.

(ii) *Human capital*

The effects of human capital were jointly significant only for international migration, which increased with individual and household education. International migration in this case thus positively selects for education, consistent with other studies of costly and distant international migrations (Adams, 2003). Internal migration also marginally increased with individual education.

Table 3. *Odd ratios from the event history analysis of local, internal, and international migration*

Variable	Level	Local	Internal	International
Demographic characteristics				
Female	Indiv	1.847*	0.985	0.610*
Age	Indiv	1.529***	1.316	2.520**
$(Age)^2$	Indiv	0.993**	0.994	0.982**
Union	Indiv	0.692	1.321	1.948*
Other relation to head	Indiv	0.351+	0.547***	0.795
Minors	HH	1.170*	1.067	0.855**
Young women	HH	1.159	1.318*	0.981
Young men	HH	1.239	0.944	0.809
Adult women	HH	0.509*	1.344+	0.585+
Adult men	HH	0.440***	0.973	0.677
Community population	Com	1.044*	0.984+	1.036
Human capital				
Primary education	Indiv	0.904	2.701+	3.263***
Secondary education	Indiv	0.600	2.890+	2.538**
HH secondary education	HH	1.143	0.961	1.362*
Social capital				
Migration experience	Indiv	3.171+	0.531*	0.711
HH migration experience	HH	0.342**	1.245	0.919
HH internal migrants	HH	0.993	1.209***	0.886
HH international migrants	HH	1.130	0.749**	1.424**
Com migration experience	Com	1.032+	1.000	0.971*
Com internal migrants	Com	0.985***	1.002	0.991
Com international migrants	Com	0.954*	0.978+	0.998
Physical capital				
Home ownership	HH	0.189**	1.676	0.867
Distance to road	HH	1.418**	1.112	0.918
Distance to highway	Com	0.942***	1.008	1.052***
Access to land				
HH land area	HH	0.939+	0.952*	1.023
$(HH\ land\ area)^2$	HH	0.999	1.000	1.000
Com land area	Com	1.068***	1.028***	1.011
Land quality				
Flat land	HH	2.300*	1.110	1.083
Slope	Com	1.085**	0.992	1.007
Precipitation	Com	0.999	0.984**	0.970*
Harvest fluctuations				
Unusual harvest	HH	2.214*	1.670**	1.575

Indiv: individual, HH: household, Com: community.
$(Variable)^2$ represents the squared term from a quadratic fit for a continuous predictor.
$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$; $+p < 0.10$.

(iii) *Social capital*

The effects of migration experience and networks were jointly significant for all the three streams. At the individual-level, local mobility marginally increased with previous migration experience and internal migration significantly decreased, suggesting that individual return migrants commonly settle elsewhere in the study area rather than re-migrating. At the household-level, internal and international migration both increased with the number of current migrants to those destinations as expected. Internal migration also decreased with current international migrants, indicating competition between these streams. Local mobility also decreased with household migration experience but marginally increased with community migration experience, indicating that members of whole in-migrating households are not likely to relocate locally but that new household formation is more common in communities with return migrants. Competition between migration streams was evident in the effects of community-level networks: local mobility decreased with the number of current internal and international migrants, internal migration marginally decreased with the number of current international migrants, and international migration decreased with the number of community members with internal migration experience. These unexpected effects of community-level networks may reflect the pervasiveness of out-migration in the study area (see above), which gives nearly all households access to contacts in various destination areas through their extended social networks.

(iv) *Physical capital*

The effects of physical capital were jointly significant for all the three migration streams. Local mobility decreased with

home ownership but increased with distance to a local road, likely because members of these households move to new dwellings and to be closer to local roads. Distance to a paved road decreased local mobility but increased international migration, indicating that residents of the most isolated communities select more distant destinations, likely because opportunities for return visits are limited even from local destinations. More generally, accessibility variables are among the most easily measured of contextual characteristics, and these results suggest that they should be included in future multilevel studies of migration (see Beauchemin & Schoumaker, 2005).

(b) *Agrarian and environmental conditions*

(i) *Access to land*

The effects of land area owned by the household were jointly significant for all the three migration streams and differ substantially across them. Figure 2 displays the predicted probabilities for the three streams with the other predictors held at their mean values. Local mobility, the least common form of migration overall, is highest for landless households and declines to near zero for land-rich households. Internal migration, the most common form of migration overall, is highest from landless households and declines with land area but at a diminishing rate. Finally, international migration is lowest among landless households and increases nearly linearly with land area. A comparison of landless households to those owning 20 ha (at the 95th percentile of land ownership) is illustrative of the differences across streams. With other predictors held at their mean values, individuals in landless households had a 6.7% probability per year of departing to internal destinations but only a 0.7% probability of international migration and a 0.8% probability of local mobility. In contrast, individuals in households owning 20 ha of land had a 3.0% probability of internal migration, a 1.1% probability of international migration, and a 0.2% probability of local mobility. Consistent with the prediction that land would be more important as a capital for costly migrations, these results suggest that land acts as an amenity and a source of employment to potential local movers and internal migrants, whereas it acts as a capital for potential international migrants, who commonly must invest $4,000–12,000 in order to migrate (Jokisch & Pribilsky, 2002). Among previous studies which have investigated the nonlinear effects of land ownership, these results are most consistent with those of Mendola (2008) who found that land area had a negative effect on internal migration but a positive effect on international migration.

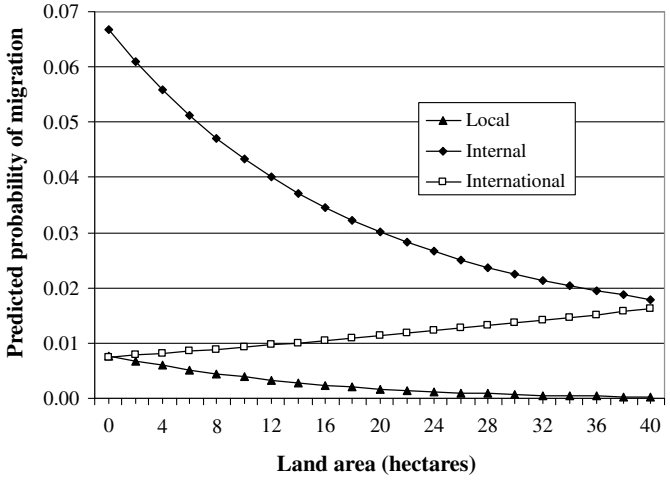

Figure 2. *Predicted probabilities of migration by destination type and household land area with mean values of the other predictors and the mean baseline hazard from 1996 to 2005.*

In addition to household land area the model also controlled for the total agricultural land area in the community, which significantly increased local mobility and internal migration. Given that community population and land quality are controlled, this result suggests that access to community lands for renting and borrowing acts as a capital that facilitates local mobility and internal migration. This result is consistent with the descriptive analyses revealing that land-poor households access the majority of their agricultural lands through renting and borrowing.

(ii) *Land quality*

The effects of land quality were jointly significant for local mobility and internal migration, and jointly marginally significant for international migration. Local mobility increased with both household ownership of flat land and the mean slope of community lands. This apparent contradiction suggests that flat land acts as a capital, facilitating local mobility through increased land value or agricultural production, whereas the slope of community lands acts as a disamenity, likely by increasing the difficulty of travel within and to/from the community. Internal and international migration both decreased with community precipitation, suggesting that precipitation acts as an amenity by increasing agricultural productivity. These results suggest that the effects of land quality on out-migration are likely to differ with the scale of measurement, for example, household *versus* community-level.

(iii) *Harvest fluctuations*

Local mobility and internal migration both significantly increased with fluctuations in agricultural harvests, but international migration was not affected. These results are consistent with the environmental-risk hypothesis, with the idea that households diversify their incomes against risk through migration, and with the specific predictions that harvest fluctuations would increase migration, and would be more important for shorter-distance moves. These results are also consistent with a study by Halliday (2006) who found that out-migration increased with crop and livestock losses in El Salvador.

(iv) *Summary*

Overall, agrarian and environmental conditions were jointly significant for all the three migration streams but were most important for local mobility and internal migration, consistent with predictions. Potential local and internal migrants are more likely to be poor and to carefully consider environmental conditions given their immediate importance to the subsistence of these households. Among the three hypotheses regarding the direction of environmental effects, the effects of access to land and land quality do not consistently support either the environmental-amenity or the environmental-capital hypothesis, undermining arguments that landlessness and environmental degradation will universally lead to out-migration. The environmental-risk hypothesis is supported by the effects of fluctuations in agricultural harvests, the one available measure of temporal environmental variation. Overall, these effects are generally consistent with the two most relevant previous studies: Massey *et al.* (2007) also found that environmental factors were more important for shorter-distance migrations, and Henry *et al.* (2004) similarly showed that migration could increase or decrease with favorable environmental conditions depending on the destination type.

6. CONCLUSIONS

These results have important implications for future studies of migration streams and of the relationships between migration, access to land, and the environment. This analysis of three migration streams reveals that the determinants of out-migration from the study area differ strongly by destination type, a result consistent with other studies. Local mobility was particularly responsive to demographic factors, physical capital, and agrarian and environmental conditions. Internal migration was particularly responsive to social capital and access to land. Finally, international migration was especially influenced by human capital and least influenced by agrarian and environmental conditions. The implication of these findings for future empirical studies of origin areas with diverse migrant destinations is that the traditional dichotomous approach to modeling migration is likely to conceal considerable heterogeneity, and a multinomial approach is more appropriate. The implication for policy is that development and environmental policies are likely to affect migration streams differently given the considerable differences in their underlying drivers. For example, extension of the network of paved roads in the study area would be most likely to increase local mobility but to decrease international migration.

This analysis of the effects of land ownership supports the importance of land in determining the overall probability of migration as well as selection into particular migration streams. Consistent with the role of land as a key form of household wealth, internal migrants and local movers were negatively selected on land ownership, and international migrants were positively selected. Effects were strongest for internal migration, consistent with the commonly held view that migration will always be most common among the land-poor and the role of land as a source of employment. Nonetheless, the effects of land on international migration provide a counter-example to this view. Given the wide variation in the direction and functional form of land effects across studies, even from within Ecuador, these effects are likely to be specific to the southern Ecuadorian Andes. Across the developing world, land management and tenure systems vary substantially within and across the countries, and one challenge for future larger-scale studies will be to identify the contextual characteristics that influence the nature of the migration–land relationship.

This analysis of environmental effects on migration supports the overall importance of environmental factors for internal migration but also suggests that environmental factors influence migration through multiple pathways. In most cases, positive environmental characteristics (e.g., precipitation) decreased out-migration and negative environmental characteristics (e.g., harvest fluctuations) increased out-migration, consistent with the environmental-amenity and environmental-risk hypotheses. However, household access to flat land increased local mobility, suggesting that environmental conditions can also act as capital. These results and those of other studies indicate that the assumptions of the literature on environmental refugees should not be accepted uncritically: negative environmental conditions may decrease instead of increasing out-migration, and international migrants are less likely to be affected. Future studies of migration and the environment should examine additional contextual and time-varying measures of environmental conditions such as land cover and exposure to natural hazards, and should investigate the roles of agricultural productivity and access to credit in mediating environmental effects on migration. Among the demonstrated environmental effects, those indicating environmental-risk are most amenable to policy intervention. The results suggest that policies designed to mitigate agricultural and environmental-risks such as disaster relief and subsidized crop insurance are likely to reduce internal migration but might have no effect on international migration. Conversely, future climate changes that decrease the predictability of agricultural production are likely to increase internal migration.

NOTES

1. Mailing address: UNC-CH Carolina Population Center, CB# 8120 University Square, 123 West Franklin Street Chapel Hill, NC 27516-2524, USA.

2. Propensity equals the number of migrants divided by the population resident in 1996, from my calculations based on data from the 2001 Ecuadorian census (INEC, 2003) assuming international migrants to have departed from the household's place of residence in 2001.

3. The study area includes the cantons (roughly equivalent to US counties) of Calvas, Gonzanama, Espindola, Quilanga, and Sozoranga of Loja province.

4. This approach does not allow detailed data collection about entire out-migrating households. Limited data collected on these households at the community-level reveal that (1) approximately 80% of all migrants since 1995 departed from households still resident in 2006 rather than as part of entire out-migrating households and (2) out-migrating households did not differ markedly (other than being smaller) from still resident households across several socio-economic characteristics.

5. Information was not collected about the small proportion of household residents or migrants who died in the study interval and thus these individuals are not included in the dataset described below.

6. In the event that the individual identified as the household head was not in residence for part of the study interval, headship was assigned to the head's spouse, or to another adult relative in the case of absence by both the head and spouse.

7. Migration propensities were lower for 2006 due to the short interval of data collection (January–March). This is accounted for by allowing the baseline hazard (α_{rt}) to vary with each year in the event history models below.

8. To account for missing data, 0.1% of person–year values of independent variables were manually interpolated based on other information in the questionnaire.

9. This measure includes only internal migration experience as few individuals in the origin area had international migration experience.

10. Other household-level measures of land quality including ownership of land with black soil or erosion were consistently non-significant, and were removed from the model for the sake of parsimony.

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