Agricultural Risk and Remittances: The Case of Uganda

Stefanija Veljanoska*

Abstract

The economic literature showed that remittances could replace missing credit and insurance markets. As a result, it is natural to expect that higher amounts of remittances will motivate agricultural farmers to engage in riskier activities. The present study aims to verify the latter hypothesis by answering two distinct questions: do households that receive higher remittances choose to cultivate a riskier crop portfolio; do households that receive higher remittances choose to engage either in crop specialization or in crop diversification? I use the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) dataset on Uganda established by the World Bank to test these hypotheses. The results show that remittances have no significant impact on farmers' risk decisions in terms of crop portfolio and crop diversification. There is some evidence that credit constrained households that receive remittances engage in crop specialisation, which can be interpreted as a wealth effect.

JEL Classification: O13, O15, Q12

Keywords: agricultural risk, crop diversity, insurance, remittances, Uganda

*Paris School of Economics, C.E.S. - Université de Paris 1 Panthéon-Sorbonne; 106-112, Boulevard de l'Hôpital, 75647 Paris Cedex 13, France. Email: veljanoska.stefanija@gmail.com

1 Introduction

The stock of migrants in the world is 215.8 million people which represents about 3.2 percent of the total world population [World Bank, 2010]. The major part of these migrants comes from the developing world: 171.6 million international and local migrants [World Bank, 2013]. This trend is followed by an important increase in the amount of remittances sent to the developing countries which achieved a level of $401 billion in 2012 and provide a financial flow that is higher than the official development aid [World Bank, 2010]. It is expected that remittances in developing countries will grow even faster. Today the growth rate of remittances in developing countries is 5.3 percent and is expected to reach 8.8 percent during 2013-15. This phenomenon confirms the "New economics of labour migration" (NELM) assumption that the decision of a household member to migrate is taken collectively by the household and migrants keep interacting economically with their remaining family [Stark, 1991]. Given the size of these financial transfers, it is essential to study their effect on remaining households' decision making. Taking into account that the agricultural sector represents 17 percent of the African GDP and that 75 percent of the African population live in rural areas, investigating the impact of remittances on different agricultural outcomes and agricultural behaviour is crucial for understanding farm organization.

The NELM assumes that migration and remittances have the role to replace missing credit and insurance markets by generating informal risk-sharing strategies. The mechanism behind this hypothesis is the following: consider a household which sends a migrant away from his home such that the covariance of facing a negative shock of the remaining household and the migrant simultaneously is zero and thus diversifies the sources of income for both parts [Stark and Levhari, 1982]. In this sense, migration is considered to be an insurance strategy, as remittances will serve to absorb any negative shock of the remaining household and to smooth consumption. Yang and Choi [2007] and Gubert [2002] showed that households facing a negative crop income shock received higher amounts of remittances, but the received amount did not allow them to fully buffer the shock. Notwithstanding, it is intuitive to expect that better insured households (households with higher remittances) are those that will undertake riskier agricultural activities and will have less need to diversify their production. By riskier agricultural activity, I include the crop choice of the farmer in terms of risk and secialisation or diversification choices.

The first question that the present study seeks to answer is whether households that receive remittances increase the riskiness of their crop production by cultivating more crops with higher but uncertain revenue. Damon [2010] studies this question by estimating how basic grains acreage, coffee acreage and other cash crop acreage respond to remittances. She finds that this hypothesis is not supported by data from agricultural households in El Salvador as the land area dedicated to basic grains increases and the area dedicated to commercial cash crops decreases with remittances and migration. In an analysis on community-level data Gonzalez-Velosa [2011] finds that remittances reduce the proportion of farmers cultivating low income crops (corn, coconut) and increase the proportion of farmers cultivating high income crops (mango). Thus these two studies do not show a consensus. Instead of focusing only on a selected types of crops, the novelty of the present study is to construct a measure of riskiness of each crop cultivated by a given household and to evaluate how different crops contribute to the riskiness of the total crop portfolio by taking into account the interdependence that might exist at a farm level and afterwards to study its relation to remittances. In that way the research question can be reformulated as: does the riskiness of the crop portfolio of a household increase with remittances? To this end, I will use the Single Index Model (SIM) developed by Turvey [1991] and applied by Bezabih and Di Falco [2012] in order to construct the measure of the individual crop and portfolio riskiness.

Following the intuition that migration and remittances represent an alternative for missing credit and insurance markets, a second question arises: do households with higher amounts of remittances engage in crop specialisation or crop diversification? There are two possible answers. On the one hand, farmers that receive higher remittances might choose more specialized crop production as specialization is seen as a risk increasing strategy. In addition, as their income is spatially diversified, then there is less need to use crop diversification as an ex ante insurance. Gonzalez-Velosa [2011] shows that remittances increase the probability of specialization (by reducing the number of cultivated crops) in either high-risk crops or low-risk crops. Another possible mechanism is that as remittances increase household's wealth and households with higher wealth can deal more easily with risk, remittances induce crop specialisation as a consequence of this wealth effect. On the other hand, several studies showed that farmers in developing countries under-diversify their portfolio due to knowledge and financial barriers [Di Falco et al., 2007, Di Falco and Chavas, 2009] . In particular, remittances are seen as substitutes or complements to rural loans [Richter, 2008]. In other words, they can relax credit constraints directly by substituting them and indirectly by initiating a risk adverse household to take a loan that previously was not taken because of fear of losing the collateral. Therefore, it is possible that farmers can diversify more their crop production with the help of remittances. This paper seeks to answer this question by complementing the existing literature with other measures of diversification such as the Shannon index, the Simpson index and the Berger-Parker index which take into account the distribution of shares to each variety and not only the number of different crops [Baumgärtner, 2004].

In order to test for the impact of remittances on the agricultural outcomes discussed before (production riskiness and degree of crop diversification), I will use an Instrumental Variable approach (IV). Estimating this impact by Ordinary Least Squares (OLS) will yield biased results. The diversity indices (Inverse Simpson, Shannon and Berger-Parker index) are left-censored which requires a Tobit estimation model. Also, remittances are not random and depend on household characteristics. Thus, households that have migrants and receive remittances may differ from those households that have neither migrants nor remittances, which might be based on some unobservable characteristics of the household. At the same time, there might be some household unobservable characteristics that have a simultaneous impact on migration, remittances and agricultural decisions such as entrepreneurial spirit. I solve this issue by using an instrumental variable (IV) approach and using district level of migrants as instruments. The results show that remittances have no significant impact on farmers' risk decisions in terms of crop portfolio and crop diversification. However, there is some evidence that credit constrained households that receive remittances engage in crop specialisation, which can be interpreted as a wealth effect.

The answers to these questions have important policy implications. On the one hand, the economic literature state that African farmers choose low yield/low risk portfolios because of their negative past experience (weather shocks). This is mostly due to missing insurance and credit markets, but also absence of irrigation systems. It was shown that low yield portfolios are suboptimal, and taking more risk in the decision making can increase the efficiency of the household agricultural portfolio as farmers forgo more profitable opportunities for the sake of certainty [Mendola, 2008]. Farmers in developing countries choose low-risk portfolios and low-risk production technologies that result in low yields in order to avoid the damages of weather shocks that occur often. Therefore, the existence of insured risk makes households stuck in poverty traps, especially when households are obliged to avoid risk as this risk is linked to their subsistence needs. The consequences are amplified in the case of African farms when considering climate change. The African continent is the most vulnerable to climate change. Adaptation to climate change by cropping drought/flood resistant crops will make a pressure on farmers to engage in risk avoidance thus pushing them into poverty.

2 The Context

Uganda is a landlocked country situated in East Africa with about 34 million inhabitants. The Ugandan agricultural sector represents about 23 percent of its GDP a share that has declined in the last years [World Bank, 2011]. Still, the agricultural sector employs about 71 percent of the active population and covers about 70 percent (around 17 million ha) of the total area that is available for cultivation [FAOSTAT, 2011]. This confirms the importance of Ugandan agriculture for the country's economy. Ugandan agriculture is mostly rain-fed and it benefits from the number of lakes and rivers present in the country. Uganda's climate is tropical, generally rainy (particularly during the months of March to May and September to November), while the remaining months, from December to February and from June to August represent Uganda's two dry seasons.

2.1 The sample

I use data from the Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) established by the Bill and Melinda Gates Foundation and implemented by the Living Standards Measurement Study (LSMS) within the Development Research Group at the World Bank. The Uganda National Panel Survey (UNPS) sample includes economic and social information on about 3.200 households (with about 2000 households that are engaged in agriculture). These households were previously interviewed in the 2005/2006 Uganda National Household Survey (UNHS). The sample also includes households that were randomly selected after 2005/2006. This sample is representative at the national, urban/rural and main regional levels (North, East, West and Central regions). Afterwards, the initial sample was visited for two consecutive years (2009/10 and 2010/11).

2.2 The descriptive statistics

The surveys on the agricultural activities in the LSMS-ISA include information on the two separate cropping seasons: from January to June and from July to December. Interviewing households twice a year allows to reduce the recall bias that is due to poor household accountability. In order to better understand the crop choice patterns of the sample, I calculated the share of households cultivating a given crop (Table 1) and the average contribution of each crop to the total value of each household's production (Table 2). According to Table 1, the major cereal crops are maize, cassava, finger millet and sorghum; important vegetables and fruits are beans, groundnuts, sweet potatoes and food banana; the traditional cash crops are coffee and to some extent cotton and sugarcane. What we observe is that, on average, other crops than cash crops are (mostly) included in the household's portfolio even if their average contribution to the average production value is lower than that of cash crops. On the one hand, the average revenue coming from each of these (other than cash) crops constitutes less than one fourth of the total average agricultural revenue. On the other hand, households that cultivate a cash crop have a return from this cultivation that is more than a third of the total revenue. For example, about 75.2 percent of the households cultivated maize in the first wave of the survey (2005/2006) and the revenue coming from maize on average represents only 22.6 percent of the total. There is also about 1.8 percent of the households that cultivate tobacco, the revenue of which accounts for 39.3 percent of the average total household production income.

Given these average statistics on the crop choices in the sample, I proceed with construction of the different types of dependent variables based on what households crop, how they allocate inputs (land) and the kind of production technologies they use. Three different sets of dependent variables will be

Table 1: Share of Households cultivating:

Crop:	**2005-2006**	**2009-2010**	**2010-2011**
wheat	0.26	0.23	0.05
barley	0.04	/	/
millet	25.6	24.4	21.3
rice	4.8	4.5	5
maize	75.2	73.4	71.3
sorghum	28.2	28.7	22
beans	67	71.9	70
field peas	2.8	6.4	6
pigeon peas	4.6	5.8	4
chick peas	0.57	0.05	/
cow peas	4.3	1.7	1.5
ground nuts	30.5	33	32
soya beans	3.6	5.3	6.8
sunflower	2.9	3.4	5
simsim	9.5	11.7	10
cabbage	1.4	1.7	2
tomatoes	3.3	3.9	3.8
carrots	0.04	/	0.1
onions	1.1	1.2	1.3
pumpkins	1.5	2.2	3
dodo	0.5	0.9	1
eggplants	0.8	1.5	1
sugarcane	3.7	4.5	3.8
tobacco	1.8	2.3	1.6
Irish potatoes	6.9	6.2	6
sweet potatoes	54.1	58.4	58
cassava	62.4	68.8	71
yam	6	4.9	6.4
oranges	0.8	1.2	1.5
paw paw	2	0.8	1.5
pineapples	3.1	1.4	1.4
banana food	47.5	46.7	50
banana beer	16.2	8.7	11.2
banana sweet	10.4	6.2	7.8
mango	1.7	1.2	2
Jack fruit	3.2	1.5	3
avocado	3	1.9	3
passion fruit	1.2	0.5	0.6
coffee	27.6	25.3	27.5
cotton	9.4	2.5	4.2
cocoa	0.8	0.8	0.6
tea	0.3	0.19	0.2
vanilla	2.8	0.7	0.4
N	2282	2130	1979

Table 2: Average Crop Revenue Share

Crop:	**2005-2006**	**2009-2010**	**2010-2011**
wheat	6.8	2.5	0
barley	/	/	/
millet	13.8	12.75	16.35
rice	27	26.6	32.2
maize	22.6	25	19.7
sorghum	19.7	13.4	18
beans	17.5	19.7	22
field peas	11.5	18	14.35
cow peas	7.4	6.7	
pigeon peas	7.8	8.3	6.5
chick peas	8.9	9.3	5.6
ground nuts	18.15	13.5	17.5
soya beans	9.3	11	7.9
sunflower	15	16	22.7
simsim	17.3	18	22.9
cabbage	11.5	8.45	15.8
tomatoes	15.9	18.5	14,77
carrots	2.25	/	1.2
onions	18.4	9.45	7
pumpkins	6.3	10.2	3.4
dodo	3.7	11.4	12.8
eggplants	5.1	3.7	4.6
sugarcane	14.5	19	15.4
tobacco	39.3	39.4	40.2
Irish potatoes	13.8	13.5	11
sweet potatoes	20.2	16.4	15
cassava	19.5	15.8	17,6
yam	6.6	9	6.6
oranges	4.5	8	6.25
paw paw	3.2	9	6
pineapples	6.7	11.8	9.2
banana food	30.7	32.9	34
banana beer	7.4	11	7
banana sweet	4.1	5	5
mango	2.8	3.8	9
Jack fruit	5.6	5.3	4
avocado	2.9	11.7	3.3
passion fruit	13.8	14.8	21
coffee	17	16.8	17
cotton	19.8	22.7	26.5
cocoa	32.1	41	48
tea	21.8	21.7	40
ginger	0	26.9	0
vanilla	3.2	3	14.2
N	2282	2130	1979

used in the analysis. The first dependent variable is the weighted portfolio beta which is an average of each beta from a Single Index Model estimation for the crops cultivated by a given household. The construction of this variable is explained in detail in Section 3. The second set of dependent variables is constituted of different diversity indices that are borrowed from the ecological literature [Baumgärtner, 2004]. I limit my study to the interspecific aspect of diversity, including the diversity measures the different crops, but not the different varieties of a given crop. The diversity indices can be classified into three groups. The first category refers to the simplest measure of biodiversity named as richness index and it represents the total number of different species in the ecosystem. In the present study, this richness index represent the total number of crops cultivated by a household on its land. The richness index assumes an equal contribution of each crop to the household's crop diversity. However, one might argue that different crops should account differently for the degree of diversity. As a reaction, indices of absolute or relative abundance were developed in the literature. The second category of diversity index takes into account the dominance of certain species/crops over other. In particular, the Berger-Parger index (BP) takes into account the inverse weight of most abundant species/crop. According to this definition, the lower the share of the land dedicated to the most abundant crop, the higher of the value of the BP. The third group of diversity, Simpson index and Shanon index indices, include in their definition the richness and the evenness of crops. The evenness refers to level of equality of the abundance of different species/crops. Following to this, a higher value of these indices is due to a higher number of species but also a higher equality of the abundance of the different species. In the present study, the latter can be interpreted as equal land shares among different crops.

Tables 3, 4 and 5 describe the summary statistics of the dependent variables. I will comment on the statistics of the weighted portfolio beta once the construction of this variable is explained. The statistics on the richness measure shows that on average, households planted 4.92 crops in the period from 2009 to 2011. The average number of cultivated crops increased between the two periods from 4.77 to 5.1 (Table 4 and 5). Eighty percent of the households cultivated two to six crops and only three percent of the households cultivated only one crop with the median being five crops during the whole period. What can be noted is that other diversity variables are lower than the count index which indicates that land is not equally distributed to different crops. All the three indices are left-censored for households that cultivate one crop and their mean value increases from one year to the other. This increase can be due to the increase of the number of cultivated crops, but also from a more equal allocation among different crops.

Table 6 presents definitions and the summary statistics of the explanatory variables and the other control variables that will be used in the estimations. The main variable of interest is the level of remittances that a household receives from migrants. As discussed above, it is expected that remittances have a positive impact on the riskiness of crop portfolio but the impact on crop diversification is less

Table 3: Summary statistics: Dependent variable

Variable name	Mean	Standard Deviation	Min.	Max.
Risk variable				
weighted portfoliobeta	.285	.491	0	7.604
Interspecific diversity variables				
count index n	4.916	2.068	1	16
inverse Simpson	3.302	1.358	1	9.404
Shannon	1.258	0.446	0	2.304
Berger-Parker	2.372	0.875	1	6.792

Table 4: Summary statistics: Dependent variable wave 2009-2010

Variable name	Mean	Standard Deviation	Min.	Max.
Risk variable				
weighted portfolio beta	0.291	0.539	0	7.605
Interspecific diversity variables				
count index n	4.775	2.069	1	13
inverse Simpson	3.196	1.328	1	8.082
Shannon	1.22	0.454	0	2.269
Berger-Parker	2.313	0.849	1	6

Table 5: Summary statistics: Dependent variable wave 2010-2011

Variable name	Mean	Standard Deviation	Min.	Max.
Risk variable				
weighted portfolio beta	0.278	0.447	0	6.085
Interspecific diversity variables				
count index n	5.067	2.056	1	16
inverse Simpson	3.415	1.381	1	9.404
Shannon	1.299	0.435	0	2.304
Berger-Parker	2.435	0.899	1	6.792

evident. About thirty five percent of the households in the dataset reported to receive remittances locally or from abroad. The mean value of remittances is 107 363 Shs per household. About twenty two percent of the households have a migrant, a person that left the household for more then six months or left it permanently. The mean level of migrants is 0.38 per household. Among the households having migrants, on average there are 1.46 migrants per household.

Table 6: Summary statistics: Explanatory variables

Variable		**Mean**
Migration and Remittances		
migrants	migrants of the hh, locally or abroad *t-1*	.38
remittances	received by the hh from migrants locally or abroad in *t-1* (Shs)	107 363[1]
ditlevelmig	mean district level of migrants *t-1*	.58
ditlevelremit	mean district level of remittances *t-1* (Shs)	114 665[2]
Household characteristics		
sex	the gender of the hh head equals 1 if the hh head is male	0.711
age	the age of the hh head	46.95
education	the highest school level achieved by the hh head 1-primary, 2-secondary, 3-post secondary training, 4-higher studies	1.111
adults	hh member between 16 and 65 years	2.85
dep. ratio	the dependancy ratio of the hh	1.73
Wealth characteristics		
non agricultural income	income coming from non agricultural activities (Shs)	703 223[3]
assets	total assets in monetary value (Shs)	5 855 451[4]
constraint	credit/liquidity constraint dummy equals 1 if the household is constrained, 0 otherwise	0.496
Land characteristics		
land	agricultural land ownings in hectars	3.18
topography	Number of plots with different slope	1.241
soiltexture	Number of plots with different texture	1.1
soilquality	Number of plots with different quality	1.092
qualityindex	weighted index of soil quality with: level 1 being good quality and level 3 being poor quality	1.439

Controlling for socio-economic factors such as sex, age and education of the household's head is

[1]corresponds to 31.88 euros
[2]corresponds to 34.05 euros
[3]corresponds to 208.80 euros
[4]corresponds to 1738.60 euros

important as several studies showed that household heads with different gender, age and education level have different risk choices. It has been shown that older and female household heads choose lower risk activities [Bezabih and Di Falco, 2012]. Household heads with higher education may choose low risk activities as they might have more information on the negative consequences of taking risk. Also, the number of adults of the household and the land owning are included as they are the principle production factors and thus can impact the crop production decision making. The dependency ratio can also be a factor that influences the risk behaviour of households as the number of non working members can be a barrier to risk. Higher land owning might increase the possibility of diversification. Also, riskier crops can be labour intensive, thus labour will have a positive impact on the riskiness of the crop portfolio and eventually crop divesification.

Another important factor that concerns the risk taking of the household is its wealth. It is well known in the economic literature that richer households can smooth more easily their consumption when facing a negative shock than poorer households. Land owning and other assets (jewellery, houses, radio etc) are used to control for the effect that different levels of wealth can have on the risk behaviour of households. A variable that defines a dummy whether a household is credit/ liquidity constrained is included too. Such a constraint can be overcome by remittances, but also by another form of income diversification such as off-farm activities that is represented by a non-agricultural income. However, the covariance between the agricultural and non-agricultural income in the same location should be higher than the covariance of agricultural income and remittances from different places, thus remittances should offer higher insurance than non-agricultural income earned in the same location.

The previously described control variables are included when examining the impact of remittances on risk and diversification decisions and fertilizer use. In addition, the number of plots with different slope, quality and texture are included as a higher number of different plots might facilitate the diversification [Cavatassi et al., 2012]. A weighted index of land quality is included too in order to capture the fact that cultivating riskier crops might demand a higher quality of land. The land quality is measured by three different categories: 1 if good quality, 2 if medium quality and 3 if poor quality. These categories are multiplied by the weight of each parcel in the total cultivated land and then the weighted sum represents the quality index.

Household heads have on average 46.95 years, are mostly male (about seventy percent) and have on average attended only primary school. Only two percent of the households did not receive any education. The average number of adult members of the households is 2.85 and the average dependency ratio is 1.73, which means that for every adult worker there is 1.73 households memers of non working age. The average assets and nonagricultural income are higher than the average level of remittances which questions the strength of the role of remittances as insurance. About half of the households are credit constrained. As mentioned before, different types of parcels should initiate farmers to diversify as different land characteristics are compatible with different crop characteristics. On average, households possess 1.24 plots with different slopes, 1.1 plots with different qualities and 1.1 plots with different texture. The majority of the households (78.5 percent) has a one type of plot situated at a given altitude, one type of plot with a given quality (91 percent) and one type of plot with a given texture (90 percent). In conclusion, the studied sample has a poor diversity in terms of land type (quality, texture and slope).

3 The construction of the riskiness of a crop portfolio

The first estimation aims to study the effect of remittances on the riskiness of a crop portfolio and I will first concentrate on the construction of the crop production riskiness measure, the weighted portfolio beta. To do so, I will use the Single Index Model (SIM) applied by Turvey [1991] and also recently used by Bezabih and Di Falco [2012]. Unlike the Capital Asset Pricing Model (CAPM), SIM is not an equilibrium model and can be applied to any portfolio. This is an argument for the application of the SIM on African agriculture where markets are incomplete. The second step in the present paper is to examine whether or not there is an influence of the level of remittances on the portfolio beta, as well as the magnitude and the direction of this influence.

3.1 Construction of the Portfolio beta: Estimation of SIM

The Single Index Model assumes that the revenues associated with various farm enterprises are related through their covariance with some basic underlying factor or index. The risk correlated with this index is called non diversifiable or systematic index and the second risk component is the part of farm returns that is not correlated with the index, called specific risk that can be completely diversified.

The systematic risk can be determined by a reference portfolio defined as:

$$R_{pht} = \sum_{i=1}^{n} w_{iht} R_{iht} \qquad (1)$$

where w_{iht} refers to the land weights of crop i for household h in the time t and R_{iht} are the stochastic crop revenues. The choice of the reference portfolio depends on what is the most important single influence on returns. In the present case, there are two major groups of shocks that can influence agricultural returns: quantity shocks and price shocks. Thus, we can consider a household's weighted income as a reference portfolio as it is subject to all these shocks. More precisely, as a household's income depends on the household's growing conditions (weather, crop diseases, land characteristics) and prices for input factors and products.

The variance of the portfolio is given by the following expression:

$$\sigma^2_{pht} = \sum_{i=1}^{n} \sum_{j=1}^{n} w_{iht} w_{jht} \sigma_{ijht} \qquad (2)$$

where σ_{ijht} represents the crop variance and covariance relationships for the household h. According to this model, riskiness is based on the relationship between portfolio risk, the relative proportions of the crops held in the portfolio and the contribution of each crop to the portfolio variance. A change in the portfolio variance due to a change in the weight of the crop depends on the covariance between the crop and the portfolio returns:

$$\frac{\partial \sigma^2_{pht}}{\partial w_{iht}} = 2 \sum_{j=1}^{n} w_{jht} \sigma_{ijht} = 2\sigma_{ipht} \qquad (3)$$

A parameter that measures the anticipated response of a particular crop to the changes in portfolio returns needs to be estimated. This coefficient, β_i, is given by a panel regression of R_{iht} on the reference portfolio R_{pt}:

$$R_{iht} = \alpha_{it} + \beta_i R_{pht} + e_{iht} \qquad (4)$$

and by definition corresponds to $\beta_i = \frac{\sigma_{ipht}}{\sigma^2_{pht}}$ which means that β is a sufficient measure of marginal risk. The variance of the portfolio can be rewritten in terms of single index parameters as follows:

$$\sigma^2_{pht} = \left[\sum_{i=1}^{n} w_{iht} \beta_i\right]^2 \sigma^2_{pht} + \sum_{i=1}^{n} w^2_{it} \sigma^2_{eiht} \qquad (5)$$

where the first term in the equation (5) is the systematic risk and the second term is the specific risk. The terms $\sum_{i=1}^{n} w_{iht}\beta_i$ is called portfolio beta, and if we assume that the specific risk is completely diversified (is equal to 0) then $\sum_{i=1}^{n} w_{iht}\beta_i = 1$, which means that the portfolio beta for the reference portfolio equals 1. Once an appropriate reference portfolio has been identified, the systematic risk of any other portfolio can be measured relative to 1. For example, if $\sum_{i=1}^{n} w_{iht}\beta_i$ is greater than 1, it has more systematic risk than the reference portfolio.

Beta coefficients are estimated with the equation (4) by using Panel fixed effect model in order to account for the unobservable household factors that can influence each crop revenue. Once the beta coefficients are estimated we can calculate the portfolio beta as the average of all betas of the crops that are cultivated by the household.

Table 7 gives the estimates of different crop beta coefficients. We can interpret these coefficients in the following way: if we take, for example, cotton and maize, we observe that an increase in the

Table 7: Estimation results : Beta Coefficients

Crop	**Coefficient**	**Crop**	**Coefficient**
sweet potatoes	0	tobaco	5.25
rice	.03	irish potatoes	1.05
maize	0	cassava	0
millet	0	yam	.13
sorghum	.22	dodo	.001
beans	.25	oranges	.63
field peas	2.00	paw paw	.025
banana	.70	pineapples	.52
banana sweet	.14	sunflower	2.00
banana beer	.10	pigeon peas	.08
ground nuts	.12	cotton	1.22
soya beans	.11	mango	.43
vanilla	0	jackfruit	.2
simsim	.50	avocado	.36
cabbage	2.31	passion fruit	3.69
tomatos	.50	coffee	.15
eggplants	.04	cocoa	3.23
onions	-.13	tea	.78
pumpkins	0	sugarcane	7.96

reference portfolio of 1 Shs will induce a more than proportional increase of the cotton revenue of 1.21 Shs and no increase in the maize revenue. These estimates indicate that cotton is riskier than maize as it is more sensible to the variation of the reference portfolio revenue than maize. In general, most of the coefficients are consistent with the agricultural and economic literature on riskiness of crops.

The portfolio beta represents the weighted average of the betas of each crop cultivated by a given household. According to Table 3 the mean risk of crop portfolio in this dataset is relatively low 0.287, with a minimum of 0 which means that the given portfolio does not react to the movements of the reference portfolio and a maximum of 2.73 which means that an increase of 1 ShS in the reference portfolio provokes an increase of 2.73 Shs in the given portfolio.

4 The identification strategy

In this section, the econometric specification and the different estimation methods that are used to study the impact of remittances on the different outcome variables are discussed. First, I proceed by defining the general equation to estimate, which is the same for the three dependent variables. Second, according to the character of each dependent variable, different estimation methods are considered. I also propose possible solutions to the endogeneity problems generated from the econometric specification.

4.1 Econometric specification

In order to study the impact of remittances on the riskiness of the farmer's crop portfolio, crop diversity and fertilizer adoption, I use the following equation:

$$A_{ht} = \gamma X_{ht} + \delta R_{ht-1} + \mu_h + \eta_t + \kappa_r + \varepsilon_{ht} \qquad (6)$$

where A_{ht} stands for the agricultural outcome variables : the portfolio beta, the diversity indices and a dummy whether a household uses fertilizer or not. X_{ht} represents household characteristics such as the gender, the age and the level of education of the household head, the number of members net of migration, the size of the land of the household h in the time t. When using the different diversity indices as dependent variable, I add the number of parcels with different texture, slope and quality as this might increase the feasibility of diversification. X_{ht} also includes different indicators describing the wealth of a given household as wealth can be used as another tool of consumption smoothing.

Concerning the variable of interest, I use a lagged value of the level of remittances R_{ht-1} received by the household h following the assumption that households would make a decision on agricultural risk taking and crop diversification in the period t once it received the remittances in the previous period $t-1$. Households, time and regional fixed effects are also taken into account in the equation (6). Controling for regional effects is important in this study as regions might differ considerably in the weather conditions, soil characteristics, the access to infrastructure etc. In the case of Uganda, the majority of the country is exposed to two cropping and rainy seasons except the North of the country where there is only one rainy seasson and the quality of the land is moderate to poor. In this mostly flat region, farmers engage more in pastoral activities and to some lower extent in production of drought resistant crops. The central-southern region is the most productive one in terms of crop production. It benefits from the access to the Lake Victoria and better infrastructure. I take this region as a reference region and test how individual agricultural decisions vary across the regions.

4.2 The estimation method(s)

Estimating equation (6) by Ordinary Least Squares (OLS) will yield biased results. There are problems of endogeneity which occur from the OLS estimation when studying the effect of remittances on different agricultural decisions. First, remittances are not random and depend on household characteristics. Thus, households that have migrants and receive remittances may differ from those households that neither have migrants nor remittances which might be linked to some unobservablecharacteristics of the household. Second, there might be some household unobservable characteristics that have a simultaneous impact on migration, remittances and agricultural decisions such as entrepreneurial spirit. Other studies have solved the second endogeneity problem by using an instrumental variable (IV) approach. A good instrument is a variable that is correlated with the explanatory variable and uncorrelated with the outcome variable. An instrumental variable influences the outcome variable only through the explanatory variable. The choice of the instrumental variable is constrained by the availability of the data and the outcome of interest. Several authors used the distance to the borders or the consulate to instrument the outcomes of migrants in the receiving country [McKenzie et al., 2010]. Some authors used also natural shocks such as rainfall intensity [Munshi, 2003, Yang and Choi, 2007] to instrument migration when studying outcomes abroad and others used economic shocks such as depreciations of different currencies to instrument migration [Yang et al., 2007, Yang, 2008], or unemployment rates and GDP shocks in the receiving countries [Damon, 2010, Gonzalez-Velosa, 2011]. Also cultural, historical, community and political factors can be used as instrumental variables such as the historical migration rate in a given village, or migration networks in the receiving countries [McKenzie, 2005, Acosta, 2006].

What we can conclude from the previous discussion is that when the outcome of interest is connected with the remaining household, the instrument used for remittances and migration is a variable "coming from" the migrant receiving economy. In contrast, when the outcome of interest is for example the earnings of the migrant, then the instrumental variable is connected with the origin economy. Both cases satisfy the criteria that the instrumental variable should be exogenous to the outcome variable. Historical migration rates and migration networks satisfy this criteria too.

Unfortunately these kinds of instruments cannot be used in the present study because of the incompleteness of the data. For external migration, the destination of the migrant is not included in the data, thus instruments connected with the receiving economies cannot be used. Currencies in which remittances from abroad are received not included either. Also, as migration is mostly internal, we should use a local instrumental variable that is correlated with remittances and uncorrelated with agricultural risk. We are only left with community based variables, such as the average level of remittances and migrants on district level. The first stage estimation equation of remittances can be written as:

$$R_{ht-1} = \gamma Z_{ht} + \delta M_{dht-1} + \mu_h + \eta_{t-1} + \kappa_r + \varepsilon_{ht-1} \qquad (7)$$

where R_{ht-1} stands for the level of remittances received by the household h in the period $t-1$. Z_{ht} represents the household characteristics such as households head gender, age and level of education, as in the equation (6) and as before there are household, time and regional effects. Acosta [2006] uses as instrument for remittances some village level characteristics, such as the propensity of migration.

It is expected that individual remittances increase with district level of migration. As migration is a prior condition for receving remittances, districts with higher level of remittances are those that have higher level of migrants. The district level of migrants is represented by the variable M_{dht-1} where d referes to the district where the households h lived in time $t-1$. Equation (7) will be estimated using a Tobit model, as remittances are observed only for a third of the sample. A linear prediction of R_{ht-1} is introduced in the second stage of the estimation, equation 6.

The third endogeneity problem is reverse causality which may also exist if households that are prone to risk taking send a migrant once they have made their agricultural decision and expect remittances in return. The latter case of endogeneity is avoided as the lagged value of remittances is used in the equation (6).

Another technical problem arises in this case as the diversity indices (Inverse Simpson, Shannon and Berger-Parker index), and to some extent the portfolio beta, are left-censored. This requires a Tobit which is a censoring model applied to the linear model with normal residuals. Once again, using OLS estimation for a censored outcome variable will lead to biased results. Also the count index n is categorical variable that takes limited number of values. The Poisson estimation model deals with this kind of dependent variables. The nonlinearity of the different models does not allow the use of fixed effects. The number of censored observations in the sample is around three percent. Using a panel model can also be appropriate as it allows to purge the unobservable time invariable household characteristics.

5 The Results

The First Stage regression (Table 8) confirms that the district average level of migrants has a positive and significant impact on the level of remittances received by households. The magnitude of the result is similar for both: the first stage estimation of remittances used as explanatory variable in the risk portfolio beta estimation and the first stage estimation of remittances used as explanatory variable in the diversity indices estimation. Table 9 shows the marginal effects for remittances for an average household. On average, an increase of the district (to which an average household h belongs) mean level of migrants by one additional migrant of the district mean of migrants increases the level of remittances by 178 300 Shs. [5] This result is significant at one percent level which gives insights about the validity of the instrument. A Durbin–Wu–Hausman test is done in order to test endogeneity of remittances, which verifies whether it is necessay to use an IV strategy or simple Panel estimation is consistent. The results show that using Panel estimation is not consistent in the case of diversity indices, but

[5] the level of remittances is scaled in order to have a better interpretation of the results; each variable is divided by 10 000 Shs.

however we can use the panel estimation results when considering the portfolio beta estimation.

5.1 The impact of remittances on interspecific crop diversification

The regression results for equation (6) are in Table 10. The Tobit-IV and Panel-IV results show that the level of remittances influences negatively the level of richness and evenness of different crops cultivated by the farmers, but this result is insignificant. However, we observe for the three categories od diversity indices that an interaction variable composed of the binary variable credit constraint and the level of predicted remittances has a negative impact on these diversity indices. Receiving 10000 Shs remittances for households that are credit constraint lowers the level of richness by 0.004 crops at significant level of 10 percent (Tabel 13), the level of relative abundance by 0.004 points (Table 12, Inverse Simpson index) and absolute abundance of different crops by 0.003 (Tabel 13, Berger-Parker index). In other words, remittances push credit-constrained farmers into crop specialisation, thus can be considered as risk-increasing strategy. This can be interpreted as a wealth effect of remittances that encourages constrained farmers to engage in crop specialisation.

There are few socio-economic factors that influence the household's decision in terms of crop diversification. First, I observe that an increase of the land size of 1 ha decreases the relative abundance of crops by 0.01 points at significance level of 1 percent. The interpretation of this result might be linked to an existence of economies of scale on farm crop cultivation of the sample. This result is also confirmed by the Berger-Parker index estimation, an increase of land of 1 ha increases the weight of the most cultivated crop at significance level of 1 percent. As expected, land size as production factor seems to have an important influence on crop management decisions regardless of the estimation strategy. Second, if we consider the Panel FE estimation, higher number of plots with different soil texture, that a farmer owns, reduces the relative and absolute abundance of by 0.18 and 0.09 points, which is opposite of what was expected initially. If we compare the different indices that include weights in their computation to the count index, we observe that both categories are influenced by different factors in the panel/poisson analysis. The number of adults of the household that is a proxy for labour endowment of the household influences positively the number of crops, but not the diversity measurements that include weights.

If we consider the tobit estimation on the different indices, we observe that higher labour endowment and higher dependency ratio are influencing positively the predicted value of richness, evenness and absolute abundance of crops, which goes in line with the intuition. There is no diversity decision difference between male and female household's head. More educated household's heads engage in higher crop diversity as they might have more knowledge about the benefits of diversification and consequences of crop specialisation. Finally, farmers with higher number of plots with different slopes have higher predicted value of relative and absolute abundance. It is important to note that all these factors are no longer significant in the panel FE analysis, as they might be correlated with the individual effect.

The cropping season categorical variable(s) indicates that households for which we have observations only for the 1st or 2nd cropping period have a lower level of crop diversity (from every aspect) than households for which we have observations for both cropping seasons, although the dependent variable is based on an average of the two seasons. An intuitive result concerning regions is that, households coming from the Northern, Eastern and Western regions of Uganda have lower predicted degree of diversity compared to the Central (Southern) region where the capital city belongs, as the rainfall and land pattern are such that lower number of crops are cultivated in these regions especially in the North where pastoral activities are the most common and where the lands are of poor quality; also the rainfall level is lower and there is a lack of infrastructure compared to the Central region.

5.2 The impact of remittances on the riskiness of the crop portfolio

The results of the model studying the relationship between the riskiness of a crop portfolio and remittances are less significant than the previous results. Remittances have a positive but statistically insignificant effect on the level of the portfolio beta (we will focuse on Table 13 as the DWH test states that there remittances are exogenous enough). According to the panel fixed effect estimation, having a household's head that is male inceases the risk index by 0.142 points than having a female household's head. Also, a household head that has primary education has a risk portfolio index that is 0.0721 lower than household with a head that does not have any education. This result seems coherent with the initial intuition, as we expect that more educated members of the households should be more aware of the consequences of undertaking more risky activities.

Considering the tobit estimation that allow for regional effects, we observe similar significant regional results as in the case of the diversity indices. In the Northern and Eastern region, households cultivate less crops and lower-risk drought resistant crops then in the Central region. More precisely, a household that lives in the Northern region has a predicted value of the portfolio beta that is 0.1 points lower than a household in the Central region. Another intuitive result coming from the tobit estimation model is that the level of land ownings increases the predicted level of the portfolio beta which goes in line with the assumption that wealthier households are able to better smooth consumption or income shocks and thus they are better placed when undertaking higher risk/higher income activities. If we compare the results to the previous section, we observe that increase of land ownings increase riskiness in terms of crop choice and crop specialisation. Once again, we can more be confident about the panel estimation as the tobit estimation do not deal with unobserved heterogeneity and the number of censored observations is under three percent. In the Panel estimation, suprisingly we do not find other significant factors that influence the risk prortfolio. In the next section, we disscuss the possible explanation of this case.

6 Conclusion

In order to sum up the different results, I relay on the Panel (IV) estimation regarding the diversity indices as it purges the "unobservable" household characteristic and there very few censored observations, eventough by definition a Tobit estimation should be used. The main significant findings in the present study are that remittances alone do no have a significant impact neither on risk choices nor on crop diversification. This result is probably a matter of the low amount of remittances that households receive. However, when remittances are interacted with credit status of the household, crop specialisation is more observed for credit constrained households. This can be interpreted as a wealth effect for the constrained households, which was not found in the literature. The major question that arises is to discover whether households engages in low-risk crop specialisation or high-risk crop specialisation. By running a simple correlation between the riskiness of crop portfolio and the diversity indices, I find a positive but week correlation (0.05), thus no conclusions can be made and the questions stays open for further analysis. Also, migration and remittances can be seen as a risky strategy as the outcomes from these kinds of income diversification are not certain. Including the degree of certainty of remittances can give some new insights.

An additional result is that different production factors (labour and land) do affect separately the number and the weight of crops. Labour seems to be significant for the household's choice if the number of crops and land size seems to be a key factor for the distribution of weights among different crops. I find significant difference crop choices in terms of risk between male and female heads of households. There is also some evidence that head of households that have primary education have lower-risk decisions compared to non-educated household heads. However this is no longer true for higher levels of education.

Concerning the insignificance of different factors for the risk crop choices, limited variability of the portfolio beta variable may be an explanation for two reasons. The first reason is that the individual crop riskiness is not time varying so if a household that cultivates the same crops in the two periods and if the weights of these crops do not change significantly, then the portfolio beta will not differ between the periods. The second reason is that the two waves in this analysis are consecutive, thus we cannot expect that farmers easily make different decisions on what to crop. Since making different crop decisions may take time, the invariability of the dependent variable may be due to the consecutiveness of the waves and the invariability of the crop risk measure. A dataset that includes higher number of periods in the surveys or a longer gap between the periods will be more suitable to analyse the portfolio beta.

As the results of the impact of remittances on the riskiness of the crop choice are not significant, we cannot conclude that remittances help farmers to undertake riskier activities that yield higher incomes and help them to avoid or escape poverty traps. The only result(s) that we can discus is that remittances lead to crop specialization for credit constrained households. On the one hand, Ugandan agriculture is mostly rain-fed and relying only on one low-risk crop can lead farmers into a poverty trap. Instead, higher diversity in crops that have different resistance to weather shocks should be a better solution when adapting to irregular weather conditions. This strategy seems more appropriate when dealing with the consequences of climate change. On the other hand, crop specialization can yield economics of scale. A cost/benefit study on whether crop diversification or crop specialization in riskier crops is the most beneficial can be done by agro ecological zone in future research in order to evaluate if remittances contribute to undertake the right strategy. Also the analysis can be extended to interspecific diversity, by using different crop varieties that can have different impact on risk behaviour.

Table 8: Tobit First Stage Estimation

VARIABLES	Porfolio Beta	Diversity indices
Mean district level of migrants	21.88***	21.83***
	(8.049)	(8.049)
land	0.00441	-0.00392
	(0.149)	(0.150)
adults	3.517***	3.466***
	(0.900)	(0.901)
dep ratio	1.181	1.159
	(1.116)	(1.116)
male hh head	-55.99***	-56.19***
	(3.446)	(3.451)
age	0.961***	0.969***
	(0.104)	(0.104)
primary education	18.36***	18.40***
	(4.069)	(4.069)
secondary education	30.96***	30.92***
	(5.741)	(5.741)
post secondary training	34.71***	34.74***
	(6.061)	(6.062)
higher education	110.5***	110.7***
	(14.08)	(14.09)
1st cropping season	-2.962	-2.924
	(3.769)	(3.771)
2nd cropping season	1.926	1.925
	(4.316)	(4.316)
Eastern region	-7.471*	-7.424*
	(4.248)	(4.248)
Northen region	-8.853**	-9.077**
	(4.349)	(4.356)
Westren region	-32.88***	-33.43***
	(4.773)	(4.799)
non agricultural income	1.23e-07	1.15e-07
	(2.09e-07)	(2.09e-07)
assets	1.83e-07***	1.83e-07***
	(2.98e-08)	(2.98e-08)
credit constraint	-0.132	0.0217
	(3.019)	(3.020)
soil quality index	3.304	3.254
	(2.634)	(2.634)
number of plots with different texture		0.970
		(4.685)
number of plots with different slope		3.809
		(3.165)
Constant	-74.23***	-79.98***
	(9.677)	(11.09)
Number of hhid	1,849	1,849

Table 9: Tobit First Stage Marginal Effects

VARIABLES	Portfolio Beta	Diversity indices
Mean district level of migrants	17.83**	17.73**
	(7.941)	(7.941)
adults	3.150***	3.097***
	(0.903)	(0.904)
dep. ratio	1.318	1.288
	(1.121)	(1.122)
male hh head	-56.07***	-56.22***
	(3.412)	(3.417)
age	0.957***	0.964***
	(0.103)	(0.103)
education	14.39***	14.38***
	(1.793)	(1.794)
cropping season	-0.269	-0.255
	(2.023)	(2.023)
region	-9.709***	-9.867***
	(1.491)	(1.499)
non agricultural income	9.52e-08	8.90e-08
	(2.10e-07)	(2.10e-07)
assets	1.94e-07***	1.93e-07***
	(2.99e-08)	(2.99e-08)
credit constraint	-0.468	-0.307
	(3.011)	(3.013)
soil quality index	2.862	2.809
	(2.643)	(2.643)
number of plots with different slope		3.082
		(3.171)
number of plots with different texture		2.400
		(4.693)
Constant	-41.52***	-47.56***
	(9.966)	(11.19)
Number of hhid	2,252	2,252

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Second stage: Estimating the effect of relative abundance

	Inverse Simpson Index		Shannon Index	
VARIABLES	IV panel FE	IV Tobit	IV panel FE	IV Tobit
remittances	-0.00348	-0.00785	-5.57e-05	-0.00234
	(0.00974)	(0.00547)	(0.00281)	(0.00169))
credit constraint*remittances	-0.00401**	-3.11e-05	-0.00113**	5.27e-05
	(0.00176)	(0.00121)	(0.000565)	(0.000372)
land	-0.0127***	-0.00772***	-0.00394***	-0.00226***
	(0.00381)	(0.00218)	(0.00117)	(0.000671)
adults	0.00653	0.0754***	0.0171	0.0298***
	(0.0560)	(0.0255)	(0.0171)	(0.00788)
dep. Ratio	0.0193	0.0591***	0.00423	0.0196***
	(0.0421)	(0.0204)	(0.0124)	(0.00635)
male hh head	-0.310	-0.447	-0.0383	-0.132
	(0.615)	(0.313)	(0.185)	(0.0964)
age of hh head	0.00336	0.0155***	0.00132	0.00490***
	(0.0130)	(0.00561)	(0.00335)	(0.00173)
primary education	0.288	0.373***	0.0673	0.121***
	(0.247)	(0.120)	(0.0728)	(0.0371)
secondary education	0.337	0.503**	0.0738	0.171***
	(0.375)	(0.196)	(0.110)	(0.0604)
post secondary training	0.597	0.621***	0.125	0.185***
	(0.417)	(0.215)	(0.127)	(0.0663)
higher education	2.019	1.107*	0.387	0.257
	(1.328)	(0.668)	(0.400)	(0.206)
fisrst cropping season	-0.684***	-0.787***	-0.255***	-0.305***
	(0.0724)	(0.0579)	(0.0236)	(0.0178)
second cropping season	-0.530***	-0.752***	-0.238***	-0.305***
	(0.0954)	(0.0641)	(0.0292)	(0.0196)
Eastern region		-0.325***		-0.109***
		(0.0871)		(0.0271)
Northen region		-0.496***		-0.141***
		(0.0972)		(0.0302)
Western region		-0.400*		-0.124*
		(0.206)		(0.0636)
non agricultural income	8.62e-09	-1.13e-08	3.76e-09	-4.31e-09
	(9.96e-09)	(9.28e-09)	(4.65e-09)	(2.85e-09)
assets	3.37e-09	6.35e-10	1.02e-09*	2.92e-10
	(2.03e-09)	(1.33e-09)	(6.05e-10)	(4.10e-10)
credit constraint	-0.117	0.0139	-0.0383	0.00776
	(0.105)	(0.0690)	(0.0335)	(0.0212)
soil quality index	0.00755	-0.0238	-0.0188	-0.0127
	(0.0577)	(0.0429))	(0.0165)	(0.0132)
number of plots with different texture	-0.187**	-0.111	-0.0604**	-0.0263
	(0.0870)	(0.0687)	(0.0255)	(0.0211)
number of plots with different slope	0.0949	0.113**	0.0203	0.0515***
	(0.0750)	(0.0508)	(0.0220)	(0.0157)
Constant	3.174***	2.517***	1.264***	0.994***
	(0.943)	(0.439)	(0.135)	(0.00929)
Durbin–Wu–Hausman test (pvalue)	0.045	0.012	0.067	0.011
R-squared	0.096		0.138	
Number of hhid	1,849	1,849	1,849	1,849

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 11: Second stage: Estimating the effect of richness and absolute abundance

	Count Index		Berger Parker Index	
VARIABLES	IV Panel FE	IV Poisson FE	IV panel FE	IV Tobit
remittances	-0.00357	-0.000232	-0.00285	-0.00593
	(0.00998)	(0.00327)	(0.00538)	(0.00363)
credit constraint*remittances	-0.00399*	-0.000820	-0.00332***	-0.000204
	(0.00207)	(0.000669)	(0.00111)	(0.000807)
land	-0.00349	-0.000497	-0.00862***	-0.00582***
	(0.00406)	(0.00123)	(0.00219)	(0.00146)
adults	0.258***	0.0474*	-0.0287	0.0374**
	(0.0810)	(0.0260)	(0.0437)	(0.0167)
dep. ratio	0.0644	0.00975	-0.00222	0.0299**
	(0.0570)	(0.0186)	(0.0308)	(0.0133)
male hh head	-0.414	-0.0657	-0.228	-0.359*
	(0.616)	(0.203)	(0.333)	(0.207)
age hh head	0.0196	0.00347	0.00153	0.00951**
	(0.0140)	(0.00456)	(0.00757)	(0.00371)
primary education	0.450*	0.0783	0.202	0.225***
	(0.258)	(0.0845)	(0.139)	(0.0793)
secondary education	0.541	0.0991	0.205	0.303**
	(0.432)	(0.142)	(0.233)	(0.129)
post secondary training	0.526	0.0857	0.359	0.378***
	(0.467)	(0.155)	(0.252)	(0.142)
higher education	0.845	0.128	1.569**	0.856*
	(1.410)	(0.490)	(0.761)	(0.441))
first cropping season	-1.067***	-0.225***	-0.382***	-0.404***
	(0.0990)	(0.0333)	(0.0534)	(0.0386)
second cropping season	-1.141***	-0.239***	-0.256***	-0.390***
	(0.103)	(0.0343)	(0.0554)	(0.0430)
Eastern Region				-0.168***
				(0.0562))
Northen region				-0.325***
				(0.0631)
Western region				-0.277**
				(0.136)
non agricultural income	3.39e-08**	7.81e-09	1.21e-10	-6.28e-09
	(1.67e-08)	(5.67e-09)	(8.99e-09)	(6.16e-09)
assets	4.61e-09*	8.38e-10	2.75e-09*	8.04e-10
	(2.68e-09)	(8.69e-10)	(1.45e-09)	(8.76e-10)
credit constraint	-0.0971	-0.0182	-0.116*	0.00811
	(0.117)	(0.0375)	(0.0633)	(0.0461)
soil quality index	-0.0671	-0.0166	0.0159	-0.0143
	(0.0733)	(0.0236)	(0.0396)	(0.0287)
number of plots with different texture	-0.0969	-0.0211	-0.120**	-0.0896*
	(0.109)	(0.0341)	(0.0588)	(0.0462)
number of plots with different slope	0.0782	0.0119	0.0759	0.0600*
	(0.0909)	(0.0292)	(0.0490)	(0.0338)
Constant	3.438***		2.367***	1.952***
	(1.081)		(0.584)	(0.290)
Durbin–Wu–Hausman test (pvalue)	0.121	0.111	0.051	0.008
R-squared	0.135		0.070	
Number of hhid	1,849	1,688	1,849	1,849

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Second stage: Portfolio Beta

VARIABLES	IV Panel FE	IV Tobit
remittances	-0.000560	-0.000801
	(0.00243)	(0.00179)
credit constraint*remittances	-1.25e-06	-2.63e-05
	(0.000319)	(0.000386)
land	0.000824	0.00133*
	(0.00160)	(0.000707)
adults	0.0189	0.00389
	(0.0185)	(0.00906)
dep. ratio	0.00648	-0.000389
	(0.0110)	(0.00743)
male hh head	0.111	0.0236
	(0.172)	(0.103)
age	0.00185	-0.000253
	(0.00283)	(0.00187)
primary education	-0.0634	-0.0554
	(0.0818)	(0.0407)
secondary education	0.0184	-0.0211
	(0.110)	(0.0663)
post secondary training	0.00412	0.0226
	(0.136)	(0.0724)
higher education	0.0862	-0.0195
	(0.319)	(0.224)
1st cropping season	-0.0302	-0.0152
	(0.0243)	(0.0185)
second cropping season	-0.0322	-0.0431**
	(0.0259)	(0.0200)
Eastern region		-0.131***
		(0.0339)
Northen region		-0.100***
		(0.0363)
Wester region		0.0477
		(0.0691)
non agricultural income	-4.33e-10	-2.05e-09
	(1.71e-09)	(3.01e-09)
assets	5.04e-10	4.33e-10
	(6.04e-10)	(4.48e-10)
credit constraint	0.000377	0.00611
	(0.0125)	(0.0220)
quality index	0.00478	0.0118
Constant	0.0705	0.311**
	(0.240)	(0.135))
Durbin–Wu–Hausman test (pvalue)	0.900	0.121
R-squared	0.013	
Number of hhid	1,849	1,849

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Estimation Portfolio Beta

VARIABLES	Panel FE	Tobit
Remittances	0.000106	1.29e-05
	(0.000306)	(0.000238)
credit constraint*remittances	-0.000358	-0.000138
	(0.000407)	(0.000323)
land	0.000820	0.00120*
	(0.000883)	(0.000695)
adults	0.0182	0.00706
	(0.0156)	(0.00581)
dep. ratio	0.00615	0.000368
	(0.0120)	(0.00661)
male hh head	0.142***	0.0594***
	(0.0549)	(0.0217)
age	0.00127	-0.000932
	(0.00216)	(0.000655)
primary education	-0.0721*	-0.0690***
	(0.0399)	(0.0231)
secondary education	0.00367	-0.0372
	(0.0643)	(0.0331)
post secondary training education	-0.0134	-0.0209
	(0.0678)	(0.0347)
higher education	0.0273	-0.118
	(0.182)	(0.0932)
1st cropping season	-0.0289	-0.0201
	(0.0209)	(0.0173)
2nd cropping subwave	-0.0328	-0.0553***
	(0.0220)	(0.0192)
Eastern region	0	-0.103***
	(0)	(0.0282)
Northen region	0	-0.0805***
	(0)	(0.0293)
Western region	0	0.0875***
	(0)	(0.0293)
nonagricultural income	-6.11e-10	-1.38e-09
	(3.61e-09)	(1.32e-09)
assets	4.06e-10	1.66e-10
	(4.13e-10)	(1.98e-10)
credit constraint	0.00409	0.0142
	(0.0168)	(0.0142)
Constant	0.112	0.346***
	(0.129)	(0.0515)
R-squared	0.013	
Number of hhid	1,849	1,849

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

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