OUT-MIGRATION AND HOUSEHOLD LAND USE CHANGE IN ALTAMIRA, PARÁ, BRAZIL

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This paper addresses an empirical question from the literature on the human dimensions of land use change, that of what happens to land use at the level of the farm when household demography changes. It draws upon theoretical literature on land use change and on migration and agriculture in developing countries, focusing on the role of migration in facilitating investments in capital-intensive or high-risk agriculture in place of low-risk, labor-intensive agriculture. Within the literature on land use change in the Amazon, demographic research has focused on the role of changing labor availability and risk preferences over the household life cycle. This literature considers the out-migration of children of the household head to correspond to a period of consolidation of activities because of declining labor availability, and to follow a period of higher risk tolerance because of excess labor available (McCracken et al. 1999; Perz et al. 2006; VanWey et al. 2007; Walker 2003). In the more general literature on land use change worldwide, out-migration plays a different role. Out-migration from rural areas is seen to reduce demographic pressure in some studies (de Sherbinin et al. 2008) and to be part and parcel of the abandonment (and reforestation) of marginal lands in the forest transition theory (Rudel et al. 2005).

Literature coming from a very different starting point, focusing on agriculture production or on rural livelihoods, has simultaneously developed a different set of ideas about the relationship between out-migration and land use. Migration is an essential element of the income and livelihood generation strategies of rural families around the world (Ellis 1998; Stark 1991; Taylor et al. 2003; Wouterse and Taylor 2008). This is especially the case in the presence of credit constraints and the absence of insurance markets, both of which hinder investment in technology or activities to improve agricultural productivity (Stark and Lucas 1988; World Bank 2008). Migration allows such families to export excess

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labor in the presence of land constraints. It also allows families who remain on the farm to earn precious capital for investment in new agricultural or non-agricultural endeavors, or to insure against the failure of such endeavors.

These approaches give contradictory predictions about the impact of migration on land use change. If out-migration of adult children is simply a phase in the household life cycle, and represents changes in available labor, then out-migration should have no impact on area in capital-intensive or high-risk crops and negative impacts on the area in labor-intensive annual crops. If, however, migration is a source of cash to overcome other market failures and to mitigate risk, migration should be associated with an increase in the areas in high-risk or capital-intensive crops. If the forest transition story, for which we have aggregate evidence, is true, we should see a decrease in all uses of land for crops or pasture with the out-migration of population.

Linking the family to land use change is a key piece in understanding the process of development beyond simply the land use change story. If the family can move into more market-oriented production (generally higher-risk and more capital-intensive) through migration of family members to growing urban areas in the region, it has very different implications for the future of people in the region than does a movement into mechanized agriculture involving only large farmers that enter the region from elsewhere. If small farm families can diversify and simultaneously enter the agricultural market and the labor market, they are likely to be able to form a middle class and sustained economic growth based on diversified production and consumption, while the entry of a large farming class from elsewhere will displace the previous small farmers and perpetuate existing inequalities. Both processes involve out-migration from the rural to the urban or to other rural areas, but differ in their endpoints.

Theoretical Background

Recent work on land use change on small farms focuses on the role of the household life cycle, primarily on the labor constraints and consumption needs that change over time from the marriage of a young couple through childbearing and then to an almost empty nest (McCracken et al. 1999; Walker et al. 2002). The pattern of results found suggests that young families clear and/or use larger areas, they produce more extensively, while they have younger children and a shorter time horizon. During this time, labor is scarce (until children are able to help) and consumption needs are high. Thus, time horizons are short as farm owners work to meet current consumption needs and get ahead enough to plan for more long-term investments. As children age, labor becomes more plentiful and farm owners can make more long-term investments. During this period, they might extensify further or intensify, but the defining characteristic of this period in their life cycle is an investment in activities that will produce larger returns but might be more risky or require more time to pay dividends. Later, as children leave home or start their own families, the older generation pulls back on productive activities and/or gives over used land to children for their use.

The key determinants of land use in this approach are consumption needs and labor constraints. It assumes little or no constraint on land, a characteristic of frontier areas (Pichon 1997; Walker 2003). Implicit in the approach are credit constraints (families cannot substitute capital for labor), and a motivation to both ensure permanent income for the individual household and increase the value of land to be passed to children. Also implicit is the absence of insurance markets, preventing earlier risky investments in new land uses or other income-generating strategies.

These implicit conditions have well-known relationships with migration, and migration itself may change some of the expected relationships between the household stage and land use change by providing alternative approaches to credit and insurance constraints. It is well-known and demonstrated in studies around the world that migration is a source of capital to finance the purchase of land, cars, businesses, or other investments (Ellis 1998; Massey et al. 1993; Sana and Massey 2005; Taylor et al. 2003). This includes investments in more capital-intensive agriculture. Similarly, migration has been shown to facilitate risky investments through the provision of insurance (Mazzucato 2009; Yang 2007). Migrants can provide remittances in the case of failure on the farm, especially if they work in a location or economic sector subject to different exogenous shocks (Rosenzweig and Stark 1989; Stark and Lucas 1988).

This suggests that, given conditions of little available credit and insurance, a family may extensify to provide for consumption needs and to save for the future (as argued by much of the household life cycle literature), or they may send a child to a migration destination to remit monies for these purposes or as insurance if they have a crop failure (as argued by much of the literature on migration and remittances). If the latter is true, migration, rather than simply representing a loss of labor, can improve farm productivity by loosening household budget constraints and allowing investment in agricultural technology and/or crops with a higher return (Jokisch 2002; World Bank 2008). Applying this to the specific case of land use change in the Brazilian Amazon, we could further argue that migration and remittances should encourage perennial production in place of annual production or pasture. For small farmers in our study area (and much of the tropics) perennial crops produce the highest return of current feasible options. Annuals include primarily staple foods, which provide little return even when sold. Pasture does provide higher returns than annuals, but not as high as perennials. Evidence also suggests that investment in cattle (and therefore in pasture) is a savings and risk management strategy, as farmers can always sell the cattle quickly in case of income shortfalls. Pasture might, therefore, be an alternative to migration for risk management.

Study Area – Altamira, Pará, Brazil

Data for our analyses come from a longitudinal study in the Altamira settlement area in the state of Pará, Brazil. This area was initially settled (during the past century) during the 1970s when the TransAmazon highway was constructed through the city and on to the west, with settlers arriving from across Brazil to plots of land, most of which had 100% primary forest. Altamira was a model settlement area during the early years, with the government providing assistance to settlers in traveling to the settlement area and in clearing land and starting to produce. Settlers, however, were not well-screened in all cases for past agricultural experience, and the government support lasted only a few years. For these reasons, early years were characterized by many farm failures, high malaria rates, and high rates of out-migration. The area settled into a more stable pattern by the 1990s, with new areas still being opened, but more stable patterns of production and settlement.

Biophysically, the region is characterized by rolling (but steep) topography, and primarily oxisols (adequate but not ideal soils), with small patches of high quality soil or flat topography. The topography, combined with the rapid rainfall in the rainy season and the practice of building bridges of wood, lead to precarious transport systems. These are aggravated by variable levels of government maintenance of infrastructure. Given this setting, the most common productive land uses are annual food crops (manioc, beans, rice), pasture and perennial cash crops (overwhelmingly cocoa, with occasional black pepper or coffee). Cattle raised on these pastures are destined for local and regional markets, as the North of Pará (and all of Pará at the time of the surveys) still has uncontrolled endemic foot-and-mouth disease. The cocoa, in contrast, is destined for international markets (usually via domestic markets). Farmers use very basic technology, reflecting both the inability to use much machinery on the steep slopes and the low cost of labor. Labor is readily available for hire at low cost, including permanent laborers, temporary laborers (hired by the day), and sharecroppers (most common for cocoa production).

Baseline interviews for this project were conducted with the owning household for a stratified random sample of 402 properties in the region, stratified by time of initial settlement (based on satellite imagery). These interviews took place in 1997 and 1998, hard on the heels of the strong El Niño of the 1996-1997 agricultural season. In the region, El Niño conditions lead to drier and later rainy seasons, which are associated with more escaped fires, more clearing (because of escaped fires), and lower crop yields. Followup interviews took place in 2005. Initial interviews focused on the household containing the owner of the property while followup interviews focused on three groups. First, the previously interviewed owners were reinterviewed either on the same property or in a new house elsewhere in the study area. Second, the previously sampled properties were followed up through interviews with the current owner (of the same property or any piece of the previously interviewed property) and interviews with all resident households. Third, the children of the originally interviewed owner who had lived in the household of the owner in 1997/1998 were followed and interviewed wherever they lived in the region.

In addition to these interviews, location information was collected about all previous owners and coresident children who had left the region. Transfer information was also collected about all non-coresident children, regardless of followup status. We use these data to define a sample and create measures of migration, focusing on the out-migration of children as they are the most appropriate migrants for the theoretical approach taken here.

Given these characteristics of the study area, we expect to see the following patterns in our models if households use migration to allow risky investments. Migration and remittances should have positive effects on the change in area in perennials, with remittances allowing families to increase the cultivated area devoted to these high return, long time horizon crops. Because of the usual labor arrangements surrounding perennial production, households moving in this direction do not face a labor constraint. Households increasing area in pasture do face such a constraint, as much of the labor for small pastoral households comes from the family. Thus, we might expect a positive effect of migration and remittances on pasture because of the relaxation of budget constraints, but might expect a negative effect if out-migration also impacts labor availability in an important way (that is, if households do not have excess labor). Thus, predictions are ambiguous for area in pasture. Predictions are similarly ambiguous for area in forest, as the investment in perennials could allow farmers to clear forest for planting or to convert already cleared areas to perennials.

Measures and Sample

Our key variables are land use, change in property size and number of family out-migrants. We measure land use by aggregating the respondent's reports on the area of the property in a variety of land uses. The questionnaire focused on locally important categories (*pomar* [orchard], *pasto* [pasture], *roça* [garden, usually mixed subsistence crops], *mata* [forest], *capoeira/juquira* [secondary growth on previously cleared land]). We then aggregated this into forest (including only primary forest, not older secondary growth), pasture (aggregating all reported pastures along with areas that were secondary growth, but were used as pasture), perennials (including cocoa, coffee, black pepper, and a few other less common crops), and annuals (gardens, rice, beans, manioc, and a few other less common crops). We did not use area in annuals as an outcome for land use models because of previous analyses showing little variance across properties in the area planted in annuals (VanWey et al. 2008). We therefore present only models of land area in forest, pasture, and perennials.

Change in property size was created by comparing the property size in 1997/1998 and 2005 and by calibrating the results with additional field reports (from interviewers and property owners) in 2005 of aggregation or consolidation of lots over this period. In this way, we created a measure of change in size of properties belonging to the same 1997/1998 owner who still held the property in 2005 with 3 categories: 0 = same size (if property sizes in 1997/1998 and 2005 were unaltered); 1 = fragmentation (if property size in 2005 was smaller than in 1997/1998, due either to selling or ceding to an heir), and 2 = consolidation (if property size in 2005 was bigger than in 1997/1998).

Family out-migration between waves is a compilation of information from completed questionnaires and informants. We started by going to the property to look for the old owner and all the members reported as part of the original household in 1997/1998. We collected information on the current residence of any who no longer lived there. We obtained information on the current location of 398 of the previous owners of the 402 properties (two properties were inaccessible because of a bridge burning and we could find no information on the owners of the remaining 2), and information about the vast majority of the previous household members. In some cases, the information was only that they were no longer in the study area, but in the vast majority of cases we have information on the município (if in Pará) or state (if outside Pará) of the current residence, and on whether it is in a rural or urban area of the município/state. We combined information from owners and informants reported in this way with information about the location of children reported in the survey to determine the current location of children who were reported to be in the household in 1997/98, and then calculated the number of such children in the household.

To model whether remittances are the mechanism through which migration of children affects land use change, we include in models a measure of financial support given by children to the household.

The survey asks about such transfers in the year preceding the survey. Upward transfers were operationalized in models in three ways: 1) as a dummy variable indicating whether the household received any financial support from at least one child in 2004; 2) as a count variable of the number of children making financial transfers to the household in 2004, and 3) as a continuous variable of the monetary value of total upward transfers in 2004. These variables were entered in three separate models of land use change.

Control variables in our analyses include the land use in 1997/1998, measured as the areas (in hectares) in forest, pasture, and perennials. These variables are created in the same way as the 2005 land use. Control variables (all measured in 1997/1998) also include the age of household head (the property owner), the demographic composition of the household, the year of arrival of the household on the property and household total income in the year prior to the interview. Demographic composition was operationalized as the number of: children from 0 to 12 years old, males from 13 to 45 years old, females from 13 to 59 years old, males aged 46 years old and above, and females aged 60 years old and above. The year of arrival on the property is continuous. The total household income is in the year prior to the interview date and includes income from all sources. The income measure was created by combining information about total household monetary value of agricultural production sold in the previous year, off-farm income from all household members and other income sources (such as social security benefits, pensions and cash transfer social programs). Some households (8.24%) were missing information about production; for these, we imputed values based on other respondents who produced the same product. For those producing (only for sale), but with no information about the amount, we assigned them the same production as a randomly selected other respondent (selected from among others who produced that same product). For those with missing information about the price of products sold (including those for whom we imputed production values and those only missing information on prices), we assigned them the same price received by a randomly selected other respondent (selected from others who sold the same crop).

Our analytical sample for models of the change in property size includes 267 properties (of the original 402), those with the same owner in 1997/1998 and 2005 and with valid measures on all independent and control variables (including imputed income). This sample is a subset of 277 properties with the same owner in 1997/1998 and 2005 (excluding those sold, or on which the owner died). Of these, there was no information about property size and land use for 4 cases. An additional 3 households had no children (and thus were not at risk of the out-migration of coresident children) and 3 had missing information about financial transfers from children. Our analytical sample for models of land use change is the 244 of these properties which stayed the same size over the period (thus implicitly controlling the size of the lot in our estimates of land use change). Table 1 shows descriptive statistics on all variables included in each of the analyses for each analytical sample.

Modeling Strategy

Our modeling strategy for identifying the influence of migration and remittances on land use change utilizes two types of model. First, we estimate a multinomial logistic regression model predicting whether a property is the same over the 1997/8 – 2005 interval, is consolidated with at least one other property (increases in size), or is fragmented into multiple smaller properties. Second, we estimate ordinary least squares regression models of the area in each of three uses in 2005: forest, pasture, and perennials. In each base, we include a lagged dependent variable so the coefficients on covariates represent their relationship to the change in area in a particular land use over the 1997/8 – 2005 interval. Models of annuals in this region show little significant association between annuals production and almost any household characteristics, as there is very little variation in annuals production from year to year or farm to farm. In each case, the number of children who migrated out of the household in the 1997/8 interval and the number of those who remit money to their parents in the year preceding the 2005 survey are the key independent variables. We also test the sensitivity of the results to including only a dummy variable for whether any of the children send money or a measure of the amount sent in place of the number of children migrants sending money to the parents.

Results

Table 2 shows the results of the multinomial logistic regression of property status in 2005 on household and property characteristics in 1997/8, migration between 1997/8 and 2005, and transfers in the year preceding the 2005 survey. The model includes all owners who owned the same property in 1997/8 and 2005 (or a piece of that property), and uses maintenance of the property in the same size as the reference category. This table shows that, as would be expected in this region, properties with more area in pasture in 1997/8 are more likely to be consolidated into larger properties by 2005. Contrary to what we might expect if migration is being used to invest in more land, the number of children migrating out of the household in the interval is associated with a higher likelihood of consolidation only if those out-migrants do not transfer money back to the household. The coefficient on the number of out-migrant children transferring is negative and much larger in absolute value than the coefficient on the number of out-migrant children, implying that consolidation is less likely when children leave and send back money. Fragmentation, in contrast, shows no association to out-migration, with the only significant predictor of fragmentation being area in forest in 1997/8. This suggests that households receiving money from out-migrants are less likely to need to consolidate either because of an income substitution effect (remittances substitute for income that could have been earned on a larger property) or because they are able to invest in more intensive land uses.

Table A1 shows a complementary analysis to further investigate these results. If the households with more out-migrants were substituting income from remittances for income from a larger property, meaning that they were using remittances for consumption rather than investment, we should expect migrants to come from properties characterized by lower 1997/8 income and higher numbers of dependents. In contrast, if the households are using migration as part of an investment strategy in more intensive agriculture, we would expect migration to be positively related to the 1997/8 area in perennials (intensive rather than extensive farming system) and potentially positively related to 1997/8 income. Table A1 shows an analysis of the coefficients relating 1997/8 these and other property and household characteristics to out-migration of children during the interval. It shows less support for the proposition that migrants are responding to income needs and migrating in place of expanding the property than for the proposition that they are migrating in support of investment in perennial production. While household income in 1997/8 is negatively related to out-migration of children between then and 2005, migrants are more likely to come from properties with more perennials already and from those properties with more working age residents (not more children and elderly).

Table 3 shows the relationships between household and property characteristics in 1997/8, migration and transfers, and land use change over the interval. It provides further evidence consistent with the argument that households are using migration to increase production of perennials in place of expanding the pasture area on the property (this analysis is limited to the 244 properties that stayed the same size with the same owner over the interval). Migration and transfers from out-migrant children have no significant relationships with change in area in pasture, but they have a consistent pattern of effects on perennials and a significant effect in one model on area in forest. Specifically, out-migration of children is associated with a more negative change in the area in forest (not significant) or perennials (significant) unless those children remit money. If any of the children send home money, the positive effect of such remittances on the change in the area in forest outweighs the negative effect of out-migration. Similarly, in the models of perennials, the negative effect of out-migration is outweighed by the positive effects of remittances. In models of pasture, in contrast, out-migration has a negative (but non-significant) effect on the change in the area in pasture, while remittances have a positive (but also non-significant) effect on the change in the area in pasture.

Conclusion

Empirical and theoretical treatments of the role of migration in land use change have focused on permanent in-migration and out-migration, arguing that extensive conversion of natural landscapes occurs at the moment of in-migration or settlement, and that out-migration for non-agricultural employment in urban areas is part of the regrowth in the forest transition (Rudel et al. 2005). At the same time, literature on land use decision-making among small farmers in the Amazon focuses on the role of labor constraints and credit constraints, including the importance of capital for hiring labor and the formation of a labor market to allow intensification (and extensification) of agricultural production (Caldas et al. 2007). These then beg the questions of, on the one hand, how households overcome credit constraints, and on the other hand, where the labor comes from in the labor market. Research on agricultural productivity and migration, primarily in agricultural and development economics and in economic demography, suggests that migration can be the answer to one or both of these questions.

Migration of household members, generally young unmarried children of the household head, is often motivated by the household's need for cash income throughout the developing world (Massey et al. 1993; Stark 1991). This cash income meets a variety of needs, including increasing the level of consumption or smoothing consumption (Rosenzweig and Stark 1989), as well as loosening household budget constraints to allow households to invest in agricultural (or business) activities that are higher risk or have a longer time until the household sees a return on the investment (DeBrauw and Rozelle 2008). Clearly, the migration tightens labor constraints on the farm if the migrant is able to remit less than the cost of replacing his/her labor. Thus, assuming that migration only happens in this situation (that individuals are selected into migration based on their ability to earn and remit more than could be produced on the farm), migration and remittances can be expected to have two possible associations with land use change. If migrant remittances are substituting for on-farm production in meeting consumption needs (as might be implied in the forest transition theory), migration and remittances should be associated with a decrease in the area used for production. If, however, migration and remittances are loosening budget constraints and allowing farms to invest in riskier or longer term practices, we should see a positive effect of migration (and particularly of remittances) on the area used for perennials. Perennials in this region are a higher return but longer term and riskier investment than are annuals (which are primarily used for consumption, in contrast to in other regions of the Amazon) or pasture.

Results show no evidence that migration is being used to substitute for agricultural production in meeting current consumption needs. Migration and remittances are not significantly associated with changes in the area of the property in forest or in pasture, but show significant associations with perennials that are robust across specifications of the model and are consistent with the proposition that remittances from migration allow households to invest in perennials. Out-migration is negatively associated with the change in the area in perennials, but this negative effect of migration is more than outweighed by the positive effect of remittances. An additional migrant is associated with half a hectare decrease in the change in area in perennials, but if that migrant remits that effect becomes positive (-.5 + .9 = 0.4). While this effect may seem small in magnitude, the change in the average area in perennials from 1997/98 to 2005 was only 2.1 hectares.

These results suggest that the prevalent models of settler household land use decision-making in the Amazon have drawn the boundaries of the household too firmly at the boundary of the farm. When settlers arrived in the Amazon, they were generally young without grown children and with few close family members in the region. The break in the family networks brought about by migration to the frontier created a situation in which farm, household, and family boundaries coincided and decision-making was based on household labor and capital. As the frontier developed, farmers were able to take advantage of developing labor markets to the extent that they could raise cash to pay workers. This paper shows that we need to further expand our consideration of their decision-making to include migration as a strategy for raising such cash.

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Table 1. Descriptive Statistics for Analysis Sample (N=267 Properties with Same Owner in 1997/8 and 2005).

Variable	Mean	Std. Dev.	Min	Max
Household Size 1997/98	8.13	3.29	2	18
Age of Household Head (Years)	51.15	12.52	24	79
Any Out-Migration 1997/98-2005 (0/1)	0.61	0.49	0	1
Number of Out-Migrants 1997/98-2005	1.21	1.31	0	7
Any Transfers from Out-Migrants in 2004-05	0.12	0.33	0	1
Number of Out-Migrants Transferring in 2004-05	0.19	0.63	0	5
Amount of Transfers in 2004-05 (Reals)	65.49	313.26	0	3000
Area in Pasture 1997/98 (ha)	41.46	50.15	0	409
Area in Forest 1997/98 (ha)	51.26	40.76	0	350
Area in Perennials 1997/98 (ha)	8.27	12.10	0	88
Area of the Property 1997/98 (ha)	112.20	74.48	26	540
Area in Pasture 2005 (ha)	55.10	67.07	0	460
Area in Forest 2005 (ha)	34.41	28.27	0	232
Area in Perennials 2005 (ha)	10.37	14.46	0	88
Area of the Property 2005 (ha)	112.08	74.46	25	540
Source: Altamira database (1997, 1998 and 2005)				

Table 2. Multinomial Logistic Regression Analysis of Fragmentation, Consolidation and Maintenance of Property 1997/98-2005 (N=267 Properties with Same Owner in 1997/8 and 2005).

VARIABLES	MODEL B2		MODEL C2		MODEL D2	
	Fragmentation	Consolidation	Fragmentation	Consolidation	Fragmentation	Consolidation
Number of Out-Migrants	-0.248	0.517**	-0.248	0.518**	-0.209	0.517**
	(0.292)	(0.246)	(0.310)	(0.246)	(0.311)	(0.246)
Age of Household Head	-0.0378	-0.106**	-0.0392	-0.106***	-0.0343	-0.106**
	(0.059)	(0.041)	(0.061)	(0.041)	(0.063)	(0.041)
Area in Perennials in 1997/98	0.0364	0.0466	0.0432	0.0468	0.0352	0.0467
	(0.031)	(0.029)	(0.036)	(0.029)	(0.030)	(0.029)
Area in Forest 1997/98	0.0264**	-0.00873	0.0273**	-0.00875	0.0264**	-0.00870
	(0.012)	(0.007)	(0.012)	(0.007)	(0.012)	(0.007)
Area in Pasture 1997/98	-0.0144	0.00898**	-0.0138	0.00899**	-0.0158	0.00897**
	(0.014)	(0.004)	(0.014)	(0.004)	(0.013)	(0.004)
Girls 0-12 1997/98	0.230	-0.298	0.191	-0.298	0.282	-0.297
	(0.753)	(0.663)	(0.734)	(0.663)	(0.807)	(0.663)
Women 13-59 1997/98	19.86	20.21	19.24	20.21	20.11	20.20
	(149.664)	(92.227)	(159.910)	(92.292)	(150.115)	(92.328)
Women 60+ 1997/98	0.771	2.223**	0.712	2.220**	0.815	2.226**
	(1.602)	(1.073)	(1.550)	(1.072)	(1.604)	(1.075)
Boys 0-12 1997/98	1.578	-0.0472	1.500	-0.0504	1.560	-0.0457
	(1.156)	(0.612)	(1.149)	(0.611)	(1.180)	(0.612)
Men 13-45 1997/98	-0.453	0.883	-0.411	0.883	-0.380	0.884
	(0.789)	(0.814)	(0.856)	(0.813)	(0.887)	(0.814)
Men 46+ 1997/98	0.100	0.942	-0.0407	0.937	0.154	0.943
	(1.380)	(0.912)	(1.466)	(0.910)	(1.334)	(0.913)
Years on the Property	-0.00814	-0.00786	-0.000738	-0.00768	-0.0112	-0.00789
	(0.075)	(0.046)	(0.081)	(0.046)	(0.075)	(0.046)
Income 1997/98	-1.25e-05	-2.51e-05	-1.41e-05	-2.52e-05	-1.35e-05	-2.52e-05
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Any Transfers	0.459	-40.59***				
	(0.922)	(1.098)				
Number of Out-Migrants Transferring			0.513	-33.75***		
			(0.481)	(1.232)		
Amount of Transfers (reals)					-0.000328	-0.566***
					(0.001)	(0.024)
Observations	267	267	267	267	267	267
Robust standard errors in parentheses						
*** p<0.01, ** p<0.05, * p<0.1						
Source: Altamira dataset (1997, 1998 and 2005)						

Table 3. Ordinary Least Squares Regression Analysis of Change in Areas in Forest, Perennials and Pasture 1997/98-2005 (N=244 Properties with Same Owner and Same Size in 1997/8 and 2005).

Independent Variables	Land Cover/Use Outcome											
	Area with Forest (ha)				Area with Perennials (ha)				Area with Pasture (ha)			
	Short	Model 1	Model 2	Model 3	Short	Model 1	Model 2	Model 3	Short	Model 1	Model 2	Model 3
Age of household head in 1997/98	-0.139	-0.170	-0.142	-0.140	0.0957	0.0841	0.0870	0.0826	0.177	0.229	0.205	0.206
	(0.168)	(0.174)	(0.171)	(0.170)	(0.069)	(0.069)	(0.069)	(0.067)	(0.210)	(0.210)	(0.212)	(0.211)
Area in perennials in 1997/98 (ha)	0.0485	0.0602	0.0651	0.0595	1.033***	1.033***	1.038***	1.036***	-0.130	-0.118	-0.126	-0.120
	(0.073)	(0.079)	(0.079)	(0.080)	(0.047)	(0.056)	(0.056)	(0.055)	(0.092)	(0.098)	(0.098)	(0.099)
Area in primary forest in 1997/98 (ha)	0.686***	0.687***	0.685***	0.687***	0.00627	0.00695	0.00673	0.00977	0.226*	0.220*	0.221*	0.218*
	(0.107)	(0.111)	(0.111)	(0.111)	(0.012)	(0.011)	(0.011)	(0.011)	(0.126)	(0.130)	(0.130)	(0.131)
Area in pasture in 1997/98 (ha)	-0.0415	-0.0380	-0.0391	-0.0409	-0.0139**	-0.0137**	-0.0134**	-0.0152**	1.123***	1.125***	1.125***	1.128***
	(0.043)	(0.041)	(0.041)	(0.041)	(0.007)	(0.006)	(0.006)	(0.006)	(0.051)	(0.050)	(0.050)	(0.050)
Number of females 0 to 12 years old in 1997/98	0.963	0.392	0.858	0.889	0.349	0.288	0.336	0.266	-1.321	-0.569	-0.963	-0.946
	(2.355)	(2.398)	(2.402)	(2.424)	(0.924)	(0.968)	(0.941)	(0.955)	(2.630)	(2.722)	(2.698)	(2.744)
Number of females 13 to 59 years old in 1997/98	-3.543	-4.312	-4.185	-3.777	3.519	3.663	3.397	3.557	-7.499	-7.115	-7.016	-7.466
	(5.758)	(5.832)	(5.879)	(5.823)	(2.470)	(2.485)	(2.493)	(2.504)	(9.316)	(9.123)	(9.500)	(9.125)
Number of females 60+ in 1997/98	2.029	2.083	1.701	2.032	1.340	1.444	1.190	1.463	-7.073	-6.942	-6.460	-6.915
	(6.930)	(7.155)	(7.143)	(7.124)	(2.162)	(2.110)	(2.105)	(2.089)	(10.586)	(10.563)	(10.846)	(10.669)
Number of males 0 to 12 years old in 1997/98	-0.0477	0.0488	-0.0668	0.0402	1.103	1.173	1.127	1.270	-3.614	-3.719	-3.596	-3.777
	(2.349)	(2.338)	(2.357)	(2.345)	(0.917)	(0.926)	(0.922)	(0.925)	(3.055)	(3.044)	(3.064)	(3.055)
Number of males 13 to 45 years old in 1997/98	-2.966	-3.076	-2.959	-3.085	0.373	0.298	0.341	0.164	4.073	3.931	3.810	4.027
	(2.343)	(2.472)	(2.486)	(2.500)	(1.147)	(1.175)	(1.176)	(1.168)	(2.682)	(2.771)	(2.771)	(2.775)
Number of males 46+ in 1997/98	-0.746	-0.669	-0.731	-0.801	-1.159	-0.790	-0.832	-0.982	-0.659	-0.525	-0.446	-0.293
	(3.136)	(3.220)	(3.207)	(3.216)	(1.567)	(1.550)	(1.552)	(1.555)	(4.275)	(4.157)	(4.181)	(4.181)
Household income 1997/98 (all sources) (R$)		-1.36e-05	-1.65e-05	-1.83e-05		3.64e-07	-3.33e-06	-1.09e-05		2.83e-05	3.32e-05	3.95e-05
		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)		(0.000)	(0.000)	(0.000)
Year of arrival		0.0274	0.0335	0.0221		-0.00258	0.00206	-0.0109		0.125	0.117	0.135
		(0.160)	(0.160)	(0.162)		(0.068)	(0.068)	(0.069)		(0.183)	(0.183)	(0.185)
Number of outmigrants 1997/98-2005		-0.213	-0.0851	-0.0417		-0.536*	-0.519*	-0.476		0.211	0.101	0.0370
		(0.800)	(0.803)	(0.795)		(0.306)	(0.302)	(0.299)		(0.967)	(0.958)	(0.947)
Any out-migrant child send money 2004-2005?		5.497**				1.434				-5.284		
		(2.578)				(1.387)				(3.368)		
Number of out-migrant children sent money			1.234				0.942				-1.647	
			(1.612)				(0.710)				(1.967)	
Money sent by out-migrant chidren				0.00188				0.00296*				-0.00345
				(0.002)				(0.002)				(0.004)
Observations	244	244	244	244	244	244	244	244	244	244	244	244
R-squared	0.675	0.679	0.676	0.675	0.760	0.763	0.764	0.766	0.887	0.888	0.887	0.887

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
Source: Altamira dataset (1997, 1998 and 2005)

Table A1. Logistic Regression Analysis of Out-Migration between 1997/98 and 2005 of Children Coresident in 1997/98 (N=267 Properties with Same Owner in 1997/98 and 2005).

VARIABLES	
Age of Household Head	0.000461
	(0.011)
Area in Perennials in 1997/98	0.00678
	(0.006)
Area in Forest 1997/98	-0.000752
	(0.002)
Area in Pasture 1997/98	-7.49e-05
	(0.001)
Girls 0-7 1997/98	-0.135
	(0.092)
Girls 8-12 1997/98	0.245**
	(0.113)
Women 13-25 1997/98	0.287***
	(0.062)
Women 26-45 1997/98	0.284**
	(0.118)
Women 46-59 1997/98	0.282
	(0.198)
Women 60+ 1997/98	0.188
	(0.256)
Boys 0-7 1997/98	-0.0591
	(0.087)
Boys 8-12 1997/98	0.0106
	(0.103)
Men 13-25 1997/98	0.262***
	(0.048)
Men 26-45 1997/98	0.212**
	(0.086)
Men 46-59 1997/98	0.285**
	(0.145)
Men 60+ 1997/98	0.284
	(0.214)
Time on Property	-0.00252
	(0.008)
Household Income	-5.15e-06
	(0.000)
Observations	267
Robust standard errors in parentheses	
*** p<0.01, ** p<0.05, * p<0.1	
Source: Altamira dataset (1997, 1998 and 2(	