Remittances as an income Diversification Strategy for Bolivian Farmers

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Abstract

This paper examines the role that remittances plays in income diversification strategies in the developing world. Using a large and nationally representative survey for Bolivia, we find that remittances alleviate production constraints and market failures that are commonly faced by rural farmers in agrarian economies. They represent an additional income source that relax credit constraints, and hence facilitate further diversification of rural households into other nonfarm activities. The results are based on an endogenous bivariate probit model where the probability of diversification is in part determined by the decision to remit.

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I. Introduction

According to the United Nations (UN 2008), in 2008, for the first time in world history, the world's total urban population would have reached the historic threshold of half of the global population, and it is expected to continue to increase. The proportion of the population living in urban areas in the less developed regions will reach this historic landmark around 2020[2], and is likewise expected to increase. In more developed countries, the urban population is expected to grow more modestly relative to rural populations during the next decades. Hence, we can expect that the future urban population increase in the world will be primarily driven by the increasing percentage of people living in urban areas in the developing regions.

Latin America and the Caribbean shows an unusually high level of urbanization for its level of development (78% in 2007), considering that the average for the two other developing areas, Asia and Africa, is 40%. Among Latin America's three sub-regions, i.e. Caribbean, Central America and South America, the latter is the main contributor to that percentage, with a 79.5% of its population already living in the urban areas in 2007. However, South America embraces striking differences in patterns of urbanization. For example, in Argentina and Venezuela more than 90% of the population already lived in urban areas in 2005. In other countries such as Bolivia, however, the proportion of urban population is relatively low (64%)[3]; this suggests that the future increase in urbanization rates in the region will mainly come from these countries.

Migration from rural areas is among the most important determinants of the urban population growth especially in the developing countries (UN 2004). In Latin America, retention capacity of the population in rural areas remains low and its contribution to urban growth high. There are three sources of urbanization, e.g. natural increase, reclassification of rural settlements into cities and towns, and net rural-urban migration, the latter contributes, more than 40%, on average, to the urbanization of its countries in the region (CEPAL 2000).

In Bolivia the proportion of people living in rural areas is still high despite its continuous decline since the mid 1980's, and despite the downturn trend shown in the rest of South America; however, it has

[2] More developed countries have already reached the percentage around 1950. Ibid. pp.2.
[3] Behind Bolivia are Paraguay with a 59% and Guyana with a 28%.

been projected that it will continue to fall during the following decades.[4] Migration movements originating in the rural area represent an annual 30% of the total migration flows in the country[5], and among those, rural-urban migrants represent an average of 59%,[6] or approximately 26,700 households per year. This number is expected to increase as already explained.

Todaro (1995) suggests several important questions in the study of migration that need to be addressed, especially when the focus is on rural-urban migration. First, why do people migrate from their home villages and what variables determine such decision? Second, how does migration affect the social and economic development of the source and the destination regions? This paper concentrates on the first of these questions.

It is widely accepted that economic considerations provide strong motivation to migrate.[7] The absence of crop insurance and shortage of liquidity are among the most important constraints that push rural families to look for diversification across alternative sources of income, which will secure a source of income not just for the migrants, but also for the family that stays behind in the village (Lucas 1997).

According to Taylor (1999), remittances represent the largest direct positive impact of migration on incomes and production of the rural families, in particular, and on migrant sending areas in general. Regmi and Tisdell (2002) explain that remittances are often the reason for the migration decision and its most important consequence. The impact of remittances on migration varies across countries, and may vary across regions within a country for several reasons. Impact depends on household characteristics; the functioning of the market in which migration and remittances decisions are taken; constraints faced by households; and, the tradition of migration/remittances-reception of the surrounding environment of the households.

Despite the fact that remittances might not be the dominant source of income among rural households[8], their impact on income on those that receive them is considerable; based on case-studies in some

[4] Since 1985 the decline in Bolivian rural population as a percentage of the total population has exceed the average percentage of the rest of countries in South America by more than 1%, and it is projected to remain at that level for the next four decades (UN 2008).
[5] The average includes migration flows in 1997 and 2002 from Tannuri-Pianto et. al. (2004). The other 70% is originated in urban and metropolitan areas.
[6] The remaining 41.4% are rural-rural migrants. Ibid. pp. 5.
[7] Todaro (1995).
[8] In Burkina Faso, only 6.3% of the rural households in the sample received internal remittances (Wourtese, 2008), while in Guatemala the number was 14.6 % (Adams, 2004).

countries of the developing world, they represent up to 16% of the total household's income[9]. Unfortunately, no such information is available for Bolivia.

Among the large existing literature related to migration and remittances, two areas have been extensively studied. The first relates to the effects of remittances on poverty and inequality; the literature shows that remittances help reduce the incidence, depth and severity of poverty in developing countries[10]; the evidence regarding the impact of remittances on inequality, however, has not been as conclusive[11]. The second area relates to the motives of migrants for sending remittances; they range from *pure altruism* (where the sole reason for the migrant for remitting is to support family consumption back in the hometown), to *pure self-interest* (where remittances are made for the aspiration to inherit or to invest in the rural town), or some combination of the two. Both areas have been applied to migration across countries, and to migration within countries. However, in both cases the analysis focused on the remitters' characteristics and their contextual settings. [12]

Adams *et. al.* (2008), using data from Ghana, takes a different approach. This paper analyzes remittances in a framework where the focus was precisely on the origin of the income flows rather than on the existence or not of migration assets in the rural household.

Finally, two are the main reasons that have been established to explain the presence of remittances among the income sources. Taylor (1999) and Lucas (1997) suggest that remittances represent an income diversification strategy. The World Bank (2006) posits that remittances ease working capital constraints, and hence represent a source of liquidity for the farmer. This has yet to be tested econometrically.

Therefore, the focus of the present work is on rural-urban migration, where migration remittances are hypothesized to be an effort by rural households to overcome market failures for credit and insurance, and hence a *means* to diversify their income sources into nonfarm activities. The rural households from which the family members have been sent as migrants, their characteristics, and the contextual settings

[9] In Burkina Faso, remittances as a share of total households income represent a 10.4% (Wourtese, 2008), Guatemala on the same indicator is 15.78% (Adams, 2004), and Egypt 15% (Adams 1991).
[10] See for example Adams *et.al* (2008) for Ghana, Wourtese (2008) for Burkina Faso, Taylor *et. al* (2005) for Mexico, and Adams (2004) for Guatemala.
[11] The World Bank (2006) explains that the effect depends on who receives the remittances (the better-off or the less well-off), if we are considering the effects in the short or long term, and other variables that affect their distribution.
[12] See for example Gopal and Tisdell (2002) for Nepal, Brown (1997) for the Pacific Island, Hoddinott (1992) for Kenya, and Lucas et. al. (1985) for Botswana.

in which they make decisions, is the framework we use to study the variables that make rural families receive or not remittances, and diversify income into nonfarm activities or not.[13]

The analysis will be performed based on data from Bolivia and its rural-urban migrants. The existing market failures that constrain production, the low urbanization rate of the country, and the prospects of continuing and increasing migration from the countryside in the next decades, make the country an attractive case to study. The distinct agroclimatic regions in which the country is geographically divided will be properly considered when estimating the model to inquire regional differences.

The rest of the paper is organized as follows. In Section II the hypothesis regarding migration remittances and their role for nonfarm income diversification strategies is proposed. Section III presents the econometric model used to estimate the relationship between remittances and nonfarm income diversification. Section IV outlines the database used for the modeling, and the variables involved in the estimation process. Section IV presents the estimations' results and relevant marginal probability effects. Section V concludes.

II. The role of migration remittances in the farmers household's budget

Remittances can affect households' budget and wealth in different ways. Remittances directly increase the income of the rural household that receives them; hence they could help poor farmers to escape poverty. Remittances also contribute to smooth household consumption. They ease capital constraints, faced primarily by poor rural farmers. Finally, remittances increase household expenditures (World Bank, 2006). In this work, we focus our analysis in the role of migration remittances of providing working capital.

Rural farmers choose between different types of income, which can be earned singly (no diversification) or in various combinations (diversification). The alternative for rural residents are farm income, farm income and remittances, farm income and income from other nonfarm activities, or finally from all three sources of income simultaneously.

Before explaining the way in which we hypothesize how rural farmers decide on income diversification through remittances, let us briefly make two notes in regards to migration decisions and the receipt of remittances. First, not all migrants should be expected to migrate for reasons related to remittances.

[13] Lucas (1997) establishes that one important group of factors that influence migration and remittances decisions are the contextual setting, or general characteristics of the sending community.

Even though an income diversification strategy through remittances may begin with the decision to send family members away as migrants (e.g. rural-urban migration), the decision of sending migrants may be motivated by other factors and necessities. Based on data provided by Andersen (2002) in his study on rural-urban migration in Bolivia, at most 18% of the migrants had remittances as the primary reason behind migration;[14] but of course, not everyone migrant remits. Therefore, from the standpoint of income diversification, the mere existence of remittances in the rural household is what matters, since this is consistent with the desire to diversify income.

Second, following Niimi and Özden (2008), we assume that if remittances are observed as part of the rural household's income, it is because the household sent at least one family member away as migrant. If it had not, no remittance would be observed. This rules out the possibility that the rural household might receive remittances even if no family members have migrated; we treat this option as unlikely or negligible.

We can now proceed with our proposition regarding the motivations and contextual conditionings involved in the process of income diversification through migration remittances.

A good characterization of the limiting conditions that rural farmers in developing countries face is the one developed by Lucas (1997), where the author states that agriculture is a high risk activity. Farmers face the prospects of floods, droughts, pests and cattle disease for which insurance rarely exists, or when it does exist, as Stark (1988) explains, the transaction costs may be prohibitive, especially for poor small farmers. Hence, insurance may be impossible to obtain. If so, rural farmers must look for a method of self-insurance, such as diversification across different sources of income. The object is to develop sources of income that are not positively correlated with farm income, e.g. sending family members as migrants to obtain remittances and/or diversify into other nonfarm activities.

Risks and lack of insurance are not, of course, the only limitation faced by rural farmers; lack of capital and imperfect or inexistent credit markets might also constrain them (Taylor 1999) in their desire of making farm and/or nonfarm investments (Taylor and Wyatt 1996).

[14] Among rural-urban migrants, 50% stated that family reunion was the reason for migration, 26% said education, 4% due to job moved, and 2% for health; the remaining 18% mentioned job search as the reason for migrating to the urban area.

Under such characterization of the limitations faced by rural farmers, and the self-insurance strategies that these agents follow to overcome them, a rural family may decide to diversify income[15] using an income source that counterbalances the lack of working capital due to the imperfect or inexistence credit markets.[16]Therefore, we hypothesize that initially rural farmers diversify (e.g. through nonfarm activities) as a self-insurance strategy against agricultural risks. However, if the farmer liquidity constrained and faces an imperfect or inexistent credit market, he/she first need to loosen this constraint in order to undertake any business venture off the farm. Therefore, remittances end up being a *means* for income diversification, through the provision of working capital, to those households that lack access to credit markets, or provide "cheaper" capital for those that can access the market but the costs are extremely high.

In concordance with our hypothesis, we explore the effect of remittances on the propensity of rural households to diversify income through nonfarm work, conditional on the characteristics of the households and on the environment in which they make their decisions. The estimation method used for this purpose is explained in the next section.

III. Econometric model and estimation

Given our hypothesis regarding the role of remittances in nonfarm income diversification strategies, the goal is to model a situation in which the decision to remit affects the decision of a household to diversify income through the nonfarm work. It is likely that unobserved factors affect both decisions for a typical farmer and that the decisions share many of these.

The bivariate probit model, an extension of the probit model, allows the presence of two binary (0,1) dependent variables correlated through their errors. Following Greene (2008), the outcomes of the two discrete choices can be viewed as a result of an underlying regression or index function, which captures the economic benefit calculation that leads to the decision of taking an action $(Y = 1)$ or not $(Y = 0)$.

Denote each equation with subscript i, and let x_i be vectors of observed *exogenous* variables that affect the utility of the decision-maker (e.g. household), ε_i be the error terms for the two possible discrete outcomes, which are jointly normally distributed with means zero, variances equal to one, and, ρ be the

[15] Decisions on income diversification are now widely understood as a family strategy rather than a individualistic process, see for example Lucas (1997) and Taylor and Wyatt (1996).

[16] The thesis that remittances are a diversification strategy has been widely analyzed and explained; see for example Taylor (1999) and Lucas (1997).

coefficient of correlation between the errors of the model. The bivariate probit model for each observation can be written as:

$$y_1^* = x_1'\beta_1 + \varepsilon_1, \qquad y_1 = 1 \text{ if } y_1^* > 0, 0 \text{ o.w.}, \tag{5}$$

$$y_2^* = x_2'\beta_2 + \varepsilon_2, \qquad y_2 = 1 \text{ if } y_2^* > 0, 0 \text{ o.w.},$$

$$E[\varepsilon_1|x_1, x_2] = E[\varepsilon_2|x_1, x_2] = 0,$$

$$\text{Var}[\varepsilon_1|x_1, x_2] = \text{Var}[\varepsilon_2|x_1, x_2] = 1$$

$$\text{Cov}[\varepsilon_1,\varepsilon_2|x_1, x_2] = \rho$$

where $y_1$represents the presence of nonfarm income for each household and y_2 the presence of remittances in the same household. For those rural farmers that we observe have diversified income through nonfarm activities, $y_1 = 1$, otherwise $y_1 = 0$, and for the ones that receive remittances $y_2 = 1$, otherwise $y_2 = 0$.

The model additionally assumes that the errors are uncorrelated across observations, i.e. ε_1 and ε_2 for each observation $t = 1,2, \dots, T$ are *iid* as pairs across the rural households, which means that the errors of the two types of outcomes for each household, i.e. diversification into nonfarm activities and reception of remittances, are the ones that are assumed to be correlated. This implies that diversification into nonfarm activities and reception of remittances, are correlated through their unobserved characteristics.

According to our proposition in Section II, remittances (y_2) determine the presence of nonfarm income (y_1), making remittances endogenous in the nonfarm income equation; this means that the observed outcome for receiving remittances is correlated with the error term of the diversification outcome (ε_1). A model that accounts for this possibility for each observation in the sample is:

$$y_2^* = x_2'\beta_2 + \varepsilon_2, \qquad y_2 = 1 \text{ if } y_2^* > 0, 0 \text{ o.w.}, \tag{6}$$

$$y_1^* = \gamma y_2 + x_1'\beta_1 + \varepsilon_1, \qquad y_1 = 1 \text{ if } y_1^* > 0, 0 \text{ o.w.},$$

The system is fully recursive, as long as the conditional mean of y_2 does not depend on y_1, and consistent estimation of the parameters can be made using full information maximum likelihood (Greene, 1998). The statistical assumptions regarding the errors terms in (5) still hold.

The four possible mutually exclusive outcomes, for each point in the sample, from our two equations can be denoted by y_{10} (when $y_1 = 1$ and $y_2 = 0$), y_{01}, y_{11}, and y_{00}, and the probability for each of them equal to[17]:

$$P_{11} = \text{Prob}[y_1 = 1, y_2 = 1|x_1, x_2] = \text{Prob}[y_1{=}1|y_2{=}1]\times\text{Prob}[y_2{=}1] \quad (7)$$

$$= \{\Phi_2(y_1, y_2 = 1)/\text{Prob}[y_2 = 1]\} \times \text{Prob}[y_2 = 1]$$

$$P_{11} = \Phi_2(\gamma + x_1'\beta_1, x_2'\beta_2, \rho)$$

$$P_{10} = \Phi_2(\, x_1'\beta_1, -x_2'\beta_2, -\rho)$$

$$P_{01} = \Phi_2(-\gamma - x_1'\beta_1, x_2'\beta_2, -\rho)$$

$$P_{00} = \Phi_2(-x_2'\beta_2, -x_1'\beta_1, \rho)$$

where, by convention, Φ_2 stands for the CDF of the bivariate normal distribution. The four expressions in equation (7) are precisely the four terms that enter the log-likelihood function for the bivariate probit model whose set up is in Equation (5). Hence, in our recursive simultaneous-equation model we can proceed as if no endogeneity would occur.[18]

If we denote θ_1 as a vector of the right-hand side variables of equation y_1, and θ_2 the corresponding vector of right-hand side variables in equation y_2, the contribution made by each observation in the sample (i.e. each farmer) is the logarithm of the probability that the two dependent variables y_i ($i = 1,2$) take on their observed value. The log-likelihood function of our recursive simultaneous-equation model, including all the observations in sample, is the sum of the individual contributions:

$$lnL_t = \sum\nolimits_{i,j=0,1} d_{ijt} \ln P_{ijt}\,(\theta_1{}^*, \theta_2{}^*, \rho^*) \quad (8)$$

[17] The bivariate normal probabilities for the four possible outcomes have been derived by Greene (2008), pp. 823.
[18] As Greene op. explains, this conclusion comes from the fact that the marginal probability for y_2 in Equation (6) is equal to the univariate probit model for y_2.

where d_{ij} is an indicator variable ($d_{ij} = I(y_i = i, y_j = j)$), equals one when its argument is true, and zero otherwise, with y_i and y_j representing the actual choices of individual t. In (6), equations y_1 and y_2 describe a system of equations for which the parameters are to be estimated simultaneously. The Full Information Maximum Likelihood (FIML) estimator is consistent and fully efficient for all the parameters in the model (Greene, 1998).

Finally, we need to ensure the identification of the model. According to Maddala (1983), the identification of the diversification equation requires that at least one variable from the remittances equation be excluded from the diversification equation. Wilde (2000), however, establishes that in the case of a bivariate model, the parameters are identified even if such exclusion restrictions do not exist. He explains that identification is simply feasible based on the presence of varying exogenous regressors. However, since identification based on exclusion restrictions is being found to be more robust (Yörük, 2009) we make sure to include those restrictions in the model.

IV. Data

The data used in the present work comes from the database of the Program for the Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean (MECOVI for its acronym in Spanish)[19], which is conducted by the INE (Bolivian Bureau of Census) in Bolivia, and provides access to it through its web page www.ine.gov.bo.

The MECOVI's have been conducted annually since 1999, and on-line information is available from the surveys conducted during 1999 through 2002. Since each survey does not track the same households, and some key questions are not asked in each survey, we perform a cross-section analysis for the survey of the year 2000. The stratified sampling procedure in the MECOVI 2000 is designed to eliminate sampling *bias* due to the household is included in the survey (Rivero and Mollinedo 2000).

The annual surveys collect data on such diverse topics such as income, expenditures, education, health, employment, food consumption, assets holdings and migration. It needs to be emphasized, though, that since the MECOVI surveys target variables related to the living conditions of the population and not

[19] The Program is executed by the World Bank (IBRD), the Inter-American Development Bank (IDB) and the United Nations Economic Commission for Latin America and the Caribbean (ECLAC), as well as specialized institutions or agencies in countries participating in the Program. Subsequently other donors, such as Canada, Denmark, Germany, Japan, Norway, Sweden, UNDP, USA, and the Soros Foundation, have supported the Program.

migration and remittances specifically, they contain limited information on these topics. With respect to migration, the information about migrants is available at the households of destination, and not at the households of origin. This makes impossible to know if the migration assets are held by the rural farmers, our target group.[20] What we have is information regarding remittances, domestic and international,[21] and whether the households receive them or not. If they do, the exact amount is provided. As Adams (2004) also establishes, it would be desirable to have information regarding the migrants of the rural household. However, having detailed information about the characteristics and the environment in which the farmers make decisions makes it possible to explore the role of remittances as a diversification income strategy.

The MECOVI survey for 2000 covers sample units from urban and rural households; for the present work we concentrate on the rural sample that comprises 2,108 households, or 9,092 persons, over 166 localities in the nine Departments of the country.[22] However, among the total rural households only 1,960 are in our final sample since our goal is to estimate the degree of income diversification of the rural *farmers* thorough remittances and/or other nonfarm activities.[23] Finally, the classification among the 1,960 farmers according to income source is shown in Table 1.[24]

Table 1. Rural households classification according to income source

Only farmers	1,086
Farmers receiving remittances	219
Farmers with nonfarm income	559
Farmers receiving both, remittances and income from nonfarm work	96

In the next sub-section, we specify the variables involved in the estimation of the bivariate probit model.

[20] In relation to migration, the survey reports whether some member of a household is an immigrant, and if it is so, it provides information regarding the general location of the geographical area of origin (e.g. if the person has migrated from within the country they are asked the Department, Province and Municipality, and if they are from abroad, the country and city names). Unfortunately, this information is not enough to track the rural household from where the person would have migrated when the migration originated from another part of the country. The survey unfortunately does not ask if the households (rural or urban) have some members that have migrated and so are not present during the interview. Therefore, it is impossible to include information regarding the migrants that rural households might have sent, and then among those, to differentiate the ones that receive remittances.

[21] The term *domestic* applies to remittances that are sent from anywhere within the country, and *international* for those remittances that are sent from abroad.

[22] From the total 2,108 households, 825 are located in the *Altiplano* region, 756 in the *Valles* and, 527 in the *Llanos*. The survey also classifies the households according to their location into two groups: rural populated centers (212 households) and rural dispersed areas (1,896 households).

[23] Rural households, whose primary and/or secondary occupation is not related with farm work, have been dropped from the sample.

[24] We later drop 257 observations, and end up estimating the model with 1,703 households that have complete information.

4.1 The independent variables

The variables included as explanatory are individual-specific and can broadly be classified within four groups. These include household characteristics (such as the age of the head and the number of adult and children members), household human capital assets (proxied by the head's education attainment and total number of years of education in the household), physical assets of the household (proxied by its landholdings), and the contextual characteristics of the surrounding environment where the rural household resides (proxied by some characteristics of the social networks of the household, and distance to the nearest capital of Department).

The logic behind those explanatory variables lies, in general, on the standard available literature on migration/remittances (Adams *et. al.* 2008) and diversification into nonfarm activities. In the case of the characteristics of the household, we can expect that if the altruistic motive is behind remittances (Lucas and Stark, 1985), households with older heads, fewer male members, and more children are more likely to receive remittances. Migrants can be thought to remit more if among those left behind are elderly, with little labor force, and many dependents[25]. With respect to human capital assets, and following Hoddinot (1992), we can expect that the higher the education attainment the better access to the formal sector of the rural labor market, and hence the rural household is less likely to be liquidity constrained. Hence we expect a negative impact on the remittances outcome. We proxy human capital with two variables: the years of schooling of the head of the household, and the total years of schooling of the entire household. A squared specification is included to permit nonlinear returns to schooling.

Asset holdings, which are proxied by landholdings, have been extensively used to approximate the wealth of the household in the study of migration/remittances (Wourtese 2008). If the aspiration to inherit, for example, is an important reason to remit, as hypothesized (Lucas and Stark, 1985), the larger the potential of inheritance, the higher the probability of the rural household to receive remittances. As a consequence, we use landholdings per capita in the remittances equation to capture this effect.

It has also been widely explained and empirically demonstrated that social networks greatly affect the decisions made by entities such a household (see for example Taylor et. al. 2005). For sampling reasons, the INE divides the country geographically into UPM's (Primary Sample Units)[26], and each observation in

[25] The composition of the household variables considers all the members left behind, after some have migrated.
[26] The INE divides Bolivia into approximately 21,000 UPM, each bringing together an average of 50 housings. The master sample used for the survey in 2000 contains 2,500 UPM, and the final sample for the MECOVI 2000 encompasses 150 UPM. More details in http://www.eclac.cl/deype/mecovi/taller9.htm.

the sample belongs to one of them. Hence, we use the UPM as the group of reference (*social networks*) for each rural farmer. In terms of the determinants of the propensity to receive remittances two variables are included in the model at the group level. First, we control for the number of households receiving remittances in the group of reference, and secondly, a group measure of wealth is included to capture indirect effects on migration remittances as suggested by Adams *et al.* (2008). These control variables are included as they might influence the availability of obtaining information, the costs of transportation, and the costs of sending money. The variable used to control for the group's wealth is the squared income of the group; this specification will eventually reduce multicollinearity problems with the land asset variable.

Finally, there are also contextual characteristics that influence the decisions of the farmers and need to be incorporated as explanatory variables. As such, we control for the distance to the nearest department's capital, since it is the nearest economic and political center for the household where rural farmers send family members away in order to pursue remittances.

In terms of our nonfarm income equation, we include the remittances outcome variable, over which we want to determine whether it has the hypothesized positive and significant impact on the diversification decision. Additionally, we also include in this equation the regressors that control for the characteristics and composition of the household, its human and physical capital assets, and the characteristics of its surrounding environment. In terms of the first group of variables, we can expect that the younger the head, the higher the number of male adults, and the higher the number of dependents in the rural household, the higher the propensity to diversify into nonfarm activities. Regarding human capital, evidence shows that households with higher education levels engage more frequently in nonfarm activities, and that human capital has an important effect on the level of nonfarm income. Hence, the years of schooling of the head of the household, and the total years of schooling of the entire household, are both included in the diversification specification, along with a squared term to permit nonlinear returns to schooling. As we mentioned before, the land assets variable has usually been used to proxy wealth. However, among all the types of assets that the rural household owns, land is among the less liquid and hence might not help diversification in terms of providing the means to do it. As a consequence, we expect a negative impact on the diversification decision. Next, we also expect that social networks influence household's choices regarding diversification decisions. The higher the income of the group of reference the greater the access to resources from the network to start a business or other entrepreneurial activities. Finally, we also believe that the contextual characteristics of the

environment where the rural household resides influence the decisions of the farmers regarding undertaking nonfarm activities. The distance to the nearest department's capital is included here as well, since the department capital is the nearest economic and political center for the rural household, where they might find nonfarm work.

Finally, dummy variables are conveniently included to capture the existence of possible regional effects. Two of them are used to discriminate among the three agroclimatic regions (i.e. *Altiplano*, *Valles*, and *Llanos*), and a third one to differentiate the regions where coca leaf production exits.

V. Estimation results

Table 2 includes some descriptive statistics of the variables used in the nonfarm income and remittances equations of our bivariate probit model. Recall that nonfarm income refers to whether a household diversifies farm income from nonfarm activities, and remittances in turn, to whether the household receives remittances. Since we want to contrast among households coming from the three different geographic regions, we present the data in this and the following tables, in regional terms.

With respect to human capital, Table 2 shows that households in the *Llanos* have more human capital than households living in the other two regions. It also shows that while households living in the *Llanos* have the highest mean land value, the asset is highly dispersed in all three regions. In terms of skewness the asset is positively skewed, with the *Valles* region having a relative longer tail.[27]

In terms of our two binary outcomes, Table 3 provides a cross-tabulation statistics for each region. According to it, a smaller percentage of households in the *Llanos* receive remittances compared to the other two regions; however, it is precisely in that region where there is a higher portion of the households having income coming from nonfarm work, while the smallest percentage of households with nonfarm income among regions is in the *Altiplano*.

[27] The overall skewness value for land is 20.11. In regional terms, the measure is 7.27 for the *Altiplano*, 16.29 for the *Valles*, and 11.13 for the *Llanos*.

Table 2. Descriptive statistics, by region [(a)]

	Altiplano				*Valles*				*Llanos*			
Variable	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Remittances (1=yes; 0=no)	0.18	0.38	0.0	1.0	0.18	0.38	0.0	1.0	0.11	0.31	0.0	1.0
Nonfarm income (1=yes; 0=no)	0.25	0.43	0.0	1.0	0.38	0.49	0.0	1.0	0.40	0.49	0.0	1.0
Number of male adults	1.0	0.7	0.0	5.0	1.2	0.7	0.0	5.0	1.4	0.9	0.0	6.0
Number of children	1.0	1.3	0.0	6.0	1.0	1.2	0.0	5.0	1.3	1.3	0.0	6.0
Age of the household head	48.6	16.9	13.0	98.0	46.2	15.7	11.0	90.0	44.6	14.8	15.0	90.0
Household total years of schooling	11.6	10.5	0.0	64.0	12.7	10.8	0.0	68.0	16.3	12.1	0.0	76.0
Head's years of schooling	4.1	3.9	0.0	17.0	3.8	3.8	0.0	17.0	4.4	3.5	0.0	16.0
Land assets [(b)]	826.0	2,151	0.0	25,000	2,343	8,079	0.0	175,000	5,337	29,570	0.0	448,000
Land assets per capita	309.7	825.1	0.0	12,500	939.1	3,931	0.0	87,500	1,567	7,275	0.0	89,600
Number of households receiving remittances in the group of reference	2.6	2.2	0.0	11.0	2.5	2.4	0.0	9.0	1.6	1.8	0.0	9.0
Wealth of the group of reference [(c)]	4,706	3,915	546	20,926	7,657	5,847	586	30,385	12,285	7,514	3,093	37,123
Distance to the nearest's capital of Department [(d)]	68.7	37.0	16.3	192.8	76.5	43.7	7.5	196.8	125.4	76.3	12.7	469.7
N	798				714				448			

[(a)] *Source* : Own calculations based on MECOVI Survey for year 2000, Bolivian National Statistic Institute (INE).

[(b)(c)] Measured in US$.

[(d)] Measured in miles.

Table 3. Cross-tabulation of Nonfarm income Vs. Remittances, by region[(a)]

	Altiplano		
	NONFARM INCOME =0	NONFARM INCOME =1	Total
REMITTANCES =0	61%	21%	82%
REMITTANCES =1	14%	3%	18%
Total	75%	25%	100%
	Valles		
	NONFARM INCOME =0	NONFARM INCOME =1	Total
REMITTANCES =0	51%	32%	82%
REMITTANCES =1	11%	6%	18%
Total	62%	38%	100%
	Llanos		
	NONFARM INCOME =0	NONFARM INCOME =1	Total
REMITTANCES =0	54%	35%	89%
REMITTANCES =1	6%	5%	11%
Total	60%	40%	100%

[(a)] *Source* : Own calculations based on MECOVI Survey for year 2000, Bolivian National Statistic Institute (INE).

Households in the *Altiplano* and the *Valles* are more likely to receive remittances than households in the *Llanos*. Since these two regions are poorer compared to the third one, this could be a sign that altruism is a stronger motive for receiving remittance in those two regions. Also, *Altiplano* farmers diversify their income less frequently compared to ones in the other two regions. This would suggest in turn a relatively lower willingness to do it, or lower means to do it. The results on the impact of remittances on the diversification decision will provide insights regarding these hypotheses. On the other hand, the

statistics also show that income diversification is more widespread in the *Llanos*. This could be driven by a stronger willingness to undertake risk-spreading strategies in the region, and that households in that region have more successfully found ways to reduce liquidity constraints. The *Valles* region is more of a mixed story, with higher number of households receiving remittances, but a relatively high proportion of them involve in nonfarm employment. Here we also want to investigate and bring some insights regarding the role of remittances in the diversification strategies, in these high prone nonfarm employment regions.

The full information maximum likelihood estimates from the bivariate probit model are given in Table 4. As mentioned already, the estimator is consistent and fully efficient for all the parameters in the model. Each set of results, marked with a number at the top, show the estimates of the remittances outcome equation in the second column, and the estimates for the presence of nonfarm income in the first column. Column (1) includes, in the nonfarm income equation, the remittances discrete variable, all the household characteristics and human capital variables, along with a social network variable (*wealth of the group of reference*), and a contextual variable (*distance to the nearest capital of Department*). The specification of land in the diversification equation is the total value of the asset, and it acts as the exclusion restriction that helps identify the presence of the remittances equation. The remittances equation on the other hand, also includes the same household characteristics and human capital variables, as well as the same social network and contextual variables. Additionally, we also add the household's land assets per capita, and the number of households receiving remittances in the group of reference. These two variables are the exclusion restrictions that identify the nonfarm income equation.

Table 4. Bivariate probit model estimates [a]

	(1)				(2)				(3)			
	Nonfarm Income		Remittances		Nonfarm Income		Remittances		Nonfarm Income		Remittances	
	Coefficients	*t*-ratios	Coefficients	*t*-ratios	Coefficients	*t*-ratios	Coefficients	*t*-ratios	Coefficients	*t*-ratios	Coefficients	*t*-ratios
Remittances (1=yes; 0=no)	0.46	2.03			0.45	1.96						
	(0.23)				(0.23)							
Age of the household head	0.00	-1.06	0.01	3.91	0.00	-0.47	0.01	3.96	0.00	-0.54	0.01	3.95
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Number of male adults	-0.04	-0.67	-0.33	-4.60	-0.06	-1.09	-0.33	-4.62	-0.06	-1.01	-0.34	-4.63
	(0.06)		(0.07)		(0.06)		(0.07)		(0.06)		(0.07)	
Number of children	0.02	0.68	-0.02	-1.47	0.02	0.63	-0.06	-1.50	0.02	0.64	-0.06	-1.50
	(0.03)		(0.04)		(0.03)		(0.04)		(0.03)		(0.04)	
Head's years of schooling	0.04	3.03	-0.05	-3.02	0.05	3.65	-0.05	-2.86	0.05	3.65	-0.05	-2.86
	(0.01)		(0.016)		(0.01)		(0.02)		(0.01)		(0.02)	
Household total years of schooling	-0.03	-3.14	-0.012	-1.02	-0.03	-3.15	-0.132	-1.13	-0.03	-3.21	-0.132	-1.13
	(0.00)		(0.01)		(0.00)		(0.01)		(0.00)		(0.01)	
Household total years of schooling squared	0.01	5.48	0.002	1.49	0.01	5.42	0.002	1.54	0.01	5.46	0.002	1.53
	(0.00)		(0.00)		(0.00)		(0.01)		(0.00)		(0.00)	
Land assets[b]	0.00	-2.76			0.00	-2.76			0.00	-2.82		
	(0.00)				(0.00)				(0.00)			
Land assets per capita			0.000	0.76			0.000	0.69			0.00	0.69
			(0.00)				(0.00)				(0.00)	
Number of households receiving remittances in the group of reference			0.25	12.95			0.26	12.67			0.25	12.63
			(0.02)				(0.02)				(0.02)	
Wealth of the group of reference	0.000	6.77	0.00	0.82	0.00	4.55	0.00	0.38	0.00	4.61	0.00	0.39
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Distance to the nearest's capital of	0.00	-0.73	0.00	0.57	-0.001	-1.69	0.00	0.27	-0.001	-1.60	0.00	0.25
	(0.00)		(0.00)		(0.00)		(0.00)		(0.00)		(0.00)	
Coca production region (1=yes; 0=no)					0.01	0.08	0.00	-0.01	0.00	0.03	-0.03	-0.01
					(0.10)		(0.14)		(0.10)		(0.15)	
Valles (1=yes; 0=no)					0.378	4.43	0.05	0.49	-0.67	-3.48	0.11	0.49
					(0.08)		(0.10)		(0.19)		(0.10)	
Altiplano (1=yes;0=no)									-1.04	-5.53		
									(0.19)			
Llanos (1=yes; 0=no)					0.39	3.65	0.14	1.01	-0.70	-3.28	0.18	0.89
					(0.1)		(0.14)		(0.21)		(0.14)	
Remittances * *Valles*									0.44	1.86		
									(0.24)			
Remittances * *Llanos*									0.82	2.56		
									(0.32)			
Remittances * *Altiplano*									0.43	1.62		
									(0.24)			
Constant	-0.87	-4.79	-1.88	-7.79	-1.05	-5.58	-1.89	-7.69			-1.89	-7.65
	(0.24)		(0.24)		(1.18)		(0.24)				(0.24)	
N	1703				1703				1703			
Log-likelihood	-1504.03				-1490.12				-1497.78			
LR chi2	584.8				612.6				695.0			
rho (ε_1, ε_2)	-0.33				-0.34				-0.37			
	(0.1273)				(0.13)				(0.13)			
Likelihood-ratio test of rho (ε_1, ε_2)=0	6.01				5.80				6.82			

[a] Standard errors in parentheses.

[b] The coefficient on the asset is negative, but since it is quite small it shows as zero with no sign.

As we can see from this first set of results, remittances are highly and positively related to diversification. The head's level of schooling, household total years of schooling, and income of the reference group each have positive and significant impacts on the probability of income diversification. The results on the total years of education for the household are quite interesting. Given the signs of the coefficients, there exists a minimum education level (i.e. 1.5 years) above which the impact of education on the probability to diversify income is not only positive, but increasingly positive. Below such threshold, the impact is negative which can be interpreted as for those extremely low education levels, the returns to education from farm work and from nonfarm work are similar. The coefficient of the land assets variable is significant and with the expected sign, but since its magnitude is quite small, the impact of the variable is almost negligible.

In turn, the remittances decision is, as expected, positively affected by the age of the household's head and adversely impacted by the number of male adults. In terms of human capital, the head's number of years of education reduces the probability of receiving remittances. The more educated the head of the household, the less likely to receive remittances due to a loosening liquidity constrain. The number of dependents, the income of the reference group, the value of land assets per capita, and distance to the nearest capital of Department, have no effect on the propensity of remittances. Finally, the results show that migration networks are an important consideration for remittances. The higher the number of households in the social network who receive remittances, the higher the probability for each of them to receive remittances as well.

In terms of the correlation coefficient between the two structural disturbances, rho, it has an estimated value of -0.33. Given the standard error for the parameter (0.13), the Wald statistic for the hypothesis that $\rho = 0$ is 6.06 which is greater than the critical value for ${\chi^2}_{[1]}$. This result suggests the likely existence of unobservable characteristics of the households that influence both outcomes. An asymptotic similar test to the Wald statistic was also obtained automatically after the estimation of the model of Column (1).The value of a likelihood-ratio test of $\rho(\varepsilon_1, \varepsilon_2) = 0$ again confirms our earlier results. With a test statistic of 5.54, the null hypothesis is rejected at the 5% level of significance.[28] Therefore, the simultaneous estimation of both equations appears to be justified relative to the estimation of independent probit models. The bivariate probit is thus consistent and provides fully efficient estimates for our model (Greene 1998). The negative sign of the correlation coefficient implies

[28] An extensive analysis of the different methods available to test the hypothesis $\rho = 0$, in simultaneous equations models, and involving limited dependent variables, can be found in Monfardini et. al. (2008).

that unobserved and/or unmeasured factors that increase the probability of receiving remittances also decrease the nonfarm income diversification propensity. Finally, as Greene and Seaks (1998) show, the results of the likelihood-ratio test can also be used, asymptotically, as a Hausman test for the exogeneity of the remittances discrete outcome in the diversification equation. This means that the correlation results also suggest that receiving remittances is, as expected, an endogenous variable in the model. Its positive and highly significant coefficient confirms the role of remittances in relaxing capital constraints that frequently prevent rural farmers from diversifying its sources of income.

The positive and significant effect of remittances on the nonfarm income diversification equation remains robust to different specifications of the model as it is shown in Table 3. Column (2) adds two dummy variables to the model to explore the possible existence of intercept regional differences. The first one includes three categories to distinguish among the three geographic regions, and the other aims to differentiate the regions where coca leaves are produced. The regional dummies for the *Valles* and *Llanos* regions are found to be significant for the nonfarm income equation, (although not for remittances), but the one for the coca leaves production region is not significant for neither of the equations. [29]

Independently of the individual significance of the dummy regional variables, we also need to test whether they altogether significantly improve the prediction of our outcomes. This was done using the likelihood-ratio test of the null hypothesis H_0: all regional dummy coefficients equal to zero. Since the test statistic value of 27.84 (p-value 0.000) was significantly larger compared to the relevant critical value, there was sufficient evidence of the joint significance of the regional dummy variable.[30]

Based on those results and on the rejection of the equality of the model parameters across regions for the income diversification equation, but not for the remittances equation,[31] the last set of results in Table 4, Column (3), includes interaction terms for the three regional dummy variables with the remittances discrete outcome in the nonfarm income equation. This last specification aims to provide

[29] The *Valles* and *Llanos* regional dummies coefficients represent deviations with respect to the reference category *Altiplano*, which has been dropped as customary to avoid multicollinearity.

[30] We also run the test including a dummy variable for coca leaf production regions (1 if the household is located in a region where it has been established there is coca production and 0 otherwise); the results confirmed the appropriateness of the inclusion of such regional dummy variables in the model.

[31] We formally tested if the estimated coefficients for the three agroclimatic regions were equal to each other in terms of each of the two equations in the model. We used the SUEST test, a variation of the Hausman specification test that ensures that the test will be well defined (i.e. the estimator of the variance of the difference between the two estimators is guaranteed to be positive semidefinite). The test statistic has a Chi-square distribution with k degrees of freedom (White, 1982). The detailed results for the SUEST test are found in Appendix A.

more insights regarding the existence of regional effects in terms of the impact of remittances on the nonfarm income diversification decision. The resulting coefficients show that two out of three regional interaction coefficients are positive and significant at conventional levels. The coefficient for the *Altiplano* region is positive and nearly significant at 10%. In terms of magnitudes, remittances in the *Llanos* have a larger effect on diversification than they do in the *Valles* region.

Our battery of specification tests includes two final steps. First, we need to make sure that our interaction terms for the three regions are jointly significant, and hence improve the specification of the model. The Hausman test of the constraint that those coefficients are all zero has a chi-squared distribution with 3 degrees of freedom. The resulting statistic of 6.75 with a p-value of 0.07 allow us to reject the null hypothesis at the 10% level. Secondly, we want to know if our regional interaction terms' coefficients are all statistically equal to each other. Again for this purpose we use a Hausman test which in this case has a chi-squared distribution with 2 degrees of freedom. The test statistic of 2.47 with a p-value of 0.292, tells us that there is no enough evidence to reject the null hypothesis of equality. This of course could have been anticipated based on the almost identical coefficients of the *Altiplano* and *Valles* regions.

It is worth to note that among all the different specifications in Table 4, the control variables have always maintained their sign and significance level.

Before examining the magnitudes of the marginal effects, one more check of the specification is performed. A consistent estimation of the parameters depends on the exogeneity of diversification in the remittances equation. If it is endogenous then the system is not fully recursive and the estimates will not be meaningful. Although this proposition is not directly testable, the possibility that the causality should be reversed can be explored. To that effect the model is estimated treating the diversification as being determined by all of its factors, save remittances, and treating diversification as an endogenous determinant of remittances. This basically flips the model around; if diversification is insignificant in the remittances equation then we have indirect evidence that the two are not jointly determined.

Thus, another bivariate probit model is estimated, but this time with the nonfarm income variable as endogenous variable in the remittances equation. The estimated coefficient is -0.36 with a standard error of 1.03. These results are consistent with the original specification that remittances affect diversification and not vice versa.

As it is widely known, only the sign and statistical significance can be directly interpreted from the estimated coefficients of a binary choice model; as Winkelmann et.al. (2006) explain, the parameter estimates β_1, β_2 and γ in our model do not directly measure the marginal effect of each x_i on the binary response variables. The marginal probability effect is then what we need to estimate. Such effect of remittances on nonfarm income diversification was computed as the change in the diversification probability when the remittances dummy variable changes from zero to one, and all other variables are fixed at their means. The marginal effect for the *Valles* is 0.19, and for the *Llanos* 0.29, both coefficients highly significant; that is, the nonfarm income propensity of rural households that receive remittances is 19 and 29 percentage points, respectively, higher than that of non-receiving remittances households. The marginal effect for the *Altiplano* is relatively smaller, but statistically insignificant at conventional levels.

Table 5. Estimated Marginal Effects

	Nonfarm income equation			
Variable	Total effect	*SE*	*Z*	Type of variable
Age of the household head	0.001	0.001	1.860	Continous
Number of households receiving remittances	0.017	0.001	11.430	Continous
Land assets	0.000	0.000	0.570	Continous
Number of male adults	-0.035	0.012	-2.840	Continous
Head's years of schooling	0.011	0.005	2.310	Continous
Number of children	-0.006	0.006	-1.090	Continous
Household total years of schooling	0.003	0.001	2.430	Continous
Wealth of the group of reference	0.000	0.000	2.730	Continous
Land assets per capita	0.000	0.000	-1.990	Continous
Distance to the nearest's capital of Department	0.000	0.000	-0.620	Continous
Coca production region (1=yes; 0=no)	0.348	0.244	1.420	Binary
Valles (1=yes; 0=no)	0.007	0.007	1.080	Binary
Llanos (1=yes; 0=no)	0.011	0.010	1.150	Binary
Remittances * *Valles*	0.191	0.054	3.560	Endogenous
Remittances * *Llanos*	0.291	0.098	2.970	Endogenous
Remittances * *Altiplano*	0.088	0.056	1.560	Endogenous

The estimated marginal effects of the variables in the nonfarm income diversification equation are given in Table 5. The derivation of the formulas for such effects of a binary variable, and that of a continuous variable, on a bivariate probit model are shown in detail in Greene (1998). Note here that the marginal effect of a variable in the nonfarm income diversification equation may be a sum of two terms. In the case in which a variable appears in both of our equations, one will be the direct effect of such variable on equation 1, and the other one will be the indirect effect of the underlying variable on equation 1, through the second equation (i.e. age of the head of the household or number of kids in the household).

A second case occurs when a variable appears just in the nonfarm income diversification equation, in which case the effect of the explanatory variable is direct (i.e. the endogenous variable remittances interacting with the regions, and land assets). We yet have a third possibility for other variables, such as land assets per capita, that only appears in the remittances equation, and which marginal effect on nonfarm income diversification decision will be indirect.

VI. Conclusions

This paper uses a nationally-representative household survey to study the role of migration remittances in nonfarm income diversification strategies in Bolivia. There are three main findings.

First, and according to the literature, migration remittances represent a complementary income source for rural households since they provide them with liquidity. The calculation of the marginal probability effects show that, at the national level, nonfarm income propensity of rural households that receive remittances is 13 percentage points higher than that of non-receiving remittances households.

Second, the results also suggest that the variable remittances is, in fact, endogenous and with a significant effect on nonfarm income diversification; not taking this effect into account could result in biased and inconsistent estimates. The significance of the correlation coefficient justifies the use of the biprobit estimation model.

Third, accounting for the existence of significant regional differences, the paper finds that remittances has a substantial positive effect on nonfarm income diversification in the *Valles* (with a marginal effect of 0.19) and *Llanos* (with a marginal effect of 0.29) regions, but not in the *Altiplano*. These results are consistent with the profile outlined for the existence of two different types of rural farmers in the country. The small poor farmers, mainly located in the Andean region, are viewed as practicing subsistent farming, where the reception of remittances may have the sole objective of supporting consumption. In the other two regions, however, the existence of capitalist farming, oriented to the domestic as well as foreign markets, could help explain the stronger willingness among those farmers to undertake risk-spreading strategies. The imperfect and sometimes inexistent insurance and credit markets make them search for diversified income sources off the farm. Hence, remittances are used in those two regions as a source of liquidity that could help compensate the imperfect functioning of the capital and credit markets in the country.

Appendix A

Table A.1 Bivariate probit model: SUEST specification tests

	Coefficient	*p* -value
Testing equality of coefficients across regions		
Ho : coefficients in *Valles* and *Llanos* are equal		
Diversification equation $\chi^2_{[10]}$	22.24	0.01
Remittances equation $\chi^2_{[10]}$	8.38	0.59
Ho : coefficients in *Altiplano* and *Llanos* are equal		
Diversification equation $\chi^2_{[9]}$	20.31	0.02
Remittances equation $\chi^2_{[9]}$	10.68	0.30

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