Rural Out-Migration and Smallholder Agriculture in the Southern Ecuadorian Andes

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Abstract

A long-running debate has weighed the implications of rural out-migration for human development and environmental conservation in origin areas of migration, including the implications for smallholder agriculture. Studies of the effects of out-migration on smallholder agriculture have found a mix of positive and negative effects on migrant-sending households, but have not consistently addressed the role of gender or differences between internal and international migration. This study draws on household survey data from the southern Ecuadorian Andes and a series of regressions to investigate the effects of out-migration and remittances on smallholder agriculture, including maize production, agrodiversity, female participation in agriculture, and the use of land, labor and chemical inputs. The results indicate that out-migration and remittances tend to have countervailing effects on agricultural activities in the study area, but with distinct effects from male and female out-migration as well as from internal and international remittances.

Keywords: smallholder agriculture, out-migration, remittances, gender.

I. Introduction

In the developing world, out-migration from rural areas is a common livelihood strategy and an important form of population redistribution. A long-running debate has weighed the implications of this process for human development and environmental conservation in origin areas of migration. Migration pessimists have argued that out-migration undermines traditional rural livelihoods and social institutions by removing the young, healthy and educated, and that migrant remittances are spent largely on conspicuous consumption (Reichert, 1981; Binford, 2003). Migration optimists respond that remittances can make important poverty-reducing contributions to household incomes, with multiplier effects that benefit households not receiving remittances (Taylor et al., 1996; Durand et al., 1996). Meanwhile, conservationists have

hypothesixed that rural out-migration can lead to land abandonment and reforestation as part of a "forest transition" (Rudel et al., 2005), but large-scale examples of this process from the developing world are few (Perz, 2007).

Amidst this uncertainty, a growing number of studies have drawn on household survey data and multivariate methods to examine the consequences of out-migration and remittances for origin-area households (e.g., Adams, 1998; Taylor et al., 2003). Impacts of migration on agricultural activities are of particular interest given the enduring importance of agriculture to rural incomes (Reardon et al., 2001) and the environmental consequences of agricultural land use, but few quantitative studies have investigated these effects. Qualitative studies indicate a large range of potential impacts of out-migration and remittances on agriculture, including abandonment of labor-intensive practices (e.g., Zimmerer, 1993), intensification of commercial agriculture (e.g., De Haas, 2006), and the absence of any clear effects (e.g., Jokisch, 2002).

This paper draws on survey data and multivariate analyses to investigate the consequences of out-migration and remittances for smallholder agriculture in the southern Ecuadorian Andes. The study area is environmentally marginal for agriculture and a center of out-migration, and thus a relevant test case for these effects. The study advances previous quantitative studies by separately testing for the effects of male and female out-migration as well as the effects of internal and international remittances on multiple components of the smallholder agricultural system, including harvests, agrodiversity, and the use of land, labor and chemical inputs. Analyses are conducted using tobit and Poisson models which control for other household characteristics and for contextual fixed effects. The results reveal that out-migration and remittances do not lead to a dramatic transformation of agricultural activities, but rather a series of shifts in strategies that reflect the costs of migration and the benefits of remittances.

II. Impacts of Out-Migration on Agriculture in Origin Areas

Potential impacts

Drawing on a variety of theoretical frameworks, previous authors have suggested a number of pathways by which out-migration might influence agriculture in origin areas (Skeldon, 1990; Black, 1993; Taylor et al., 1996; Jokisch, 2002). Out-migration of a household member commonly leads to a decline in the amount of labor available to the household, thus potentially leading to the adoption of labor-saving strategies, the abandonment of labor-intensive

strategies, or an overall decrease in agricultural activities. However in cases where the migrant did not participate in agricultural labor, the reduction in subsistence demands associated with out-migration might instead lead to an increase in household labor availability relative to subsistence demands. Given the strong gender norms which influence participation in agriculture in the Andes and much of the developing world (Katz, 2003; Deere, 2005) the departure of male and female out-migrants is likely to have distinct effects on the agricultural activities of origin households.

Out-migration can also influence origin-area agriculture via migrant remittances, both monetary and in-kind. Remittances supplement household income and can permit new investment in agricultural land, labor and inputs. Investment of remittances in agriculture is most likely in regions that are favorable for the expansion of commercial agriculture (e.g., De Haas, 2006) whereas in less-favored regions remittances may be more likely to act as a substitute for household production and lead to a decline in productive activities (Reichert, 1981). As a source of cash income, remittances might also encourage participation in markets and the monetization of previously subsistence-focused rural economies (Hull, 2007).

Together these effects can also alter the community context of agriculture in important ways, including in the availability of labor and land and in the strength of traditional social institutions. The availability of hired and reciprical laborers in the community is likely to decline with out-migration and migrant remittances, and the wage rate for such work is likely to increase (Taylor and Dyer, 2006). Land may become more available for purchase, renting or borrowing where out-migration leads to an overall decline in agriculture, or land may become less available where remittances are invested in land purchases (Preston and Taveras, 1980). Increasing cash incomes, wage rates and market participation might also lead to a decline in traditional social institutions such as reciprocal labor practices and common property management (Reichert, 1981).

Previous studies

Previous studies have employed ethnographic, ecological and survey methods to investigate the effects of out-migration on agriculture in origin areas. Among these a majority have employed ethnographic methods, revealing a range of potential impacts on agriculture (Jokisch, 2002). Among studies from the Andes, Zimmerer (1993) found that out-migration in the Peruvian highlands led to labor shortages, disintensification of agriculture, and increased

erosion. Preston and colleagues (1997) showed that out-migration in the Bolivian highlands led to decreases in the number of cattle, increases in shrublands, and decreases in erosion. Brown (1987) found that temporary labor migration lead to the decline of traditional reciprocal labor exchanges in the Peruvian altiplano. In the Ecuadorian highlands, both Preston and Taveras (1980) and Jokisch (2002) found few effects of out-migration on smallholder agriculture despite large out-flows of migrants. A small number of ecological studies have also addressed these issues, primarily by examining the effects of aggregate measures of out-migration on agricultural abandonment and the growth of secondary vegetation. Consistent with forest transition theory (Rudel et al., 2005), these studies have found positive effects of out-migration on the growth of secondary vegetation in Puerto Rico (Rudel et al., 2000), Mexico (López et al., 2006) and Albania (Muller and Sikor, 2006).

Survey methods are particularly appropriate to study the effects of out-migration on agriculture because they permit generalization to the regional scale, can incorporate factors at both household and community levels, and allow the investigation of the potentially countervailing effects of out-migration and remittances. Previous survey-based studies have examined the effects of out-migration on both total agricultural production and on specific agricultural practices such as the use of land, labor and modern inputs. Among studies examining total agricultural production or income, Lucas (1987) used aggregate data to show that crop production in four southern African countries decreased in the short-term with temporary labor migration but increased in the long-term with cumulative wages from labor migration, suggesting a short-term negative effect from lost labor but a long-term positive effect from investment of remittances. For rural China, Taylor and colleagues (2003) found that household farm income and yields declined with the number of out-migrants but increased with remittances, indicating that out-migration and remittances had countervailing effects. For rural Mexico, Mora (2005) showed that the number of international out-migrants had a negative effect on agricultural income but that remittances had no effect. Finally, Wouterse and Taylor (2008) found for Burkina Faso that international out-migration had a negative effect on income from staple crops but no effect on cash cropping.

Among survey-based studies examining specific agricultural activities, McCarthy and colleagues (2006) showed that in rural Albania international out-migration led to household declines in area planted in staples, land use diversity, and hours worked in agriculture, but to

increases in the number of livestock and agricultural income. Gray and colleagues (2008) found that cultivated area decreased with remittances for indigenous households in the Ecuadorian Amazon but that the number of out-migrants had no effect. Hull (2007) showed that households in rural Thailand with out-migrants but no remittances were less likely to plant rice, whereas households with both out-migrants and remittances were more likely to hire agricultural labor. Finally, Mendola (2008) found that international out-migration led to increased adoption of high-yielding crop varieties but that internal and temporary out-migration led to decreased adoption. Together these findings suggest that migrant departure and remittances can have opposing effects on agricultural activities. This paper advances these studies by considering the gender of out-migrants, both internal and international remittances, and seven agricultural outcomes.

III. Study Area and Data Collection

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). Additionally, 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). International remittances from these migrants represented 6.4% of Ecuador's Gross Domestic Product in 2005 (IADB, 2006). In addition to migrant remittances, many rural areas have experienced population declines due to out-migration (Figure 1). During the 1990-2001 intercensal period, seven of Ecuador's 22 provinces experienced absolute declines in rural population, a period in which Ecuador's total population grew by 26% (INEC, 2003).

The study area for this project included five rural cantons[1] in southern Loja Province in the southern Ecuadorian highlands (Figure 1). This region has for decades been a center of out-migration to urban and rural internal destinations (Brown et al., 1988; Brown & Sierra, 1994; Brownrigg, 1981) and more recently has become a center of international out-migration as well (Jokisch & Pribilsky, 2002; Ramírez & Ramírez, 2005; Gray, In press). From 1990-2001, Loja

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

experienced the sharpest rural population decline (4.9%) among all 22 provinces (INEC, 2003). This decline reached 14.9% in the study area, which is part of the largest contiguous area of rural population decline in the Ecuadorian highlands (Figure 1).

Rural land use in the study area is dominated by rainfed smallholder agriculture, small-scale cattle ranching and coffee-based agroforestry. The population is largely rural and mestizo, and rural population densities and land use intensities are considerably lower than the densely-settled central Andean valleys. Overall the region is marginal for agriculture because of steep slopes, a highly seasonal temperate-to-subtropical climate with recurrent droughts, and a poorly-developed transportation network (OAS, 1992; Bydekerke et al., 1998). This marginality suggests that out-migration might lead to agricultural disintensification, a hypothesis I test in the analysis described below.

Data collection

To investigate connections between out-migration and agricultural activities in the study area, I conducted a household and community survey in early 2006, beginning with a two-stage sampling procedure. From the five study cantons, I selected 18 rural census sectors (containing 36 communities) through systematic random sampling. In each community, I conducted a participative household listing with a group of community members to identify resident households and 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 sample household, trained local interviewers implemented a structured household questionnaire with the household head or another knowledgeable adult (Gray, In press). This interview collected information about household composition, the departure of out-migrants since 1995, receipt of migrant remittances, access to lands and other assets, and household agricultural activities in the past year. Overall the survey collected complete information for 397 households with a 2.7% non-response rate for sample households.

IV. Multivariate Analysis

To examine the effects of out-migration and remittances on agriculture in the study area, I use the survey data described above to estimate multivariate statistical models of seven agricultural outcomes (i.e., dependent variables). This approach accounts for other household

and contextual influences on agricultural activities, and allows me to compare the effects of male and female out-migration as well as internal and international remittances. Among the 397 interviewed households, 385 households that managed land and resided in the study communities in 2005 are included in the descriptive statistics and regression analyses[2].

Outcomes

The seven analytical outcomes capture agricultural activities in the previous 12 months, and include the area planted in maize and beans; the use of reciprocal, hired, and female household labor; the use of chemical inputs; maize production; and the number of varieties planted of common beans (Table 1). These activities are all key components of agricultural livelihoods in the study area and are dependent on household labor and other assets and thus likely to respond to out-migration.

I refer to the area planted in maize and beans as subsistence area, as these are the primary subsistence crops and are often intercropped. Maize and/or beans were planted in the past year by 93% of households, and the average household (across all households) planted 16.2 *tareas*[3] (0.81 hectares), representing 18% of 89.5 tareas (4.48 hectares) of household agricultural land including owned, loaned and rented parcels. Through serving primarily for subsistence, 25% of households also sold some maize and/or beans in the past year. Other important land uses included pasture (34% of agricultural area), shrubs and fallow (29%), trees (8%), coffee (4%) and a variety of other crops including bananas, cassava, sugar cane and peanuts (8%).

Reciprocal labor, also known as labor exchange or *prestamanos*, is a common practice in the rural Andes (Guillet, 1980). Use of reciprocal labor and hired labor were defined as the number of person-days of labor used of each type on the farm in the past year. Reciprocal labor was used by 48% of households for an average across these households of 9.8 person-days, and hired labor was used by 56% of households for an average of 21 person days across these households. The use of chemical inputs including fertilizers, pesticides, and herbicides was measured as the amount spent on these products over the past year. These were used by 53% of households, costing these households $54 on average in the past year. Maize was harvested by

[2] Missing data on the outcomes leads to smaller sample sizes in some cases. Additionally, to account for missing data for the predictors, 0.3% of predictor values were manually interpolated based on other information in the questionnaire.

[3] One *tarea*, a local unit of area, is equal to 0.05 hectares.

86% of households in the past year, and these households on average produced 13.5 *quintales*[4] (613 kilograms).

For subsets of relevant households, I also analyzed female participation in agriculture and the number of varieties planted of common beans. For 357 households (93% of households) that included an adult female in 2006, the number of women who worked on a household agricultural parcel in 2006 was analyzed as a measure of women's involvement in agricultural activities. Among women over age 14, 58% reported working on the farm in 2006. For 287 households (75% of households) that planted common beans (*porotos*) in the past year, the number of local varieties planted was analyzed as a measure of agrodiversity[5]. These households planted 1.2 local bean varieties on average.

These outcomes are clearly closely related but none are correlated at more than $r \approx 0.5$. Subsistence area, maize production, and input use are the most strongly correlated, suggesting that out-migration and remittances may affect these outcomes in similar ways.

Predictors

To investigate the effects of out-migration on these agricultural activities and to account for other influences, all seven models included as predictors (i.e., independent variables) four measures of out-migration and 17 control variables (Table 2), as well as sector-level fixed effects as described below. The four measures of out-migration are the number of male and female out-migrants since 1995 and the amount of remittances received from internal and international migrants in the past twelve months[6]. The inclusion of the number of current male and female migrants captures the effects of lost labor and reduced consumption demands on agricultural activities. Since controls for current household composition are included (see below) these predictors capture only effects beyond simple adjustment to the post-migration household size. Thus if migrant-sending households change their agricultural activities to reflect the new household composition following out-migration but do not change agricultural activities in any other way then the effects of migration in the models will be non-significant. Separate measures were included for the numbers of male and female migrants because the agricultural activities of men and women in the study area are heavily influenced by gender norms. Overall, from 1995 to

[4] A *quintal* is a Latin American unit of mass equal to 100 pounds or 45.4 kilograms.
[5] Improved varieties, which were planted by few households, were excluded from this measure.
[6] I also explored dividing migrants by destination rather than gender as well as remittances by gender of the migrant rather than by destination, but I found the specification described to provide the best fit.

2005 the 385 households sent 185 male internal migrants, 104 male international migrants, 189 female internal migrants and 73 female international migrants.

Remittances were measured as the value of monetary remittances in the past year from internal and international migrants who departed the household since 1995. Remittances were separated into those from internal and international migrants since the amount, frequency and timing of these two types of remittances are likely to differ. This separation is also consistent with previous studies which have found such differences (Adams, 2006; Mora, 2005; Wouterse & Taylor, 2008). Among the 46% of sample households with internal migrants, 45% received remittances from them in the past year, averaging US$400 from all internal migrants. Among the 25% of households with international migrants, 79% received remittances from them in the past year, averaging US$1162 from all international migrants. Men and women remitted at similar rates and in similar amounts from both internal and international destinations. As the remittance measures are right-skewed, they were log-transformed prior to inclusion in the model to reduce the influence of outlying values. Among the four measures of migration and remittances, all pairwise correlations are positive but none exceed $r = 0.30$.

In addition to these measures of migration and remittances, all models include a set of 17 control variables which were also expected to influence agricultural activities (Table 2). These included household-level measures of demographic composition, adult educational attainment, the area and characteristics of lands owned by and loaned to the household, and accessibility to a road. These controls are consistent with previous studies of the determinants of land, labor and input use as well as agrodiversity (e.g., Benjamin, 1992; Foster & Rosenzweig, 1995; Walker et al., 2002; Gilligan, 2004; Van Dusen & Taylor, 2005). The controls are included to reduce the bias from unmeasured household characteristics on the estimated effects of migration and remittances.

Models

Statistical models of these activities must account for the fact that many households do not participate and that positive values cluster around small numbers, i.e. the outcomes are left-censored and right-skewed. Among the outcomes, the measures of land, labor and input use and maize production have a large proportion of zero values (Table 1) and a distribution that is nearly continuous (i.e., a large number of potential values). The tobit model is designed for censored

outcome such as these[7] and models the dichotomous decision to participate and the continuous level of participation with a single set of coefficients (Long, 1997). The coefficients of this model can be interpreted as effects on the continuous latent variable representing the propensity to participate in the activity, which is observed only after passing a certain threshold. I focus my interpretation on the significance and direction of the effects but also derive and report marginal effects for coefficients of particular interest[8] (Long, 1997). Prior to estimating the models I transformed the positive values of the outcomes by *ln* (y + 1) to reduce skewness and heteroscedasticity. Thus the marginal effects can be interpreted as the percentage change in the outcome due to a one unit change in the predictor among households with outcomes greater than zero. In cases where the predictor is also log-transformed (e.g., own land; Table 2), the marginal effect can be interpreted as the effect of a 1% increase in the value of the predictor.

The final two outcomes, the number of female laborers and the number of bean varieties, can be considered to be count variables because the number of potential outcomes and the proportion of zeros are small. I analyzed these outcomes using Poisson regression[9] (Long, 1997). The coefficients of this model were transformed by exp(β), and these exponentiated coefficients can be interpreted as the multiplicative effect of a one unit increase in the predictor (i.e., independent variable) on the value of the outcome. Thus, in these models, exponentiated coefficients less than one indicate a negative effect.

All models also include sector-level fixed effects, and household-level weights. All models include census-sector-level fixed effects (i.e., one dummy variable for each census sector) to account for unobserved contextual factors that might influence both migration and assets. To account for unequal probabilities of sample selection across census sectors and households, all models also incorporate household-level weights, calculated as the inverse of the probability of selection.

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[7] Alternative models for censored outcomes include two-part models in which the dichotomous decision to participate and the continuous level of participation are modeled separately (Smith and Brame, 2003), e.g., a logit model of participation followed by linear regression on the positive values. I instead elected to use the tobit model for the following reasons: (1) the small number of censored or positive values for some outcomes, (2) an interest in overall effects on participation and the extent of participation, and (3) parsimony, given the large number of models. A comparison of the results reveals that the direction and significance of effects are largely consistent across the two approaches.

[8] Marginal effects were calculated using Stata's *mfx* command for effects on the outcome conditional on the outcome being greater than zero.

[9] This model was selected over the negative binomial model because the additional parameter in negative binomial models was consistently non-significant.

Potential sources of bias

The estimated effects of migration and remittances on agricultural activities could potentially be biased by unmeasured household characteristics that influenced both out-migration and agriculture, and some previous studies have used instrumental variable approaches to address this potential bias (e.g., Taylor et al., 2003). However, the inclusion of sector-level fixed effects and a large set of controls limit the potential scope of this bias as all contextual influences and many household-level influences have been accounted for. Thus, consistent with recent studies (Entwisle and Tong, 2005; Wong et al., 2007; Wouterse and Taylor, 2008) my approach is to include un-instrumented measures of migration as predictors, but also to interpret the causal nature of the effects cautiously.

Hypotheses

Given this approach and the discussion above, a number of predictions can be made regarding the effects of out-migration on the seven agricultural activities. If lost-labor effects are strong, the number of migrants from the household should have negative effects on subsistence area, maize production and crop diversity given the labor demands of these activities. The number of migrants should also have positive effects on the use of reciprocal labor, hired labor, female household labor, and input use given that these activities can replace the labor of migrants. As men tend to work more hours on the farm, the departure of male migrants is likely to have a larger effect in all cases. However, if households are able to absorb migrant departure through the labor of remaining household members and with no effects beyond adjustment to the new household size then effects from the numbers of migrants will not be significant.

As described above, migrant remittances might promote investment or disinvestment in productive activities depending on whether they relieve capital constraints or substitute for household production. If remittances promote investment, then remittances should have positive effects on subsistence area, hired labor, input use, maize production, and female household labor, with negative effects if remittances substitute for household production. Reciprocal labor and bean diversity might be affected similarly, but if remittances promote integration with markets for hired labor and improved crop varieties then they might be affected negatively despite investment in agriculture. In all cases international remittances are likely to have larger per-unit effects than internal remittances given their larger magnitude.

V. Results

The results of the regression analysis are presented in Table 3, including model coefficients, significance tests and fit statistics. Marginal effects for the migration predictors in the tobit models are presented in Table 4. Below I discuss the results for each of the seven outcomes, focusing on the measures of migration and significant ($p < 0.05$) and marginally significant ($p < 0.10$) effects, before concluding with a summary of the results.

Subsistence area

Consistent with the findings of Jokisch (2002), migration and remittances did not have significant effects on the area cultivated in maize and beans (Table 3). Among control variables, subsistence area significantly increased with land area and black soil and decreased with age of the head, single female headship and irrigation. Given the significant effects of land area and biophysical conditions and the non-significant effects of migration and household composition, the results suggest that the area planted in maize and beans is primarily determined by the natural capital available to the household rather than that labor availability or consumption demands. Similarly the results for remittances suggest that they are not invested in the short term in the expansion of the subsistence area.

Reciprocal labor

The use of reciprocal agricultural labor significantly increased with the number of female migrants ($p = 0.034$) but was not affected by the number of the male migrants or remittances (Table 3). For households that used reciprocal labor, the marginal effect of one additional female migrant was an increase of 9.4% in the number of person-days of reciprocal labor (Table 4). This result suggests that households use reciprocal labor to replace the previous part-time agricultural labor of female migrants, likely because the departure of a female migrant does not strongly impair the household's ability to participate in reciprocal work exchanges with other households. This mechanism is supported by the results for the effects of household composition, which indicate that reciprocal labor use increases with the number of young men, adult men and adult women in the household but is not affected by the number of young women, who are presumably less frequent participants. The absence of effects from remittances indicate that they are likely not invested in food and alcohol to be distributed at reciprocal work events, but neither does this traditional exchange appear to be imperiled by the influx of remittances. Among other control variables, reciprocal labor declined with age of the head, household education, and access to

irrigation, and increased with the number of agricultural parcels, suggesting that young, poorer households with spatially distributed parcels are most likely to rely on reciprocal labor.

Hired labor

The use of hired labor responded differently, decreasing with the number of female migrants ($p = 0.009$) and increasing with international remittances ($p = 0.003$) but remaining unchanged with male departure and internal remittances (Table 3). For households that used hired labor, the marginal effect of one additional female migrant was a 17.5% decrease in the number of person-days of hired labor and the effect of a doubling of international remittances was a 7.5% increase (Table 4). These results suggest that female out-migration promotes a shift towards the use of shared labor and away from hired labor. The use of shared labor likely becomes more attractive than hired labor following female migration due to a decrease in subsistence demands and a consequent increase in the agricultural labor surplus beyond subsistence demands. The negative effect of adult men on hired labor use is consistent with this explanation. However, in a countervailing effect, international remittances are partly invested in hired labor, likely in order improve yields and reduce labor demands on remaining household members since no effect was evident on subsistence area. Among control variables, use of hired labor increased with education, land area, and irrigation, and decreased with the number of adult men and single male headship, indicating that wealthier households with limited household labor are most likely to hire agricultural workers.

Input use

The use of chemical inputs increased with international remittances but was not affected by internal remittances or migrant departure (Table 3). A doubling of international remittances led to a 7.4% increase in spending on chemical inputs, and the effect was highly statistically significant ($p < 0.001$) (Table 4). Remittance-receiving households likely use chemical inputs to improve yields and reduce labor demands on remaining household members. Thus in this case remittances appear to promote the monetization of agricultural activities but lost-labor effects from out-migration are not evident. These findings differ from those of Jokisch (2002) who found using bivariate analysis that input use did not appear to change with international migration in Azuay and Cañar provinces. Among control variables, input use increased with the number of young men and land area, and decreased with the number of adult women, age of the

head and education, indicating that younger, less-educated households and those with more land and household agricultural labor use the most inputs.

Maize production

Maize production significantly decreased with male migration ($p = 0.010$) and marginally increased with the amount of international remittances ($p = 0.073$) but was not affected by female migration or internal remittances (Table 3). For households that harvested maize, the marginal effect of one additional male migrant was a 17.4% decrease in maize production, and the effect of a doubling of international remittances was a 4.6% increase in production (Table 4). For a simulated household that sent one male international migrant and received the average value of remittances sent by male international migrants, the positive effect of remittances is greater than the negative effect of departure, leading to net increase in maize production of 11.3%[10]. Using the same logic, a household that sent a male internal migrant would experience a net decrease in production, whereas a household that sent a female international migrant would experience a large increase given that male and female migrants remit in similar amounts.

Thus this outcome reveals another tradeoff between the effects of agricultural labor lost to migration and the investment effects of remittances. The fact that maize production significantly declines with male migration but area planted in maize and beans does not (see above) suggests that labor inputs per unit area planted and subsequent yields both decline with the loss of male agricultural labor. The increase in production with international remittances is consistent with the positive effects of remittances on hired labor and chemical input use and the expected effects of those inputs on yields. These findings correspond to those of Taylor and colleagues (2003) who found that cropping income and yields declined with out-migration but the mean value of remittances more than made up for losses due to out-migration.

Among control variables, maize production increased with education, land area, and black soil and decreased with age of the head and irrigation, indicating that younger, educated households with larger land area and fertile soil are able to produce more maize. Irrigated areas are commonly used for other crops and thus have a negative effect on maize production.

[10] This value was calculated by multiplying the natural logarithm of the mean value of remittances per international migrant ($530) by the marginal effect of international remittances on maize production (Table 4), and adding to it the marginal effect from the departure of one male migrant (Table 4).

Female laborers

The number of women in the household working on the farm increased with internal remittances ($p = 0.027$) but was unaffected by international remittances or the number of migrants (Table 3). A doubling of internal remittances led to a 4.0% increase in the number of female household agricultural laborers, a small effect which reflects the large household variation in remittances and the small variation in the number of female laborers. The significance of this effect relative to that of international remittances was unexpected, and suggests that internal remittances serve a special role in encouraging women to participate in farm labor and thus may contribute to the feminization of agricultural activities (Katz, 2003; Deere, 2005). A likely mechanism for this effect is that women have greater control over the use of internal remittances relative to international remittances, perhaps because of the smaller magnitude of internal remittances or their method of delivery (i.e., often directly by the visiting migrant). The number of female workers also increased with the number of young and adult women in the household as expected as well as with the household area planted in coffee, which is harvested by both women and men.

Bean diversity

Bean diversity also marginally increased with internal remittances ($p = 0.093$) and was unaffected by migrant departure or international remittances (Table 3). With a doubling of internal remittances the number of number of local bean varieties increased by 2.3% (Table 3), a small effect which reflects the large household variation in remittances and the small variation in the number of bean varieties. Alone, international remittances had a non-significant positive effect, but together the effects of both kinds of remittances were jointly marginally significant ($p = 0.094$). Given that this effect occurred in the absence of any remittance effect on subsistence area, it suggests that remittance-receiving households manage more crop varieties in the same area. Since many rural households in the region prefer to consume local crop varieties (Abbott, 2005), remittances may be used to gain access to additional varieties or to free the labor needed to manage additional varieties. This effect might also be related to the increase in women's farm labor with internal remittances and their potential control over these remittances, given that bean diversity also increases with the number of women in the household and women have commonly been recognized as important repositories of traditional agricultural knowledge (Zimmerer, 2003). Again in this case migration does not appear to undermine (and in fact promotes) the

traditional practice of managing multiple crop varieties. Among control variables, the number of adult women had a positive effect on bean diversity and the number of children, age of the head, and single female headship had negative effects, indicating that young households with many adults manage the most bean varieties.

Summary

Overall the results reveal important effects from the loss of labor and from changes in the sex ratio following out-migration, as well as investment-promotion effects due to receipt of internal and international remittances. The loss of male labor led to decreased maize production and the loss of female labor increased reliance on shared labor and decreased reliance on hired labor. The receipt of international remittances increased the use of hired labor and chemical inputs and the receipt of internal remittances increased agrodiversity and women's participation in farm labor. Subsistence area, reciprocal labor and bean diversity are, among the inputs examined here, the ones most associated with traditional agricultural practices, and overall were weakly positively affected by out-migration and remittances. Hired labor and chemical input use involve interaction with agricultural markets and were both promoted by international remittances, suggesting that out-migration can promote the monetization of agriculture at the same time that traditional non-market activities are preserved.

VI. Conclusions

Previous studies have found mixed and contradictory effects of out-migration on smallholder agriculture and asset accumulation, and this study is no exception. Overall, out-migration and remittances had mixed effects on maize production and the use of hired labor, and positive effects on agrodiversity, women's farm labor, and the use of chemical inputs. As expected, the gender division of labor played an important role and the departure of men and women did not have equivalent impacts on agricultural activities, but the departure of women unexpectedly had larger effects in multiple cases. Male out-migration decreased maize production and female out-migration led to a shift from hired to reciprocal labor. Similarly, the effects of internal and international remittances differed as expected but the effects of internal remittances were unexpectedly important, perhaps connected to women's greater control of internal remittances. International remittances increased the use of hired labor and chemical inputs, while internal remittances increased agrodiversity and female participation in farm work.

Thus, the impacts of out-migration on rural livelihoods in the study area are complex, with important roles for male and female out-migration as well as internal and international remittances.

Overall the results do not support the most optimistic or pessimistic of previous accounts of out-migration and agricultural change, nor are they consistent with the expectation of no effects. In particular the results do not consistently support the arguments that out-migration and remittances will undermine traditional livelihoods and agricultural production, and ultimately lead to agricultural abandonment and reforestation. Instead, households in the study area engage in a series of interconnected shifts in agricultural activities in order to mitigate the effects of out-migration and to benefit from remittances. In response to an increase in labor availability relative to consumption demands following female out-migration, households shift towards the use of reciprocal instead of hired labor. To benefit from international remittances and mitigate the effects of lost labor, households invest remittances in hired labor and chemical inputs. These shifts in livelihood strategies do not appear to endanger traditional agricultural practices such as reciprocal labor or management of diverse local cultivars, but they do appear to result in increased interaction with markets and thus a gradual monetization of the agricultural system. Taken together, these shifts do not represent a dramatic transformation, and it appears that smallholder agriculture in the study area is likely to continue in a similar form despite large out-flows of population and in-flows of remittances, highlighting the flexibility and resiliency of rural livelihoods in the face of significant economic and demographic change.

This study also has important methodological implications for future studies of migration and rural livelihoods. In this study, the incorporation of multiple measures of out-migration in models of multiple outcomes revealed complex effects of migration, effects which would not have been visible to a study using a single measure of migration (e.g., remittances) and examining a single outcome (e.g., agricultural income), nor to a study that did not incorporate multivariate analysis. A challenge for future studies will be to collect or analyze panel datasets with information on migration and agricultural activities at multiple points in time in order to better tease out the complex and contradictory effects of migration on agricultural change.

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Table 1. Definitions, sample sizes and weighted descriptive statistics for the outcomes.

Outcome	Unit	Overall		Positive values[1]		Definition
		N	Mean	N	Mean	
Subsistence area	tareas[2]	385	16.2	357	17.6	Area of maize and beans planted in the past year, 2006[3]
Reciprocal labor	person-days	380	4.96	182	9.79	Days of reciprocal agricultural labor used in the past year, 2006[3]
Hired labor	person-days	380	11.0	211	20.8	Days of hired agricultural labor used in the past year, 2006[3]
Input use	$US	383	26.8	203	53.6	Expenses for chemical inputs in the past year, 2006[3]
Maize production	quintales[4]	385	11.6	331	13.5	Harvest of maize in the past year, 2006[3]
Female laborers	persons	357	0.92		-	Number of adult female household members working on the farm in the past year, 2006
Bean diversity	varieties	287	1.18		-	Number of local varieties of common beans planted in the past year, 2006

[1] Includes only households with values greater than zero for the outcome.

[2] One *tarea*, a local unit of area, is equal to 0.05 hectares.

[3] Transformed by $ln(y + 1)$ for the regression analysis.

[4] One *quintal*, a Latin American unit of mass, is equal to 100 pounds or 45.4 kilograms.

Table 2. Definitions and weighted descriptive statistics for the predictors.

Predictor	Unit	Mean	Definition
Migration and Remittances			
Male migrants	#	0.62	Male HH residents since 1995 who left the canton by 2005
Female migrants	#	0.61	Female HH residents since 1995 who left the canton by 2005
Internal remit	$US	65.5	Remittances in the past year from HH internal migrants, 2006[2]
International remit	$US	173.8	Remittances in the past year from HH international migrants, 2006[2]
Control Variables			
Children	#	2.05	HH residents ages 0-14, 2005
Young men	#	0.52	Male HH residents ages 15-29, 2005
Young women	#	0.47	Female HH residents ages 15-29, 2005
Adult men	#	1.01	Male HH residents ages 30+, 2005
Adult women	#	0.95	Female HH residents ages 30+, 2005
Age of head	years	55.9	Age of the male (or single female) household head, 2005
Single head, male	1/0	0.12	Single male head of household, reference is dual-headed, 2005
Single head, female	1/0	0.15	Single female head of household, reference is dual-headed, 2005
Mean education	years	5.31	Mean years of education of HH members ages 15+, 2005
Own land	tareas[1]	80.7	Area of lands owned by the household, 2005[2]
Loaned land	tareas[1]	4.73	Area of lands loaned to the household, 2005[2]
Parcels	#	1.31	Number of owned and loaned land parcels, 2005
Flat land	1/0	0.27	HH manages a parcel that is predominantly flat, 2005
Black soil	1/0	0.48	HH manages a parcel with predominantly black soil, 2005
Irrigation	1/0	0.26	HH manages a parcel with irrigation, 2005
Coffee	tareas[1]	3.26	Area of coffee managed by the household, 2005
Distance to road	km	0.66	Distance to the closest road, 2006

Notes: n = 385 households, HH = household

[1] One *tarea*, a local unit of area, is equal to 0.05 hectares.

[2] Transformed by $ln(x + 1)$ for the regression analysis.

Table 3. Results from the regression analysis.

	Tobit[1]					Poisson[2]	
Predictor	**Subsistence area**	**Reciprocal labor**	**Hired labor**	**Input use**	**Maize production**	**Female laborers**	**Bean diversity**
Migration and Remittances							
Male migrants	-0.103	-0.073	0.075	0.050	-0.220*	1.048	0.982
Female migrants	0.003	0.233*	-0.412**	0.189	0.013	0.976	0.969
Log (internal remit)	0.007	0.046	0.000	0.039	0.013	1.040*	1.023+
Log (international remit)	0.022	-0.048	0.176**	0.200***	0.058+	0.983	1.019
Control Variables							
Children	0.002	0.064	-0.035	-0.104	0.016	0.988	0.945***
Young men	-0.006	0.309*	0.079	0.334+	0.046	1.037	1.018
Young women	0.087	0.154	-0.190	0.039	0.044	1.454***	1.044
Adult men	0.053	0.399+	-0.789*	0.417	0.111	0.944	0.957
Adult women	0.056	0.708**	-0.068	-0.818**	0.088	1.492***	1.178**
Age of head	-0.012**	-0.046***	-0.012	-0.051***	-0.015**	1.002	0.993*
Single head, male	-0.273	0.045	-1.341*	-0.626	0.046	0.757	1.012
Single head, female	-0.349+	-0.274	-0.751	-0.743+	-0.151	1.187	0.814*
Mean education	0.038	-0.126+	0.171**	-0.149*	0.070*	0.971	1.002
Log (own land)	0.293***	-0.029	0.488***	0.195*	0.203***	0.981	1.006
Log (loaned land)	0.173**	-0.199	-0.062	0.230	0.048	1.043	1.030
Parcels	-0.002	0.660***	-0.018	-0.030	0.015	1.078	1.052
Flat land	-0.186	-0.255	0.325	0.023	0.058	0.892	0.922
Black soil	0.265*	0.067	0.084	-0.132	0.471***	1.025	1.047
Irrigation	-0.509***	-0.734*	0.693*	0.179	-0.336*	0.937	1.020
Log (coffee)	0.006	-0.113	-0.090	0.093	-0.100	1.088+	1.018
Distance to road	-0.015	0.011	-0.050	0.013	0.051	1.010	1.032
Constant	1.656***	2.543**	-0.345	-0.487	0.673	0.296*	1.880*
σ	0.891***	1.699***	1.968***	1.871***	1.061***	-	-
Log psuedolikelihood	-12288	-12162	-13337	-11761	-13502	-9108	-7953
N	385	380	380	383	385	357	287

[1] Tobit results are untransformed coefficients, for which values less than zero represent a negative effect.

[2] Poisson results are exponentiated coefficients, for which values less than one represent a negative effect.
Models also include sector-level fixed effects, not shown.

Log (variable) represents a predictor transformed by $ln(x + 1)$

*** p<0.001; ** p<0.01; *p<0.05; + p<0.10

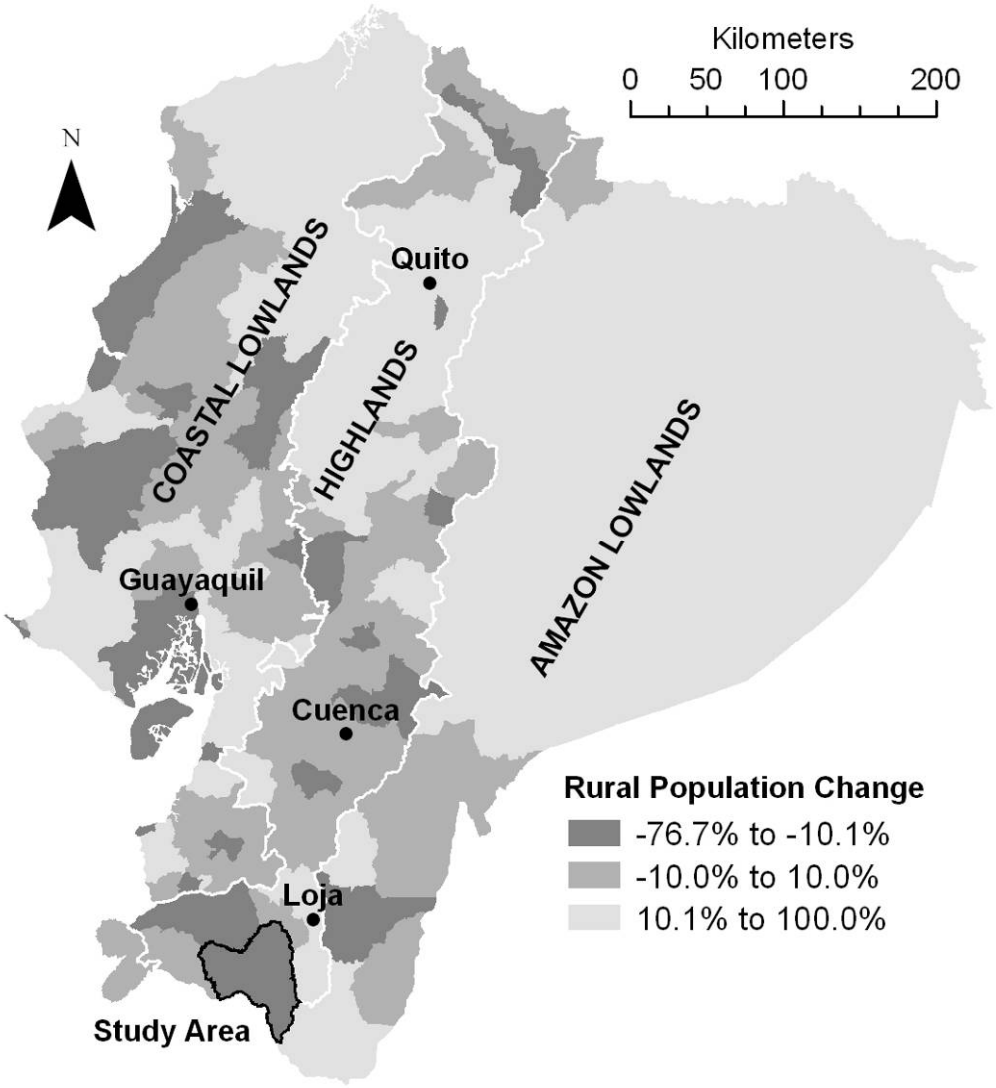
Table 4. Marginal effects of selected predictors from the tobit models[1].

Predictor	Subsistence area	Reciprocal labor	Hired labor	Input use	Maize production
Male migrants	-0.0987	-0.0294	0.0318	0.0184	-0.1741**
Female migrants	0.0028	0.0936*	-0.1751**	0.0697	0.0102
Log (internal remit)	0.0072	0.0184	-0.0002	0.0144	0.0104
Log (international remit)	0.0214	-0.0194	0.0748**	0.0736***	0.0458+

*** p<0.001; ** p<0.01; *p<0.05; + p<0.10

[1] Marginal effects on the outcome conditional on the outcome being greater than zero, derived from the tobit models presented in Table 2 using Stata's *mfx* command.

Figure 1. Map of Ecuador showing canton-level changes in the rural population from 1990-2001.



Values of rural population change calculated by the author using data from the 1990 and 2001 Ecuadorian censuses (INEC, 2003).