Remittances and Income Diversification in Bolivia's Rural Sector

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Abstract

This paper examines the role of remittances in income diversification strategies in Bolivia's rural sector. Remittances can be consumed or invested by the recipient. As an investment, funds can be used for farming or to finance other nonfarm income earning activities. In this paper we use a large and nationally representative survey to estimate the effect that remittances has on the probability of producing income from nonfarm activities (diversification) using a bivariate probit model. Our evidence shows that remittances increase the probability that a rural family engages in nonfarm activities. Moreover, households that receive remittances do tend to diversify more than those who do not, thus relaxing credit constraints commonly faced by rural farmers.

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I. Introduction

> "Bolivia's rural areas, still dependent on rain cycles, are the most financially vulnerable to drought, frost, hail, floods and other weather adversities. Lose your crops, farmers say, and you're left with nothing but your debts." Cabitza (2011)

Managing risks associated with farming is a vexing problem. This is especially true for farmers in developing countries where access to insurance and credit is limited. Farmers in developed countries can insure crops against failure or rely on credit, borrowing against future crops. Subsistence farmers face even steeper challenges, since they must grow enough to feed the family through the winter. Members of rural families may migrate in search of employment for wages; in many cases migrants send a portion of his/her earnings back to the family in the form of remittances.

Crop insurance is often unavailable to agricultural families in developing economies and has only recently become available in Bolivia. Even today it exists only as part of a pilot program in the southern region of Tarija (Cabitza, 2011). Crop insurance works in two ways: 1) farmers with insurance receive some income when crops fail, which in turn helps to keep family and farm intact until the next season and 2) because a farmer with insurance is likely to survive a complete crop failure, he has greater access to credit, which can be used to resume planting in the following year. An ability to borrow in times of failure is a significant buffer against what would otherwise be a ruinous catastrophe.

Although among developing countries Bolivia has a relatively substantial micro-credit industry, many farmers are unable or unwilling to borrow against future production even from microfinance institutions.[1] In this case farmers may follow another strategy. To mitigate the effects of crop failure, the farmer may be forced to seek other work. In this

[1] In a country of approximately 10 million, it is reported that the largest micro-financier, BancoSol, is lending approximately $500m to 150,000 Bolivians (Cabitza, 2011) in 2011. But, it is only recently that access to such institutions has been possible in Bolivia.

way, migration has become a means that many families rely on to manage the considerable risks associated with (uninsured) farming.

Rural-urban migration is an important force behind the continued increase of the world's urban population. South America encompasses striking differences in patterns of urbanization ranging from an urbanization ratio of more than 90% in Argentina and Venezuela to less than 30% in Guyana. In Bolivia the proportion of urban population is 64%, and rural-urban migrants represent approximately 20% of overall migration.

In this paper we seek to answer the question whether remittances from migration represent an end in and of itself for the household of origin, or whether there is a significant additional effect whereby remittances are being used to diversify a farm family's income earning portfolio. We speculate that this is likely to occur due to market imperfections (e.g., absence of credit and insurance) that are commonly faced by rural farmers in agrarian economies. Our results indicate that remittances do increase the likelihood that a rural family will diversify into other income earning pursuits, at least in portions of Bolivia.

We focus on Bolivia because of the prevailing market failures that constrain agricultural production, the relatively low urbanization rate of the country and the prospects of continuing and increasing migration from the countryside in the next decades. Our analysis focuses on how the receipt of a remittance by a Bolivian family affects the probability that the family diversifies into nonfarm production. We hypothesize that remittances and diversification are jointly determined and our estimation strategy takes this into account.

The rest of the paper is organized as follows. Section II presents a brief review of the literature as it relates to the main questions addressed in this paper. The basic econometric issues are discussed in section III while the data and the specific specification of the empirical model are found in section IV. Section V includes the major results and discussion. We draw conclusions in section VI.

II. Theoretical Background

Lucas (1997) indicates that the absence of crop insurance and shortage of liquidity are among the most important constraints that push rural families in developing countries to diversify away from agriculture and explore migration remittances as a source of income not just for the migrants, but also for the family that stays behind in the village. It is in the presence of these constraints that the New Economics of Labor Migration (NELM) (Stark and Bloom, 1985) explains that migration remittances can facilitate diversification and provide resources for rural households to invest into nonfarm activities. In this study, we explore the role of migration remittances as a complement to home (farm) earnings within the Bolivian context.

The role migration remittances play through the provision of liquidity that helps rural households undertake productive investments, particularly in the nonfarm sector, has been highlighted in the literature (Stark and Levhari, 1982; Stark, 1991; Taylor *et al.*, 2003). Empirically, there is some indirect evidence for this role. Banerjee and Munshi (2004) use data from an Indian urban survey to show that migration networks are an important determinant of patterns of investment as they provide easier access to resources. Woodruff and Zenteno (2007) also use migration networks as a proxy for access to liquidity, and show that they increase significantly investment and capital output ratios in urban microenterprises in Mexico. Richter (2008), in turn, shows that the probability of rural households to obtain credit is significantly explained by the level of remittances.

While all these studies connect migration and remittances with access to liquid resources by rural households, they do not directly relate remittances to the household's decision to undertake productive investments in the nonfarm sector. Some authors have tackled this indirectly. Dustmann and Kirchkamp (2002) suggest that credit constraints are an important motive behind the duration of the migration period and the choice of activity after return, and the characteristics of the migrant before migration explain significantly the choice of activity, notably nonfarm work. More relevant evidence regarding

the effect of migration remittances on activity choice is presented by Ilahi (1999), with data from Pakistan, and Mesnard (2004) and Mesnard and Ravallion (2006) for Tunisia. These studies show that the savings migrants have accumulated abroad are a significant factor in the choice of nonfarm activities when they return home. Their focus, however, is on the likelihood of returning migrants to engage in nonfarm activities using their foreign accumulated savings, not on the likelihood of rural households to use remittances for purposes of income diversification.

The main interest of this paper lies in the effect that remittance income streams have on the receiving household's decision to engage in nonfarm activity. The potential of income diversification, in general, and migration remittances, in particular, to overcome credit and risk constraints, is part of rural household livelihood strategy and the decisions are taken at the household level (Stark and Bloom, 1985). In this respect, Massey and Parrado (1998) estimate the likelihood of Mexican households to form a business, partially using migration remittances. Although the results suggest a positive role for remittances, they do not discern the individual effect of remittances, since both remittances and migrant savings are added together; neither are they informative regarding the role of migration remittances for rural farmers, given that the data include both urban and rural households.

Taylor *et al.* (2003) analyze remittances within an income diversification framework from the household perspective. They estimate household income equations for different sources and include remittances as explanatory variable. They find that the estimated coefficient for this variable is not statistically significant in the nonfarm income equation. In our work, we investigate whether remittances facilitate diversification and focus on their impact on the choice to engage in an activity (i.e. nonfarm work involvement) rather than on the income generated by the activity. In this direction, Wouterse (2008) examine the impact of migration on the income diversification decision based on a household survey of four villages of Burkina Faso. She finds that the number of migrants in a rural household has a negative impact on the probability of participating in nonfarm

activities. The authors conclude that the negative impact from the decrease in the supply of household labor due to migration outweighs the positive impact that the eventual remittances, sent by those migrants, would have on liquidity constraints.

Migration, however, does not always result in remittances being received by the rural household because not all migrants leave home for reasons related to remittances (Gibson and McKenzie, 2007)[2], or even if they do, not all migrants send remittances (Benedicte *et al.*, 2002).[3] Andersen (2002) finds that for no more than 18% of the migrants were remittances the primary reason behind rural-urban migration in Bolivia. Following Niimi and Çağlar Özden (2008), we assume that if remittances are observed as part of the rural household's income, it is because the household[4] sent at least one family member as migrant.[5] This is important because, as Taylor (1999) observes, remittances represent the largest direct positive impact of migration on income and production of rural families, in particular, and on migrant sending areas, in general.

Two other papers find conflicting evidence on whether other sources of income affect diversification. Ruben and van den Berg (2001) find a significantly positive effect from capital income and pensions, suggesting that non-farm income facilitates diversification. Berdegue *et al.* (2001) find that, in Chile, government assistance has no significant effect on diversification.

The hypothesis that remittances represent a source of liquidity that facilitates farmers' income diversification into nonfarm activities is tested using data collected by the Bolivian Bureau of Census (INE). The source household, from which migration has originated, as well as the characteristics of the surrounding community, are the focus of the analysis. The literature on migration and remittances focuses mostly on remittors' characteristics

[2]When Tongans participating in a survey were asked to rate the importance of different factors influencing their desire to migrate, many motives were mentioned, most of them not related to remittances.

[3] Based on a survey conducted on farm households in communities of the Dominican Sierra, approximately 52% of the households that sent migrants receive remittances.

[4]A household consists of all those individuals, with or without a relationship, that inhabit the same dwelling and at least for food they depend on a common budget.

[5]This assumption rules out the possibility that a rural household might receive remittances even if no family members have migrated. We treat this option as unlikely or negligible.

and their contextual settings, not on the impact of migration and remittances on the source household.[6] This is another contribution this paper makes by focusing on the implications of migration for the source household.

III. Model

Farm income, nonfarm income, remittances, or any combination of these three constitute the sources of income of rural households. We examine the effect of remittances on the propensity of rural households to diversify their income through nonfarm work, conditional on the characteristics of the households and on the environment in which they make their decisions. In the model, one decision is to engage in nonfarm income earning activities. This is the outcome of a cost/benefit analysis on behalf of the farm family. We do not observe any expected surplus associated with farming or other activities in this case, only the outcome i.e. whether the family earns nonfarm income or not. If farmers engage in nonfarm activities the net benefits of this strategy are assumed higher than those of specialization in farming.

Let y_1^* denote the surplus associated with diversification. We observe:

$$y_1 = \begin{cases} 1 & \text{if } y_1^* > 0 \\ \\ 0 & \text{otherwise} \end{cases} \tag{1}$$

Thus, if the net surplus is positive we observe some nonfarm income. The variable y_1^* is a *latent* variable since its value is not directly observable. The observed or *actual* variable, y_1, is presence of nonfarm income in the household budget. A household that receives a remittance must decide how to use the funds. It can consume, save, or invest in farm or nonfarm production (or some combination of the three). Our analysis focuses on the last of these, i.e., how the remittance affects the likelihood of diversifying.

[6] See for example Regmi and Tisdell (2002) for Nepal, Brown (1997) for the Pacific Island, Hoddinott (1992) for Kenya, and Lucas and Stark (1985) for Botswana. An exception that focuses on the source household is Adams, Jr. *et al.* (2008).

As for remittances, a migrant leaves home in order to seek employment outside the family. Gainful employment and circumstances permitting, the migrant may decide to send some money home to the family. Let y_2^* denote the value of an intended remittance. This can be thought as the outcome of utility maximization, where the individual considers pay and circumstances against own need and family needs. If the migrant's consumer surplus from remitting is positive, he/she arranges to have some money sent home. We do not observe the value of the net benefit of remitting (y_2^* is a latent variable) only whether the individual does or does not. Only if the consumer surplus of remitting is positive do we observe a remittance (y_2 is the actual variable). Therefore,

$$y_2 = \begin{cases} 1 & \text{if } y_2^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{2}$$

There are a number of exogenous factors that influence whether an individual farmer diversifies (x_1), or that determine whether a remittance occurs, (x_2). The basic model we consider is:

$$y_1^* = y_2^*\gamma_1 + x_1\beta_1 + u_1 \tag{3}$$

According to this model, the decision to send remittances may itself determine the decision to seek nonfarm income sources. This is the central hypothesis of this paper. Moreover, the desired remittance, y_2^*, may be endogenous, another important hypothesis we investigate below.

Following Wooldridge (2010), the binary endogenous variable model can be expressed

$$y_1 = 1[x_1\beta_1 + \gamma_1 y_2 + u_1 > 0] \tag{4}$$

$$y_2 = 1[x\beta_2 + u_2 > 0] \tag{5}$$

where $1[\,]$ is the indicator function which takes the value 1 if the argument in the bracket is true, and x contains all exogenous variables $x = [x_1 \; x_2]$. Technically, the separate determinants of remittances, x_2, are not required; if any are available, however, the iden-

tification of the model's parameters is enhanced. Equation (5) can be thought of as the reduced form equation for y_2, which is equal 1 if a remittance is received by the family. The error vector, (u_1, u_2) is independent of the exogenous x and is distributed as bivariate normal with mean zero, each with unit variances, and correlation $\rho = \text{Corr}(u_1, u_2)$. If the binary variable y_2 is correlated with u_1, then the probit maximum likelihood estimator (MLE) of (4) will be inconsistent. Therefore, estimation of (4) and (5) together is necessary via the bivariate probit model.

The likelihood function $f(y_1, y_2|x) = f(y_1|y_2, x)f(y_2|x)$ has a particularly convenient property: the conditional density $f(y_1|y_2, x)$ is the same even if x_1 contains y_2. This makes the log likelihood equivalent to the one used for bivariate probit. This feature has been exploited by Greene (1998) and others to estimate endogenous probit models. Maddala (1983, chap. 5) gives an intuitive explanation of why this works. One can estimate a binary choice regression that contains an endogenous binary variable via a bivariate probit, provided the equation is properly identified. As Wooldridge (2010, p. 509) points out, for purposes of identification and computing average partial effects, it is helpful to include variables in x that are excluded from x_1(the x_2 here).

In the context of this empirical specification, a parametric test of the null hypothesis $\rho = 0$ is a test of the endogeneity of y_2 (see Wooldridge (2010, p. 597)).

IV. Data Sources and Model Specification

Data Sources

The data come from the database of the Program for the Improvement of Surveys and the Measurement of Living Conditions in Latin America and the Caribbean (MECOVI),[7] and is conducted by the Bolivian Bureau of Census (INE).[8] Data from the surveys are available for the period 1999-2002. Since each survey does not track the same households,

[7]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 institutions or agencies in countries participating in the program.

[8]The data are available at www.ine.gob.bo.

and some key questions are not asked in each survey, we perform a cross-section analysis using the survey conducted in 2000 because it contains the widest available coverage of variables that are necessary for the estimation of our model. The stratified sampling procedure used by the surveys is designed to eliminate sampling bias in order to provide a representative picture of the Bolivian economy (Rivero and Mollinedo, 2002).

The surveys include data on such diverse variables as income, expenditures, education, health, employment, food consumption, asset holdings, migration and remittances. 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 2000 survey covers sample units from urban and rural households. 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.[9] Because our goal is to estimate the degree of income diversification of rural farmers, rural households whose primary and/or secondary occupation is not related to farm work have been removed from the sample. Moreover, an additional 171 households do not have complete information on all the variables necessary for the estimation of the model. Therefore, our final sample size consists of 1725 rural households; their classification according to income source is shown in Table 1.

Explanatory Variables

The goal of this paper is to determine whether remittances increase the probability that a farm family diversifies into nonfarm production. To do this it is important to control for other factors that affect decision-making. This is especially true in empirical specification of binary choice models like the one considered here. The control variables to be included in the diversification equation (4) can be classified into four broad groups: (i) household characteristics such as the age of the household head and the number of adult and children

[9]Of the total 2,108 households, 825 are located in the Highland region, 756 in the Valleys, and 527 in the Lowlands. The survey also classifies households according to their location into two groups: rural populated centers (212 households) and rural dispersed areas (1,896 households).

members; (ii) household human capital assets such as the educational attainment of the household head and total number of years of education in the household; (iii) physical assets of the household measured by its landholdings; and (iv) the general characteristics of the sending community (known as contextual setting) which include the social networks of the household and regional fixed effects.

Diversification

With these four broad categories in mind, the specification of the diversification model in equation (4) is discussed. We anticipate that the ability to earn nonfarm income (and thus diversify) will depend on factors related to the family's access to credit, savings, and human capital. It is also possible that location, either the region of the country[10] or proximity to the local Department capital determines nonfarm income. The MECOVI 2000 survey includes several variables that can serve as controls for these factors.

With respect to human capital, following Hoddinott (1992), it is likely that higher educational attainment, especially that of the household's head and elder members, will have a positive impact on the availability of liquid resources. As Reardon *et al.* (2000) explain, households with higher levels of education tend to have better chances for nonfarm employment, enjoy higher wage earnings and success in business, and tend to be more productive farmers; in sum, they face better chances to increase their income through diversification. This view is consistent with that of Andersen *et al.* (2009), who also find significant regional differences in diversification behavior in Bolivia.

Two variables measure human capital: years of schooling of the head of the household, and the total years of schooling of the entire household. A squared variable for household

[10]More successful farmers in the Altiplano have taken advantage of technical innovations to improve productivity. This requires investment. For less successful farmers of the Altiplano: "For the vast majority of farmers who feel that their productivity has decreased, the coping strategy has mainly been to do more of the same, i.e. to expand the area under cultivation. Seasonal migration, a change in the main crop cultivated, and a participation in non-farm activity in order to generate more income have also been used as coping mechanisms." (World Bank, 2002, p. 29)

years of schooling is also included to permit flexibility in the specification of the effect of education on the diversification decision.

Wealth, which includes accumulated savings, can serve as a source of capital, negating the need for remittances to solve problems with liquidity. Asset (land) holdings have been extensively used in the literature as proxies for household wealth (Hoddinott, 1992; Lucas and Stark, 1985; Wouterse, 2008). We also include the number of adults in the family to control for otherwise unobserved density effects. We add to this by including the size of the entire household, recognizing that the age distribution of the household may affect how families decide to use remittances.

Credit may come informally by borrowing from neighbors. Hence we also include the average wealth of the farmer's reference group. In addition, it has been explained and empirically demonstrated that social networks affect household decisions (e.g. Taylor *et al.* (2005)). For sampling reasons, the INE divides the country geographically into UPMs (Primary Sample Units). The UPM is the group of reference (social network) for each rural farmer. There are two sizes of UPM in our sample: larger communities have a larger collection of households (150) in their UPM and smaller communities have fewer households in the reference group (50). Our explanatory variable is the size of the UPM measured as an indicator variable, taking the value 1 if the household is in a larger UPM and 0 otherwise.

Remittances

To estimate the reduced form model for remittances by bivariate probit,[11] we include a variable (x_2) to the model that is likely to affect remittances without directly influencing diversification (exogenous to diversification). Although this is not strictly necessary, as the model is weakly identified by the nonlinearities associated with the joint density function, the statistical properties of the bivariate probit are enhanced with stronger

[11] Although equation (5) is referred to here as a reduced form, the parameters of this equation are estimated jointly along with those of equation (4) via bivariate probit. Wooldridge (2010) explains the reasoning.

identification (Wooldridge, 2010). Additional variables would then become available as instruments that can be used to estimate a linear probability model using two-stage least squares. Substantial differences between the results of the two approaches would suggest a misspecification of the model. This is explored further below. Therefore, variables that are included in equation (4) as exogenous determinants (controls for human capital, wealth, and location discussed in section IV) need no separate justification to be included in (5).[12]

As far as the variable included in the remittance decision equation (5) but excluded from (4), we note that social networks have an important effect on a household's remittance decision. Specifically, we use the number of households receiving remittances in the UPM as a separate determinant of remittances. This variable has been used in previous work to help explain the likelihood of receiving remittances (Adams, Jr. *et al.*, 2008). As World Bank (2006) suggests, migration/remittances networks are expected to influence the availability of information and the costs of sending money and thus the remittance decision. Once again, we allow for different size effects based on the two UPM sizes used by INE.

Descriptive Statistics

Table 2 provides descriptive statistics for the variables used to estimate the model. Because there are important and interesting differences across Bolivia's regions, we present the data broken down according to three distinct geographic regions: the highlands (*Altiplano*) in the west, the semi-tropical Yungas and temperate valleys of the eastern moun-

[12]There are ample examples in the literature that suggest these variables influence migration and remitting behavior. Although asset (land) holdings have been extensively used in the literature as proxies for household wealth (Hoddinott, 1992; Lucas and Stark, 1985; Wouterse, 2008), there is disagreement over its effect on the remittances decision. For instance, a larger quantity of land increases the marginal productivity of land and may reduce the pursuit of remittance income (Ilahi, 1999). However, if the aspiration to inherit is an important reason to remit (Lucas and Stark, 1985; Hoddinott, 1992), we can expect that the larger the potential for inheritance, the higher the probability of the rural household of receiving remittances.

tain slopes (*Valles*), and the tropical lowlands or plains in the east (*Llanos*) (see Hudson and Hanratty (1989)).

Household demographics indicate that the Llanos has the youngest household head, the most children, and the largest number of adult males in the household. Households in the Altiplano have, on average, the oldest head, the smallest number of children, and the smallest number of adult males. Gross consumption per family is much lower in the Altiplano than in the other regions.

There are marked differences in human capital and asset holdings across regions. Households in the Llanos have, on average, the highest total years of schooling and the head has more years of schooling than those in the other regions. Moreover, households in this region have the highest mean land value and mean land value per capita. Land value is highly asymmetric in all three regions: it is positively skewed in all three regions, with the Valles region exhibiting a relatively longer right tail.[13] Finally, similar to the availability of physical assets, the wealth of the social group of reference increases from the Altiplano to the Valles and to the Llanos regions.

Table 3 is a summary table for the two binary decision outcomes in our model. The Llanos, the richest region of the country, has the smallest proportion of households receiving remittances (11% compared to 17% for the other two) and the largest proportion of households engaging in nonfarm activities (40% compared to 24% and 38%). These values may reflect stronger willingness to undertake risk-spreading strategies in the region or that households in that region have more successfully found ways to reduce liquidity constraints. On the other hand, the poorest region of the country (Altiplano) has the highest percentage of households receiving remittances but the lowest participation in nonfarm activities. Estimation of our model, especially the impact of remittances on the diversification decision, will provide insights into these stylized facts.

[13]The overall skewness value for land is 20.01; regionally, skewness is 7.27 for the Altiplano, 16.29 for the Valles, and 10.84 for the Llanos.

V. Estimation and Discussion

The model in equations (4) and (5) is estimated two different ways: via maximum likelihood and as a linear probability model (LPM) using two-stage least squares (2SLS). There are a few modelling issues that must be considered. First, because there may be regional differences in diversification behavior, the regions are estimated separately and the possibility of combining the regions is explored. Second, identification of the parameters of the model is enhanced by including variables in x that are excluded from the diversification equation, (4). Statistical significance of the additional variables in the remittances equation provides evidence that identification is enhanced. Because the parameters can also be estimated consistently as an LPM via 2SLS, we can conduct tests of instrument strength and exogeneity (overidentification).

The central hypothesis of interest is: what is the effect of the receipt of remittances by a rural household on the probability of diversification. If there are regional differences, then the most general approach would be to estimate the model for each region separately. The coefficient estimate and its asymptotic p-value for the remittance variable is given in Table 4. The receipt of a remittance is statistically significant at 5% for the Valles and at 10% for the Llanos region. There is no evidence that remittances lead to diversification in the Altiplano. The coefficient ρ, which serves as a test for the endogeneity of remittances, is statistically significant for the Valles at 5%. For the Llanos, ρ is smaller (in absolute value) than in the Valles and its p-value is 0.167. Type II error may be costly in this instance; incorrectly concluding that remittances are exogenous leads to inconsistent estimation of the parameter of interest by the usual probit MLE. On the other hand, type I error is not costly–the bivariate probit is consistent in either case and it *may* be more efficient.[14] We can limit the probability of type II error by choosing a large significance level for the test. As is well-known, the size of a test and the probability of type II error are the same

[14]There is no theoretical reason why the probit MLE will be more efficient than the bivariate version that allows for the possible endogeneity of a regressor. To our knowledge, the question has not been studied formally.

when the null hypothesis is almost true. Thus, to limit the probability of type II error to a maximum of say 50%, one would use a significance level of 0.5. Under this criterion, we conclude that it is best to treat remittances as endogenous in the Llanos. Also by this criterion, it is also safe to conclude that remittances are not endogenous in the Altiplano.

Failure to find statistical evidence that remittances affect diversification in the Altiplano could, at least in principle, be due to inefficient estimation of the models' parameters. Efficiency would improve if restrictions on the parameters of the model can be found. Unfortunately, we are unable to find any restrictions that allow for further gains in efficiency. Specifically, a model is considered that allows for separate parameters for equations (4) and (5) in each region while combining the regions in such a way as to force the correlation parameter to be equal across regions. The only restriction considered relative to estimating the regions separately is to restrict the value of ρ to be equal across regions. This amounts to only two parameter restrictions. A likelihood ratio test is used to test these restrictions; the LR= 8.98 which has a p-value of 0.011, indicating that the regions should not be combined, even in this minimal way. The outcome for the remittance coefficients under the restriction can be found in Table 8 in appendix A.

Two-stage least squares estimation of a LPM is also consistent for the parameters of the diversification equation (4). There are several of advantages of estimating the model this way: (1) It allows use of standard regression diagnostics to assess strength and exogeneity of instruments (2) It provides an easy way to confirm the endogeneity of remittances and (3) as is well-known, the LPM also provides a reasonable approximation of the average partial effects in the model. Since the model contains an extra explanatory variable in the reduced form equation, i.e., the remittances received by the reference group, this can be treated as an instrument in the estimation of the LPM. In addition, we interact this variable with the indicator variable for the size of the UPM to create an additional instrument.[15] The complete results appear in Table 7 below. Based on 2SLS estimation

[15]This was added to the bivariate probit models and found to be individually and jointly insignificant and dropped from the model. Here its purpose is to overidentify the model so that an overidentification test can be used. It should be noted that without it, the overall instrument strength improves.

of the LPM, the instrument strength is ample, the instruments are not significantly misspecified at 10% and only the regression for the Altiplano shows no evidence of the endogeneity of remittances. The results are quite similar to those from bivariate probit in Table 6 and give us more confidence in the conclusions we draw based on the bivariate probit regressions.

The average treatment effect (ATE), which measure the average effect of receiving a remittance on the probability of diversification within the sample, is computed[16] based on the bivariate probit and compared to those obtained by 2SLS. Ordinarily, we would expect the two sets of effects to be similar, but the unbalanced nature of the data (relatively few families receive remittances and diversify) will cause the estimate based on 2SLS, which is constant for all families, and that for bivariate probit to diverge somewhat.

The ATEs appear in Table 5 below. The results are roughly similar, though the statistically significant ATE's based on the bivariate probit are about one-third smaller than those based on a linear probability model. This is due to the fact that the diversifying families that receive remittances are found at the tails of the joint probability distribution (i.e., they are relatively few in number). In neither case is there any evidence of a diversification response by the mainly subsistence farmers of the Altiplano.

Since remittances in the Altiplano may be exogenous, equation (4) for the Altiplano is estimated using the usual probit MLE. The coefficient on remittances is -0.067 with an asymptotic p-value of 0.487, which is not significant at any reasonable level. Once again, we find no evidence that remittances affect diversification in the Altiplano.

Our conclusion is that there is strong evidence that remittances increase the probability of diversification in the Valles; there is moderate evidence that they increase the probability of diversification in the Llanos; there is no evidence that they increase diversification in the Altiplano.

The complete set of regional regressions estimated using the bivariate probit MLE can be found in Table 6 below. It includes the coefficient estimates and standard errors for the

[16]These are sometimes referred to as the average value of the marginal effect.

control variables.[17] The other variables in the diversification equations have the expected signs and most are statistically significant. In general, the head's years of schooling increases the probability of diversification. The effect of total years schooling is increasing at an increasing rate. This suggests that high levels of schooling increase the probability of diversification more so than low levels. The larger UPM size (150 households) reduces the probability of diversification relative to the smaller size (50 households) found in smaller and often more remote localities. As expected, greater wealth of the reference group increases the probability of diversification. The number of adult males has a positive impact on diversification, but only in the Valles. Household size has a positive effect on diversification in the Llanos and in the Valles.

The results from 2SLS estimation of the diversification equation in Table 7 are very similar to those of bivariate probit in Table 6. The specification tests suggest that the instruments (remittances of the reference group in the large and small UPM) are very strong in each region and that the model is suitably overidentified. The Hausman test suggests that remittances in the Altiplano are not endogenous, but are (at least at 10% level) in the other two regions.

Of interest in the reduced form for remittances is the significance of the remittances of the reference group. In each region the coefficient is positive and significant at the 1% level. This should improve the identification of the diversification equation in both the bivariate probit and the 2SLS estimation of the linear probability model.

The industrialized farmers are located mainly in the Llanos, and produce export products like cotton, sugarcane and soybeans. This region accounted for 13% of Bolivia's agricultural GDP during the period 1990-2004. Families in this group own relatively more land; are more specialized, modern and profitable; and, more easily linked to foreign markets.

The non-industrialized farmers are mainly located in the Altiplano and the Valles. The Altiplano accounted for 47% percent of total agricultural GDP (1990-2004). This group

[17]These and all other estimations were obtained using gretl 1.9.9.

is mainly comprised by farmers that own small plots of land, have little specialization or technology, are based on family work, and whose agriculture outputs are devoted to self subsistence or domestic markets. The production of this group consists mainly of roots and tubers, corn, vegetables and fruits. According to the Agrarian Question literature,[18] we can characterize these small farmers as a "poverty refuge" *minifundio*, economically incapable of significant accumulation, and yet resistant to total elimination, probably because the peasants themselves highly value their land as a way to assure their subsistence.

Despite these apparent commonalities, the families in the Valles region appear to use remittances much differently than those in the Altiplano. In fact, our analysis suggests that on average, a family in the Valles is approximately 33% more likely to diversify if it receives a remittance and that it has no effect in the Altiplano. The diversification behavior of the farm families of the relatively poor Valles is actually quite similar to that of the industrialized farms of the Llanos. Our results suggest that a family from the Llanos receiving remittances is about 25% more likely to diversify than one who does not receive one.[19]

VI. Conclusion

Based upon data from the MECOVI 2000 survey, our analysis shows that the receipt of remittances by many families in Bolivia has a positive impact on the probability of income diversification. In addition, there are regional differences that cannot be ignored. The families of the Valles and Llanos are more likely to diversify if they receive a remittance while those of the Altiplano do not. For the small poor farmers located mainly in the Altiplano who practice mostly subsistence farming, the receipt of remittances largely

[18]The Agrarian Question debates the destiny of the small-scale farmers e.g. its survival or extinction over time; it includes three different hypotheses, namely: the Chayanovian view that explains the survival of a competitive and stable peasant sector, the class differentiation view, that argues the disappearance of the sector over time, and the "poverty refuge" view, that imputes a resistance and longevity of small farmers, with income levels that only ensure their survival. More details in Carter and Mesbah (1993).

[19]For a more thorough discussion of the nature of Bolivian farming, see Lazarte-Alcala (2010).

supports consumption. In the other regions, however, the existence of a capitalist farming sector, oriented to the domestic and foreign markets offers alternative sources of income and remittances are being used as a source of liquidity. Given the imperfections in capital markets and the absence of crop insurance programs, the farm families apparently view remittances as a way to manage the considerable risks associated with farming in Bolivia.

Appendix A explores whether the empirical model can be improved by pooling. Appendix B is provided for referees and not intended to become part of the manuscript (unless, of course, its inclusion is desired by the reviewers or editors of AE).

A. Pooling the Regional Regressions

We explored whether the regional regressions could be safely pooled and conclude that they cannot. In Table 8 the model is estimated using bivariate probit imposing only two restrictions on the separate regional regressions (Table 6). The restrictions are that the correlation parameters, ρ, are equal across regions; all of the other coefficients are allowed to differ across regions. The unrestricted log-likelihood is obtained by summing the log-likelihoods from individual regression, i.e., those found in Table 4. The LR statistic is 8.9837 and the $\chi^2(2)$ p-value is 0.011. This result implies that the regions should be estimated separately.

B. Simultaneous Binary Choice

A simultaneously determined structural model, discussed by Maddala (1983, chap. 5),

$$y_1^* = y_2\gamma_1 + x_1\beta_1 + u_1 \tag{6}$$

$$y_2^* = y_1\gamma_2 + x_2\beta_2 + u_2 \tag{7}$$

is technically indeterminant without some restrictions on the parameters of the model. As Schmidt (1981) shows, the model is only coherent in a probability sense if $\gamma_1 = 0$ or $\gamma_2 = 0$. The economic implication of this is that intended nonfarm income and the utility maximization associated with the sending of remittances cannot be accomplished simultaneously if they depend on realized values of the latent variables. The decision must be *recursive* or *sequential*. The model is *sequential* if a remittance, $y_2 = 1$, is a precondition for earning nonfarm income, $y_1 = 1$. This is clearly not the case for there are farmers who successfully diversify without receiving remittances using savings or via credit.

A *recursive* relationship merely says that $y_2 = 1$ precedes $y_1 = 1$. That means that the receipt of a remittance precedes being able to use it as an investment instrument. Parametrically, $\gamma_2 = 0$ to establish logical consistency and $\gamma_1 \neq 0$ if remittances affect the probability to earn nonfarm income. That is completely reasonable. The converse, though possible, seems very unlikely. In that scenario, the farmer produces nonfarm income and because of this, family members migrate in order to remit. In this case $\gamma_1 = 0$ to establish logical consistency and $\gamma_2 \neq 0$ if remittances affect the probability to earn nonfarm income. This can be tested of course and we have done so. γ_2 is not significantly different from zero at 5%, which is consistent with the main hypothesis tested in this paper.

The only other possibility is a model where y_1^* and y_2^* appear on the right-hand side of the equations in place of their observed counterparts. In this model *intentions* are completely jointly determined. This model says that the **intentions** about diversification

and remittances are jointly determined by the variable in x_1 and x_2. The actual outcomes, y_1 and y_2 are unimportant determinants of those intentions. Since none of the intentions are observable, the model is not useful for estimation.

Therefore the logical consistency of the model, which requires the probabilities of each combination available to the family sum to one, requires one of these decisions to become realized before the other is made. Mathematically, that is $\gamma_1 = 0$ or $\gamma_2 = 0$. So, the family must receive a remittance before spending it, or the farmer must be engaged in earning income before planning for remittances.

Unlike the decision to diversify however, the receipt of a remittance is not the outcome of intentions but rather is an actualization of the remittor's behavior. Thus, intended value of remittances (a latent variable) is not of interest; only whether the family actually receives one or not. The distinction is important, because of issues associated with coherent probability modeling of this decision-making process.

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Table 1. Sources of income for Bolivian farm households from the MECOVI survey, 2000.

Farm families income sources	Number of families
Farming only with no remittances	970
Farming only with remittances	185
Diversified with no remittances	492
Diversified with remittances	78

Table 2. Descriptive Statistics for Households by Region

	Altiplano				Valles				Llanos			
	Mean	SD	Min	Max	Mean	SD	Min	Max	Mean	SD	Min	Max
Demographics												
Number of adult males	1.03	0.67	0	5	1.22	0.72	0	5	1.40	0.87	0	6
Number of children	0.98	1.25	0	6	1.05	1.23	0	5	1.31	1.29	0	6
Gross consumption ($1000)	0.41	0.32	0.03	2.08	0.71	0.60	0.04	8.07	0.98	0.79	0.07	8.54
Age of household head	47.95	16.74	16	95	45.65	15.10	16	90	44.15	14.78	18	90
Human Capital												
Total years of schooling	11.96	10.50	0	64	13.33	11.05	0	68	16.46	12.01	0	76
Total years of schooling of household head	4.37	3.98	0	17	4.08	3.87	0	17	4.56	3.45	0	16
Physical Assets												
Land (US$)	826.02	2151.18	0	25000	2343.43	8078.55	0	175000	5337.35	29570.18	0	448000
Land per capita ($US)	309.66	825.13	0	12500	939.09	3930.54	0	87500	1566.85	7274.70	0	89600
Contextual Variables												
Number of households receiving remittances in UPM	2.59	2.25	0	11	2.48	2.39	0	9	1.61	1.84	0	5
Wealth of reference group (US$)	777.32	657.00	88.43	3386.15	1282.55	968.59	94.79	4916.62	1991.81	1233.98	500.52	6007.01
N	683				629				413			

Source: Calculations based on MECOVI Survey, 2000, Bolivian Bureau of Census

Table 3. Cross-tabulation of nonfarm income vs. remittances, by region.

	Nonfarm Income=0	Nonfarm Income=1	Total
	Altiplano		
Remittances=0	61.93%	21.23%	83.16%
Remittances=1	13.62%	3.22%	16.84%
Total	75.55%	24.45%	100%
	Valles		
Remittances=0	51.35%	32.11%	83.47%
Remittances=1	10.81%	5.72%	16.53%
Total	62.16%	37.84%	100%
	Llanos		
Remittances=0	54.24%	35.11%	89.35%
Remittances=1	5.81%	4.84%	10.65%
Total	60.05%	39.95%	100%

Source: Calculations based on MECOVI Survey, 2000, Bolivian Bureau of Census

Table 4. The effect of receiving a remittance on the probability of earning nonfarm income in Bolivia, by region.

	Diversification yes=1		
	Altiplano	Valles	Llanos
Remittances Coefficient	0.027	1.000	0.773
yes = 1	(0.948)[a]	(<0.01)	(0.063)
ρ	-0.131	-0.817	-0.345
	(0.582)[a b]	(<0.01)	(0.167)
N	683	629	413
log-likelihood[c]	-544.512	-541.225	-346.630

[a] Asymptotic two-sided p-value in parentheses
[b] Nonzero ρ is evidence of the endogeneity of remittances in the diversification equation.
[c] Each region is estimated separately using bivariate probit. Complete regression results are found in Table 6 below.

Table 5. Average treatment effects (ATE) computed based on two-stage least squares estimation of a linear probability model and bivariate probit for each region in Bolivia

	Altiplano		**Valles**		**Llanos**	
Estimator	ATE	SE[a,b]	ATE	SE	ATE	SE
2SLS	0.046	0.101	0.527	0.138***	0.395	0.212*[c]
Bivariate Probit	0.007	0.103	0.338	0.114***	0.265	0.137**

[a,] Standard errors for 2SLS computed based on HC3 and are robust with respect to heteroskedasticity.
[b] The standard errors for bivariate probit computed using the delta method.
[c] Significance: *0.1 **0.05 ***0.001

Table 6. Bivariate probit regressions for each region of Bolivia. Land and network wealth have been rescaled to units of $1000 and $10,000, respectively.

	Altiplano		Valles		Llanos	
Equation: Diversification	Coeff	SE	Coeff	SE	Coeff	SE
Remittances (yes=1)	0.027	0.410	1.000	0.218 ***	0.773	0.415 *
Constant	-0.125	0.304	-0.578	0.272 **	0.898	0.441 **
Head's Years Schooling	0.049	0.022 **	0.057	0.022 ***	0.058	0.027 **
Total Years Schooling	-0.016	0.027	-0.040	0.022 *	-0.087	0.026 ***
Years Schooling squared	0.005	0.002 **	0.005	0.002 ***	0.007	0.002 ***
Land	0.030	0.045	-0.005	0.020	-0.052	0.028 *
UPM=1 if HH=150	-1.104	0.215 ***	-0.575	0.188 ***	-1.936	0.393 ***
Wealth of Reference Group	0.230	0.086 ***	0.196	0.058 ***	0.119	0.057 **
Adult Males	0.078	0.116	-0.284	0.095 ***	0.052	0.101
Household Size	-0.121	0.086	0.166	0.066 **	0.195	0.080 **
Equation: Remittances						
Constant	-0.528	0.292 *	-0.577	0.307 *	-1.283	0.513 **
Head's Years Schooling	-0.084	0.024 ***	-0.113	0.027 ***	-0.074	0.041 *
Total Years Schooling	-0.014	0.031	0.001	0.026	-0.018	0.046
Years Schooling squared	0.003	0.003	0.001	0.002	0.002	0.004
Land	-0.076	0.132	0.014	0.024	0.004	0.006
UPM=1 if HH=150	-0.311	0.244	-0.629	0.227 ***	0.029	0.433
Wealth of Reference Group	0.070	0.100	-0.005	0.076	-0.005	0.089
Adult Males	-0.230	0.133 *	-0.075	0.111	-0.359	0.163 **
Household Size	-0.153	0.099	-0.140	0.087	0.032	0.138
Remittances of Reference Group	0.235	0.028 ***	0.300	0.029 ***	0.321	0.048 ***
Log-Likelihood	-544.512		-541.225		-346.631	
ρ and p-value of Ho: ρ=0	-0.131	0.583	-0.818	0.000 ***	-0.345	0.167 +

Significance: *0.1 **0.05 ***0.001

Table 7. Two-Stage Least Squares estimation of a linear probability model.

	Altiplano		Valles		Llanos	
	Coeff	HC3[b]	Coeff	HC3	Coeff	HC3
Remittances (yes=1)	0.046	0.101	0.527	0.138***	0.395	0.212*[a]
Constant	0.423	0.092***	0.208	0.115*	0.649	0.114***
Head's years schooling	0.017	0.006***	0.026	0.009***	0.022	0.010**
Total years schooling	-0.008	0.006	-0.009	0.007	-0.032	0.009***
Years schooling squared	0.002	0.001***	0.001	0.000**	0.002	0.001***
Land ($1000)	0.011	0.016	-0.003	0.009	-0.004	0.003
UPM=1 if HH=150	-0.343	0.066***	-0.217	0.066***	-0.563	0.065***
Wealth of UPM ($1000)	0.062	0.023***	0.072	0.023***	0.041	0.020**
Adult males	0.024	0.032	-0.079	0.037**	0.030	0.036
Household size	-0.023	0.021	0.056	0.024**	0.070	0.027***
Tests	Statistic	*p*-value	Statistic	*p*-value	Statistic	*p*-value
Hausman	0.770	0.380	33.168	0.000***	3.392	0.065*
Sargan	2.183	0.140	1.781	0.182	0.000	0.996
Weak instruments	38.804	>10[c]	50.215	>10	20.571	>10

[a] Significance: *0.1 **0.05 ***0.001
[b] Heteroskedasticity robust standard errors (HC3)
[c] $F > 10$ suggests strong instruments.

Table 8. The effect of receiving a remittance on the probability of earning nonfarm income in Bolivia, by region.

	Diversification yes=1		
	Altiplano	Valles	Llanos
Remittances Coefficient	0.690	0.557	1.06
yes = 1	(<0.01)[a]	(<0.01)	(<0.01)
ρ[b]	-0.529	(<0.01)	
N	1725		
log-likelihood	-1436.860		

[a] Asymptotic two-sided p-value in parentheses

[b] ρ is restricted to be equal across regions, but these restrictions are rejected at 5% based on a LR test.