The Effect of Remittances on Sorghum Production

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Abstract

The large increase in remittances from migrants has generated optimism about the potential development benefits of these capital flows in rural communities where capital market failures are prevalent. This paper examines the causal effect of remittances on sorghum production by using the 2014 Living Standards Measurement Study (LSMS) dataset on Burkina Faso. We use a Bayesian instrumental variables approach to explore several specific pathways. The results show that land size, the number of workers and the quantity of herbicide used are the factors that significantly improve sorghum production in Burkina Faso. We also find that a 1% increase in the amount of remittances leads to a 0.938% decrease in production of sorghum. We suggest that public policies aimed at improving agricultural productivity will be more effective if there is a remittance use scheme in place, along with the transparency of decision-making concerning land allocation.

JEL Classification: O13, O15, Q12.

Keywords: Remittances, Land, Sorghum Production.

1. Introduction

Agriculture is important for sustainable development, poverty reduction and enhanced food security in Sub-Saharan African countries. It is also an important source of income, employment, and raw materials for small and medium industries (Kaninda et al., 2014). However, agricultural productivity in this region has continued to decline over the last decades and poverty levels have increased (Doss, 2006; Ouma and De Groote, 2011). In Burkina Faso, poverty has worsened consistently over the past two decades despite the antipoverty measures implemented by the Government and international development agencies. Over 43.7% of the Burkina Faso population in 2014 was estimated to live below the poverty line (World Bank, 2014).

The lack of rural financial markets has been one of the major constraints in improving agricultural productivity in developing countries (Dercon and Christiaensen, 2011; Dupas and Robinson, 2013; Mo et al., 2011; Ouma and De Groote, 2011; Suri, 2011). The provision of micro-credit is generally perceived as an effective way to promote the adoption of improved technologies and boost agricultural productivity in developing countries (Simtowe and Zeller, 2006). However, agricultural subsidy programmes implemented by many governments in the late 1960s and early 1970s, the creation and the promotion of microfinance institutions since the 1980s, and other financial services programmes to boost agricultural and rural activities have failed or shown their limits (Adams and Vogel, 1984; Andrews, 2006; Nagarajan et al., 2005; Zeller, 2003). As a result, the provision of financial services to the rural poor remains a challenge in Sub-Saharan African countries in general and Burkina Faso in particular.

The lack of formal financial institutions has led poor households in developing countries to rely on informal credit markets, family members and friends to increase their productive capacities, share risks and smoothen their consumption over their life cycle (Diagne et al., 2000). In addition, many households have been relying on migration and remittances as a source of revenue and diversification, and a way to protect themselves against credit and insurance market imperfection (Kaninda and Fonsah, 2014). International remittances constitute the second largest source of external finance[2] and represent almost two times the official foreign aid to developing countries (Bettin and Zazzaro, 2012; De Haas, 2009).

Remittances are viewed by the New Economics of Labour Migration (NELM) theory as a substitute for formal or informal credit that may enable households to overcome liquidity constraints and invest in new technologies and activities (Taylor and Wyatt, 1996; WouTerSe, 2010). By reducing risk and credit constraints, migration and remittances can increase agricultural productivity (Quinn, 2009; Zahonogo, 2011). To the best of our knowledge, the only one paper which addressed the relationship between remittances and agricultural productivity is Rozelle et al. (1999) in China.

This paper therefore aims to fill the gap by exploring how remittances affect farmers' productivity in Burkina Faso. In this country, emigrants make up between 8% and 10% of the population (about 90% of them live in Côte d'Ivoire) and remittances have grown from 1% of GDP in 2009 to 4% in 2015[3]. At the same time, many people from Burkina Faso returned or immigrated (for those born there) from Côte d'Ivoire during the decade-long conflict in that country. The agricultural sector in Burkina Faso represents about 33.8% of GDP and occupies almost 80% of the active population (Hochet, 2014). The sector is dominated by small-scale farms of less than 5 hectares and its main products are sorghum, millet, maize, and cotton. Traditional cereals such as sorghum and millet dominate the food consumption and expenditure of rural households, while urban households prefer rice and maize. Indeed, it is crucial to investigate the effect of remittances on agricultural productivity especially for sorghum production. In this paper, we define sorghum productivity as total sorghum output.

To assess the effect of remittances on sorghum productivity in Burkina Faso, we follow Craig et al. (1997), Rozelle et al. (1999) and proceed using the Bayesian instrumental variables approach proposed by Lopes and Polson (2014). We use data from the 2014 Living Standards Measurement Study (LSMS) survey on Burkina Faso established by the World Bank. Right now, Burkina Faso has implemented six (6) rounds of LSMS. The previous surveys were conducted in 1994, 1998, 2003, 2007 and 2010. The 2014 data allow us to rely on the remittances amount received by households and their use. We then investigate which households' characteristics and inputs are responsible for increased sorghum production. The results indicate that land size, the number of workers, and the quantity of herbicide used are the factors that significantly improve the sorghum production in Burkina Faso. Specifically, the elasticity of these inputs is respectively equal to 0.023, 0.1 and 0.107. In addition, we find that a 1% increase in the amount of remittances leads to a 0.938% decrease in total production of sorghum. This result is not entirely surprising even though, according to the New Economics of Labour Migration (NELM) scholars, remittances constitute an important source of investment capital in developing countries (Richter et al., 2008; WouTerSe, 2010) and then can increase total factor productivity (Imai et al., 2014). Rozelle et al. (1999) analyse the effect of migration, remittances and agricultural productivity and find that an additional remitted increases maize yield by about 3.28 kilograms per hectare. However, the result is consistent with several empirical studies in developing countries which have repeatedly shown that an important implication of migration and receiving remittances as a non-labour source of revenue could be the generation of a state of dependence, thereby reducing the labour market participation of the recipient household and its production effort (Berker, 2011; Jean and Jimenez, 2007; Ndiaye et al., 2016; Ruhs and Vargas-Silva, 2014; Schumann, 2013). In addition, Amuedo-Dorantes (2014) shows that remittances can reduce labour supply and create a culture of dependency. The results also show that with respect to risk-neutral farmers, risk-averse farmers are more likely to produce more. This may be because risk averse farmers would think it possible that they will no longer receive transfers (remittances or any kind of additional income) in the future, and therefore invest suitably in their agricultural activities.

Moreover, the results also show that each additional FCFA of remittances received by households significantly decreases the cultivated area and land size. This result, therefore, suggests that since remittances are sometimes used to explain cultivated area, one may think that households are cultivating more hectares and when doing so, cultivate the increased area less intensively. In addition, the migrant households generally improve their access to land mainly through consolidation of their existing land rights by putting the land into more productive use through hired labour and agricultural inputs, and land rent.

In terms of policy implications, the results suggest that since decentralization is in place in Burkina Faso and local governments have been given land management responsibilities, remittance flows can provide invaluable source of finance for local development, but also alter power relations within the community. The transparency of decision-making concerning land allocation, and the extent to which it successfully considers the interests of both migrant and non-migrant households are key for local democracy and equitable development.

This paper is structured as follows: The model and estimation strategy are discussed in Section 2, while the data are described in Section 3. Section 4 collects the empirical evidence and Section 5 investigates the robustness of the results with respect to production technology misspecification. Finally, Section 6 discusses the interplay between remittances and agricultural inputs, and Section 7 concludes the paper.

2. Model

To assess the role of remittances for agricultural productivity, we estimate the following Cobb-Douglas production function:

$$Y_i = e^{\beta_0 + \beta_1 r_i + \sum_{j=2}^{J} \beta_j w_j + \epsilon_{1i}} \prod_{k=1}^{K} X_{k,i}^{\theta_k} \tag{1}$$

where Y_i is the total sorghum output of household i ; r_i is the logarithm of the amount of remittances received by household i ; $\boldsymbol{w} = (w_2, w_3, \dots, w_J)$ is a vector which includes the following controls: age, gender, education, risk preferences, crop system, and welfare; ϵ_{1i} is an error term that captures household heterogeneity; the vector of inputs $\boldsymbol{X} = (X_1, \dots, X_K)$, $K = 8$, and includes the cultivated area, the labour used for production and other inputs such as the quantity of herbicide, pesticide, inorganic and organic NPK; and the parameters $\theta_1, \theta_2, \dots, \theta_K$ are technical coefficients to be estimated. Taking logarithms on both sides yields:

$$y_i = \beta_0 + \beta_1 r_i + \sum_{j=2}^{J} \beta_j w_j + \sum_{k=1}^{K} \theta_k \log(X_{k,i}) + \epsilon_{1i}$$

where y_i is the logarithm of Y_i . In particular, we consider the following model:

$$y_i = \beta_0 + \beta_1 r_i + \boldsymbol{x}_i^{'} \delta + \epsilon_{1i} \tag{2}$$

where the vector $x = (w_2, w_3, \dots, w_J, \log(X_1), \dots, \log(X_K))$. Since migration leads to a reduction in family labour and remittances increase[4] available capital for production, we follow Li et al. (2013) and assume that remittances may have differential effects on households with different production systems. For example, maize and peanut production in Burkina Faso are relatively labour-intensive activities.

Their productivity responses to labour reduction may be significant. In contrast, rice, cotton, sorghum or millet productivity in the plains might be responsive to remittances due to their capital-intensive mechanized production. Since sorghum is one of the most widely grown and consumed cereal products in Burkina Faso, we estimate equation (2) for households that monocrop sorghum. We present our estimation strategies in the next section.

OLS estimation

We first rely on a baseline strategy that uses least square regressions when estimating equation (2). We estimate heteroscedasticity robust standard errors to deal with the potential clustering of observations at the neighborhood level. However, as acknowledged, equation (2) has potential endogeneity issues. In fact, if remittances were randomly assigned among households, then the Ordinary Least Square (OLS) estimates would be consistent. However, with this approach, the remittances may not represent an exogenous shock for the households and may be endogenous. As discussed in Sasin and McKenzie (2007), two sources of endogeneity occur. First, if unobservable characteristics of households with remittances and without remittances substantially differ, then selection bias arises. Also, it is possible that there are unobservable shocks (crops failures, floods, droughts, etc) that affect agricultural productivity and that, at the same time, are correlated with remittances (for example, if migrants send more money to face these shocks). In this case, the error term ϵ_{1i} and r_i could be correlated and there will be a problem of omitted-variable bias, which will make OLS estimates inconsistent. Thus, the main challenges confronting the identification of the causal effect of remittances on agricultural productivity are the potential issues of omitted variables bias, the reverse causality and the measurement errors[5]. To resolve these potential endogeneity issues, we use the instrumental variables approach as our second estimation strategy.

2SLS estimation

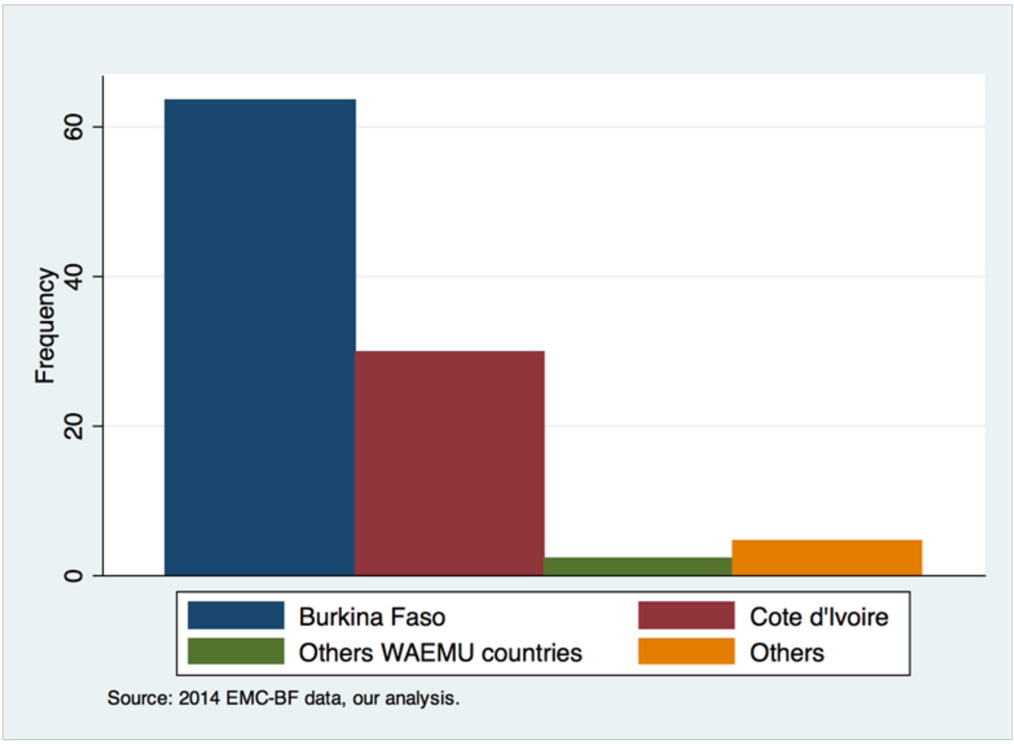
The Two-Stage Least Squares (2SLS) approach involves estimating a two-stage model in which the second stage consists of estimating equation (2), while the first stage consists of estimating the following equation:

$$y_i = \beta_0 + \beta_1 r_i + \boldsymbol{x}_i^{'} \delta + \epsilon_{1i} \tag{3}$$

where z is the vector of instruments and x is the vector of control variables as in equation (2). Several empirical studies have emphasized the importance of migration network in determining migration from Burkina Faso (Beauchemin et al., 2007;

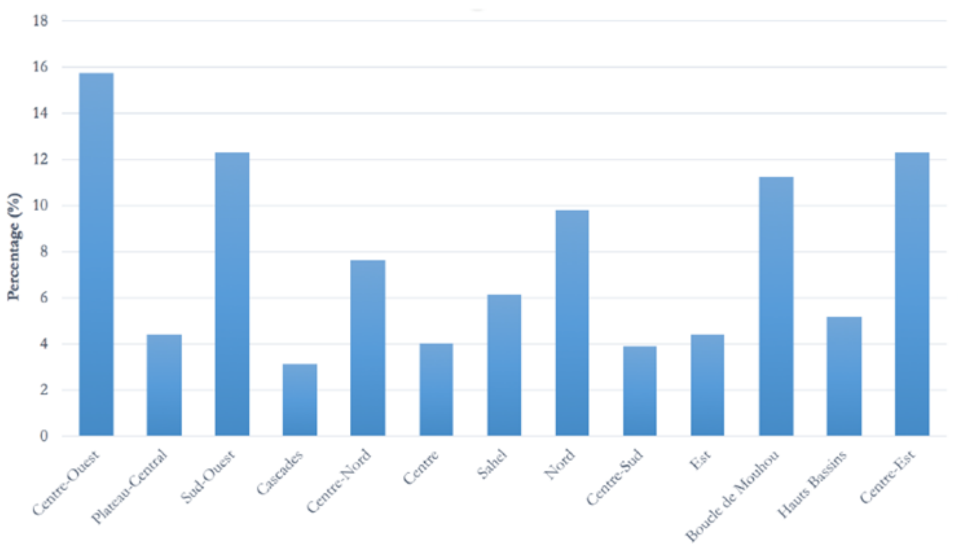
Henry et al., 2004; Kniveton et al., 2011; Konseiga, 2006). We follow earlier studies in using the distance to the nearest railroad station in 1954 times the age of household head (Adams and Cuecuecha, 2013), and the historic region-level migration rates as instruments for current remittances received (Hildebrandt et al., 2005). Our interest in the first instrument can be justified by the fact that, in Burkina Faso, as in most West African countries, migration flows have their roots in the colonial era. The first migrations of populations in West Africa after the slave trade were targeted at the peanut growing areas or coffee and cocoa plantation areas of Ghana or Cote d'Ivoire. Railroads built from 1913 and 1954 were the best way for people in Burkina Faso to reach Cote d'Ivoire. As shown in Figure 1, Cote d'Ivoire is the second source of remittances received in Burkina Faso due to its long migration history with this country. Since the nearest railroad station in 1954 is not correlated to the present agricultural productivity, it may be a good instrument to address the endogeneity of remittances.

Figure 1: Remittances by source countries: Percentage of total remittances received



In addition, as for the first instrument, the region-level migration rate in the past allows the understanding of the current migration stocks for each state, and thus the likelihood of receiving remittances. However, unlike the first instrument that affects only the migration network of Burkina Faso in Cote d'Ivoire, the migration rate at the state level takes into account the global network. The Burkina Faso migration rate in 2006 for the region in which the household is located is taken from the 2006 National Census of the Population. Figure 2 shows the geographical distribution. The highest rates are found in the central-west, southwest and in the Centre-East regions. The lowest rates are found in cascades, central and south-central regions. As discussed in Adams and Cuecuecha (2013), we multiply the region-level migration rate variable by the age of the household head to obtain variation at the household level.

Figure 2: The 2006 migration rate by region in Burkina Faso



Source: Burkina Faso-General Census of the Population, 2006.

We estimate the causal effect of remittances on agricultural productivity using each instrument separately, then using them simultaneously. This effect is estimated using two 2SLS. To provide additional evidence for the validity of the instrumental variable strategy, we undertake three statistical tests:

(i) the Hausman exogeneity test which consists of testing the null hypothesis of exogeneity of remittances;

(ii) the Sargan test for over-identification of the two instruments when we use them simultaneously; and

(iii) the Stock-Yogo test, which tests weak identification of the instruments.

Most earlier studies analysing the relationship between migration, remittances and agricultural productivity have estimated equations (2) and (3) using the 2SLS approach. As comprehensively reviewed in standard texts (Angrist and Pischke, 2008; Wooldridge, 2010), 2SLS is an intuitive and robust way of estimating causal effects in a wide variety of situations. Nonetheless, this now-standard instrumental variable estimation technique has at least two important limitations (Bound et al., 1995; Kleibergen and Zivot, 2003; Staiger and Stock, 1994). First, 2SLS estimators are asymptotically biased with weak instruments and have a non-standard (possibly bimodal) distribution (Bound et al., 1995; Staiger and Stock, 1994). Second, 2SLS can provide more precise but more biased estimates when additional weak instruments are introduced. Moreover, in multistage settings, 2SLS is not invariant to the ordering (Kleibergen and Zivot, 2003). These limitations mean that 2SLS can lead to wildly incorrect estimates and overly large confidence intervals in the presence of weak instruments and finite samples. Due to this, we follow Lopes and Polson (2014) and estimate equations (2) and (3) by using the Bayesian instrumental variables approach.

Bayesian instrumental variables

This approach requires that we re-write the equation (3) as follows:

$$r_i = \boldsymbol{z}_i^{'}\lambda + \epsilon_{2i} \tag{4}$$

where z is independent of ϵ_{1i}. We assume that $\epsilon_i = (\epsilon_{1i}, \epsilon_{2i})$ are i.i.d. $N(0, \Sigma)$, where ∑ has diagonal components σ_{11}, σ_{22}, and $\sigma_{12} = \sigma_{21} = \sqrt{\rho\sigma_{11}\sigma_{22}}$. The reduced form representation of equations (2) and (4) is:

$$y_i = \beta_0 + z_i^{'}\Pi_y + x_i^{'}\delta + \mu_{1i} \tag{5}$$

$$r_i = z_i^{'}\Pi_r + \mu_{2i} \tag{6}$$

where $\Pi_y = \beta_1\lambda$; $\mu_{2i} = \epsilon_{2i}$; $\mu_{1i} = \epsilon_{1i} + \beta_1\epsilon_{2i}$; and $\Pi_r = \lambda$. The relation between ϵ_i and μ_i is:

$$\mu_i = \begin{pmatrix} 1 & \beta_1 \\ 0 & 1 \end{pmatrix} \epsilon_i = \boldsymbol{B}\epsilon_i \tag{7}$$

Thus, the distribution of the reduced form errors μ_i is also bivariate normal

$N(0, \Omega)$, where:

$$\Omega = \boldsymbol{B\Sigma B}' = \begin{pmatrix} \sigma_{11} + 2\beta_1\sigma_{12} + \beta_1^2\sigma_{22} & \sigma_{12} + \beta_1\sigma_{22} \\ \sigma_{12} + \beta_1\sigma_{22} & \sigma_{22} \end{pmatrix} \tag{8}$$

As discussed in Rossi et al. (2012), we specify the prior for the structural parameters from equations (2) and (4) as follows:

$$(\beta_0, \beta_1, \delta)' \sim N(b_0, B_0) \tag{9}$$

$$\lambda \sim N(d_0, D_0) \tag{10}$$

$$\Sigma \sim IW(\nu_0, \Sigma_0) \tag{11}$$

where $b_0, B_0, d_0, D_0, \nu_0, and\ \Sigma_0$, and Σ_0 are known hyper-parameters; $IW(\nu_0, \Sigma_0)$ denotes the standard Inverted Wishart distribution with parameters ν_0 (prior degrees of freedom) and Σ_0 (prior scale matrix). The full conditional distributions of the structural parameters can be drawn using the Gibbs Sampling algorithm. In the next section, we list the set of conditional posterior distributions required by the Gibbs sampler.

Posterior distributions

Given the prior distributions, the joint posterior density (probability) function of all parameters in our models can be constructed by using Bayes' theorem:

- For the parameter Σ, the posterior distribution of the error variance is:

$$\Sigma|\beta_0, \beta_1, \delta, \lambda, data \sim IW(\nu_0 + n, \Sigma_0 + S) \tag{12}$$

where $S = \sum_{i=1}^{n} \epsilon_i \epsilon_i'$ and $data = (y, r, x, z)$.

- For the parameter $(\beta_0, \beta_1, \delta)$. The joint distribution of the regression parameters has the following form:

$$\beta_0, \beta_1, \delta \mid \Sigma, \lambda, data \quad \sim \quad N(b_1, B_1) \tag{13}$$

$$B_1^{-1} \quad = \quad B_0^{-1} + \sum_{i=1}^{n} r_i r_i^{'} \tag{14}$$

$$B_1^{-1} b_1 \quad = \quad B_0^{-1} b_0 + \sum_{i=1}^{n} \tilde{r}_i \tilde{y}_i \tag{15}$$

$$\tilde{r}_i \quad = \quad \frac{1}{\sqrt{\sigma_{22}(1-\rho^2)}} (1, r_i, \boldsymbol{x}_i)^{'} \tag{16}$$

$$\tilde{y}_i \quad = \quad \frac{1}{\sqrt{\sigma_{22}(1-\rho^2)}} \left[y_i - \frac{\sigma_{12}}{\sigma_{11}} (r_i - z_i^{'} \lambda) \right] \tag{17}$$

- The regression parameters λ for the instrument have the following distribution:

$$\lambda \mid \beta_0, \beta_1, \delta, \Sigma, data \quad \sim \quad N(d_1, D_1) \tag{18}$$

$$D_1^{-1} \quad = \quad D_0^{-1} + \sum_{i=1}^{n} \tilde{z}_i \tilde{z}_i^{'} \tag{19}$$

$$D_1^{-1} d_1 \quad = \quad D_0^{-1} d_0 + \sum_{i=1}^{n} \tilde{z}_i \tilde{r}_i \tag{20}$$

$$\tilde{r}_i \quad = \quad \frac{1}{\sqrt{\sigma_{22}(1-\rho^2)}} \left[r_i - \frac{\sigma_{12}}{\sigma_{22}} (y_i - \beta_0 - \beta_1 r_i - x_l^{'} \delta) \right] \tag{21}$$

$$\widetilde{z}_i = \frac{1}{\sqrt{\sigma_{22}(1-\rho^2)}} z_i \qquad (22)$$

Our approach aims to compute the posterior distribution for whole parameters. This result allows us to better characterize the effect of remittances on agricultural productivity. The posterior distribution of β_1 gives a complete insight on how the remittances can increase the agricultural productivity or not. Specifically, we use the following Monte Carlo Markov Chain (MCMC) to draw from the posterior distribution of $\Sigma, \beta_0, \beta_1, \delta, and\ \lambda$.

Sampling algorithm

We start our algorithm by picking $\left(\Sigma^{(0)}, \beta_0^{(0)}, \beta_1^{(0)}, \delta^{(0)}, \lambda^{(0)}\right)$ as starting values. By specifying a normal prior for these parameters and a normal likelihood we can easily sample $\left(\Sigma^{(t)}, \beta_0^{(t)}, \beta_1^{(t)}, \delta^{(t)}, \lambda^{(t)}\right)$ from a multivariate normal distribution. An inverted Wishart prior distribution for Σ allows us to sample it from an inverted Wishart distribution. A Gibbs sampler step is then performed:

Algorithm: MCMC algorithm
Set initial values to $\left(\Sigma^{(0)}, \beta_0^{(0)}, \beta_1^{(0)}, \delta^{(0)}, \lambda^{(0)}\right)$.
For t = 1 to T where T denotes the number of MCMC iterations
[1]- Sample Σ^t from $IW(\nu_0 + n, \Sigma_0 + S)$
[2]- Sample $(\beta_0^t, \beta_1^t, \delta^t)$ from $N(b_1, B_1)$
[3]- Sample λ^t from $N(d_1, D_1)$.
End for

We let our MCMC runs for 10,000 iterations discarding the first 4,999 iterations. Figures in the Annex present the posterior distribution for all the parameters.

3. Data

Our empirical analysis is based on data from the Living Standards Measurement Study (LSMS) survey conducted in 2014 by the National Institute of Demographics and Statistics of Burkina Faso. The LSMS survey was funded through the national budget of Burkina Faso and the Swedish International Development Cooperation Agency, with cooperative funding from the World Bank. The database covered about 10,860 households. The sample was representative for the national, rural and urban, and regional levels. A stratified two-stage survey was conducted to collect the data where, in the first stage, the primary units or enumeration areas (EAs) were drawn with a proportional probability to the number of households counted in the EAs. A sample of 905 enumeration areas was drawn on that occasion. In the second stage, 12 households were drawn with equal probability in each enumeration area.

Four features of the LSMS dataset are central to our analysis:

(i) it provides information about the use of remittances by recipient households;
(ii) it has a high dimension, which provides households' information on education, income, access to land, employment and labour participation;
(iii) it features a rich set of variables on credits and risk preferences, including internal and international remittances;
(iv) it has a large sample size that allows us to find a sub-sample of households that conforms to the requirements of our analysis. In the case where a farmer has more than one piece of land, we retain the land with the greatest productivity.

Table 1 provides descriptive statistics of the sample. The sample comprises 3,925 farmers who produce sorghum. On average, each farmer produces 96.2 kg with a standard deviation of 27.04. In terms of individual characteristics, we can see that the male-female population is unequally distributed in the sorghum sector in Burkina Faso, and that farmers under 45 years old are about 58%. Male farmers are more represented (95%) than female farmers. The percentage of farmers who have received remittances is about 23%. On average, farmers cultivate 1.28 hectares and 89% of them have no education level. Most of the farmers (82%) live in rural areas and are mostly risk averse (64%). Table 2 provides more details about farmers' risk preferences.

In addition, Figure 3 shows that the remittances received by the households are more likely (about 84%) to be used for consumption and production (more precisely, financial support and rural work). Even if our data do not indicate what proportion of these remittances has been allocated to agricultural inputs, we believe that the remittances will enable the receiving households to be in good condition to produce more, to diversify their crops, and even to cope with future productivity shocks.

Table 1: Summary statistics

	Mean	Std	Min	Max
Characteristics of the parcels				
Production (in kg)	96.2	27.04	20	300
Cultivated area (in hectares)	1.28	1.08	0.01	12
Labour input and fertilizers used				
Labour (number of workers)	19.75	15.84	2	314
Herbicide (in kg)	1.13	4.01	1	500
Pesticide (in kg)	1.06	3.1	1	360
Inorganic NPK (in kg)	1.08	1.4	1	82
Organic (in kg)	3.68	7.44	3	502
Households characteristics				
Remittances received (in %)	0.23		0	1
Remittances (in FCFA)	46,141.79	72,299.51	2,000	500,000
Male	0.95		0	1
Age 15-30	0.16		0	1
Age 31-45	0.42		0	1
Age 46-65	0.31		0	1
More than 65	0.11		0	1
No education	0.89		0	1
Primary education	0.08		0	1
Secondary education	0.03		0	1
Welfare	181,731.60	93,195.26	38,538.91	1,038,227
Rural	0.82		0	1
Farmers' attitude toward risk				
Risk averse	0.64		0	1
Risk neutral	0.12		0	1
Risk tolerant	0.24		0	1
Observation	3,925			

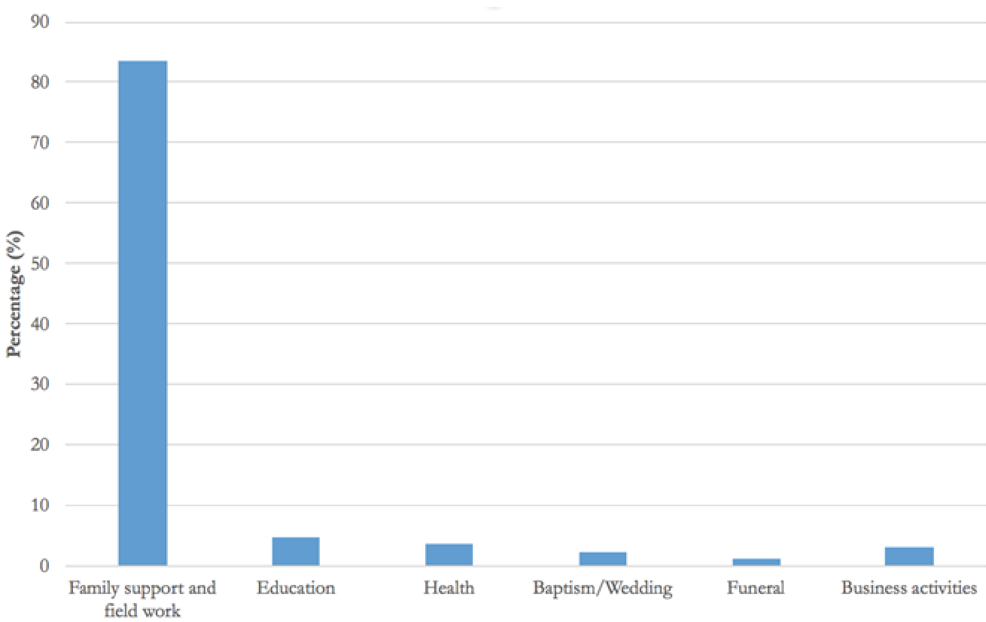
Note: The "Welfare'' variable is considered as the total household consumption. There are detailed questions on cash expenditures, on the value of food items grown at home or received as gifts, and on the ownership of housing and durable goods (for example, cars, televisions, bicycles and sewing machines) to make it possible to assign them a use rental value. The labour variable refers to the number of workers who have been employed by the farmer to produce sorghum.

Table 2: Distribution of risk preferences among farmers

Degree of risk	Type	Distribution
0-1	extreme risk aversion	14.22
2	high risk aversion	17.54
3	moderate risk aversion	13.87
4	weak risk aversion	18.7
5	risk neutral	12.37
6	moderate risk loving	12.52
7	high risk loving	6.9
8	extreme risk loving	3.43
9-10	stay in bed	0.44

Note: The specific question read to the respondent is: "On a scale of 0 to 10, how willing are you to take risks in general?''. The first column presents the degree of risk chosen during the survey. The second column presents the typology used by Holt and Laury (2002).

Figure 3: Use of the remittances received by households



Source: LSMS-Burkina Faso, 2014.

4. Results

In this section, we report our estimates, contrasting baseline estimates with those obtained using the standard instrumental variables approach (2SLS) and the Bayesian instrumental variables approach.

OLS estimates

We first report OLS estimates of equation (2) in Table 3. Each column adds a new covariate (or group of covariates) to see how the coefficient on remittances varies with the addition of new controls. In our most restrictive specification, column (6), we impose constant returns to scale. Our results reveal that a 1% increase in remittances increases farmers' production by 0.027%. This finding is in line with several empirical studies, which find that greater access to capital through remittances generates increased agricultural productivity (Imai et al., 2014; Quinn, 2009; Rozelle et al., 1999; Zahonogo, 2011). Comparing the movement in the coefficient estimate on remittances reveals that the smallest movements arise when we add controls for fertilizers. For that reason, we only control for herbicide and organic fertilizers in the rest of our paper. The covariate that does not appear to predict farmers' productivity in a statistically meaningful way is risk aversion. In general, the coefficient estimates enter the equation with the expected sign; higher cultivated area and labour used correlate with higher production, and farmers who live in rural regions produce more. The direction of the welfare coefficient is consistent with previous works showing that low agricultural productivity is positively associated with poverty in developing countries. Perhaps somewhat surprising is that once we condition on farmers' level of education, we find that those with no formal education produce more. A closer consideration of this finding reveals that farmers living in the rural regions often have, on average, lower educational qualifications (see Table 1 for more details). This should lead to a downward bias in the coefficient estimate for farmers with no formal education.

Table 3: OLS estimates of remittances on the logarithm of total sorghum production

Variables	(1)	(2)	(3)	(4)	(5)	(6)
Log of remittances	-0.015***	0.002	0.002	0.002	0.002	0.027***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
Cultivated area		-0.005	-0.005	-0.005	-0.005	0.003
		(0.004)	(0.004)	(0.004)	(0.004)	(0.005)
Log of labour		0.057***	0.057***	0.057***	0.057***	0.095***
		(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Herbicide			0.016	0.016	0.016	0.272***
			(0.020)	(0.020)	(0.020)	(0.074)
Pesticide				-0.024	-0.024	0.377***
				(0.045)	(0.045)	(0.133)
Organic fertilizer					0.004	0.036***
					(0.010)	(0.013)
Inorganic NPK						0.216***
						(0.075)
Male		0.012	0.011	0.011	0.011	0.076***
		(0.020)	(0.020)	(0.020)	(0.020)	(0.022)
Age 15-30		0.059***	0.059***	0.059***	0.059***	0.008
		(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Age 31-45		0.032*	0.032*	0.032*	0.032*	0.043**
		(0.018)	(0.018)	(0.018)	(0.018)	(0.020)
Age 46-65		-0.006	-0.006	-0.006	-0.006	0.018
		(0.017)	(0.017)	(0.017)	(0.017)	(0.018)
No education		-0.113***	-0.113***	-0.113***	-0.113***	0.078***
		(0.022)	(0.022)	(0.022)	(0.022)	(0.029)
Primary		-0.305***	-0.305***	-0.305***	-0.305***	-0.153***
		(0.038)	(0.038)	(0.038)	(0.038)	(0.042)
Welfare		-0.001	-0.001	-0.001	-0.001	0.293***
		(0.011)	(0.011)	(0.011)	(0.011)	(0.005)
Rural		0.134***	0.134***	0.134***	0.134***	0.172***
		(0.017)	(0.017)	(0.017)	(0.017)	(0.018)
Risk averse		-0.009	-0.009	-0.009	-0.009	0.047**
		(0.019)	(0.019)	(0.019)	(0.020)	(0.022)
Risk tolerant		0.060***	0.061***	0.060***	0.061***	0.103***
		(0.019)	(0.019)	(0.019)	(0.019)	(0.022)
Observations	3,719	3,719	3,719	3,719	3,719	3,719

Note: This table presents OLS estimates from equation (1). Column (1) shows the correlation between the logarithm of remittances and the logarithm of sorghum production. Column (2) controls for farmers' characteristics, cultivated area, and labour as inputs. In the columns (3), (4), (5), and (6) we control, respectively, for fertilizers. We impose constant returns to scale in column (6). Robust standard errors are in parentheses. *** p<0.01; ** p<0.05; * p<0.1

2SLS estimates

The IV estimates are presented in Table 4. In column (1), the instrument of remittances is the region-level migration rate in 2006. In column (3), we use both instruments simultaneously. We find that a 1% increase in the amount of the remittances leads to a 4.2% decrease in the total production of sorghum. The covariates that appear to predict farmers' production are the cultivated area, the number of workers used, the welfare and whether the farmers live in rural areas. We undertake three statistical tests to investigate the validity of these instruments. First, we test the null hypothesis that the remittance amount is exogenous. The Haussman test indicates that we can consider remittances as an endogenous variable (Table 4). Second, we perform the Sargan-Hansen test for over-identification when we use both instruments. The test indicates that the instruments are valid. Third, we perform the Stock-Yogo test, which tests weak identification of instruments. The weak instrument problem arises when the correlation between the endogenous regressor and the set of instrument variables is weak. There is no evidence to reject the null hypothesis of weak instruments in all three specifications of the test. These tests indicate that the estimated effects of remittances on sorghum production is not causal. Therefore, we should deal with the identification issue.

Table 4: IV estimates of remittances' effect on sorghum production

Second stage regressions: Dependent variable is Log. of sorghum production			
Variables	**(1)**	**(2)**	**(3)**
	Region-level migration rate	**Distance railroad**	**Both IV**
Log of remittances	0.638	-14.137***	-4.252
	(2.003)	(3.567)	(4.003)
Cultivated area	1.428***	0.742***	1.111***
	(0.286)	(0.392)	(0.294)
Log of labour	4.060***	1.434	1.758*
	(0.612)	(0.877)	(0.927)
Herbicide (quantity in log)	2.468	3.142	-1.518
	(1.515)	(2.282)	(1.163)
Organic fertilizer	0.813	0.913	-0.351
	(0.755)	(0.987)	(0.733)
No education	1.854	10.837***	6.439***
	(2.296)	(3.231)	(2.993)
Primary education	1.626	11.425	3.652
	(2.570)	(3.863)	(2.884)
Welfare	-0.221	2.728**	3.291***
	(0.947)	(1.346)	(1.367)

continued next page

Table 4 Continued

Second stage regressions: Dependent variable is Log. of sorghum production			
Variables	**(1)**	**(2)**	**(3)**
	Region-level migration rate	**Distance railroad**	**Both IV**
Rural	7.134***	1.707	6.736***
	(1.307)	(1.923)	(1.613)
Risk averse	-0.637	7.570***	0.448
	(1.654)	(2.558)	(1.875)
Risk tolerant	4.306***	7.751***	3.061**
	(1.502)	(2.079)	(1.689)
Region	yes	yes	yes
Observations	3,595	3,595	3,595
Haussman test: statistic (p-value)	52.617 (0.000)	4.05896 (0.0440)	59.549 (0.000)
Sargan-Hansen test Wald	-	-	64.985 (0.000)
Weak ID (Cragg-Donald Wald F-stat.)	8.569	6.554	0.847
Stock-Yogo weak ID test critical values:			
10% maximal IV relative bias	16.38	16.38	19.93
15% maximal IV relative bias	8.96	8.96	11.59
20% maximal IV relative bias	6.66	6.66	8.75
25% maximal IV relative bias	5.53	5.53	7.25

Note: Heteroskedasticity-robust standard errors and p-values for Haussman and Sargan tests are in parentheses. Column 1, also called region-level migration rate, is the effect of remittances on agricultural productivity using Region-level migration rate in 2006 as an instrument. In column 2, also called Distance railroad, the distance to the nearest railroad station in 1954 is used as an instrument for remittances. In column 3, also called Both IVs, both instruments are used and constant returns to scale was imposed.

Bayesian IV estimates

As discussed in section 2.3, we present in column (3) of Table 5 our results using the Gibbs sampling algorithm when simultaneously estimating equations (5) and (6). It shows the posterior means of the inputs used, remittances and individual characteristics. We let our Markov Chain run for 10,000 iterations, discarding the first 4,999 iterations. The posterior distribution for all parameters is displayed in the Annex. Our results show that land size and labour inputs significantly improve sorghum production in Burkina Faso. In addition, a 1% increase in the amount of remittances leads to a 0.938% decrease in total production of sorghum. This result is not entirely surprising even if according to the New Economics of Labour Migration (NELM) scholars, remittances constitute an important source of investment capital in developing countries (Richter et al., 2008; WouTerSe, 2010) and then can increase total factor productivity (Imai et al., 2014). Rozelle et al. (1999) who analyse the effect of migration, remittances, and agricultural productivity also find that an additional Yuan remitted increases maize yield by 3.28 kilograms per hectare. However, our result is consistent with several empirical studies in developing countries, which have repeatedly shown that an important implication of migration and receiving remittances as a non-labour source of revenue could be the generation of a state of dependence, thereby reducing the labour market participation of the recipient household and its production effort (Berker, 2011; Jahjah et al., 2003; Jean and Jimenez, 2007; Lipton, 1980; Massey and Parrado, 1998; Ndiaye et al., 2016; Ruhs and Vargas-Silva, 2014; Schumann, 2013).

Table 5: Determinants of sorghum productivity

	OLS	2LS	Bayesian IV
	(1)	(2)	(3)
Log of remittances	0.037***	-4.252	-0.938***
	(0.005)	(4.003)	(0.024)
Cultivated area	0.023***	1.111***	0.023***
	(0.004)	(0.294)	(0.009)
Log of labour	0.091***	1.758*	0.100***
	(0.009)	(0.927)	(0.019)
Herbicide (quantity in log)	0.203***	-1518	0.107**
	(0.044)	(1.163)	(0.057)
Organic fertilizer	0.059***	-0.351	0.017
	(0.014)	(0.733)	(0.025)
σ_{11}			1.821***
			(0.094)
σ_{22}			1.963***
			(0.048)
ρ			0.859***
			(0.005)
Region fixed effect	yes	yes	yes
Controls	yes	yes	yes
Observations	3,596	3,335	3,292

Notes: We let our MCMC chain run for 10,000 iterations, discarding the first 4,999 iterations. Controls include gender, age education, welfare, residence and attitude toward risks. *** p<0.01; ** p<0.05; * p<0.1

According to Jahjah et al. (2003), a significant part of remittances is spent on "status-oriented consumption" that might imply a lower development impact of income stemming from remittances compared with income from any other source. Remittances could also give rise to behavioural changes of the remaining family members by decreasing their incentives to work. This can be explained through decreased opportunity costs of leisure, often leading to decreasing labour market participation (Antman, 2013). As argued by Jahjah et al. (2003), recipients of remittances might moreover face the danger of moral hazard problems, as the remaining family members may have incentives to reduce their work effort. In addition, Amuedo-Dorantes (2014) shows that remittances can reduce labour supply and create a culture of dependency. In other words, remittances exit because one or more persons left the household. The loss of labour to migration has a negative effect on household cropping income in source areas and that remittance receipts partially compensate for this lost-labour effect by increasing crop yields at the household level (Taylor and Lopez-Feldman, 2010). Moreover, as discussed by Deaton and Drèze (2009), recipient farmers generally compare the remittances with the income they derive from agricultural production. If remittances are greater than agricultural income, those farmers will prefer to allocate the remittances to the consumption of goods and services, decreasing their agricultural production at the same time.

5. Robustness checks

In this section, we check the robustness of our results with respect to misspecification of sorghum production function. More precisely, we assume that sorghum production technology follows a translog form and that equation (1) becomes:

$$\log(Y_i) = \beta_0 + \beta_1 r_i + \sum_{j=2}^{J} \beta_j w_{ij} + \sum_{p=1}^{6} \theta_p \log(M_{ip}) + \frac{1}{2}\sum_{p=1}^{6}\sum_{q=1}^{6} \psi_{pq} \log(M_{ip}) \log(M_{iq}) + \epsilon_{1i} \quad (23)$$

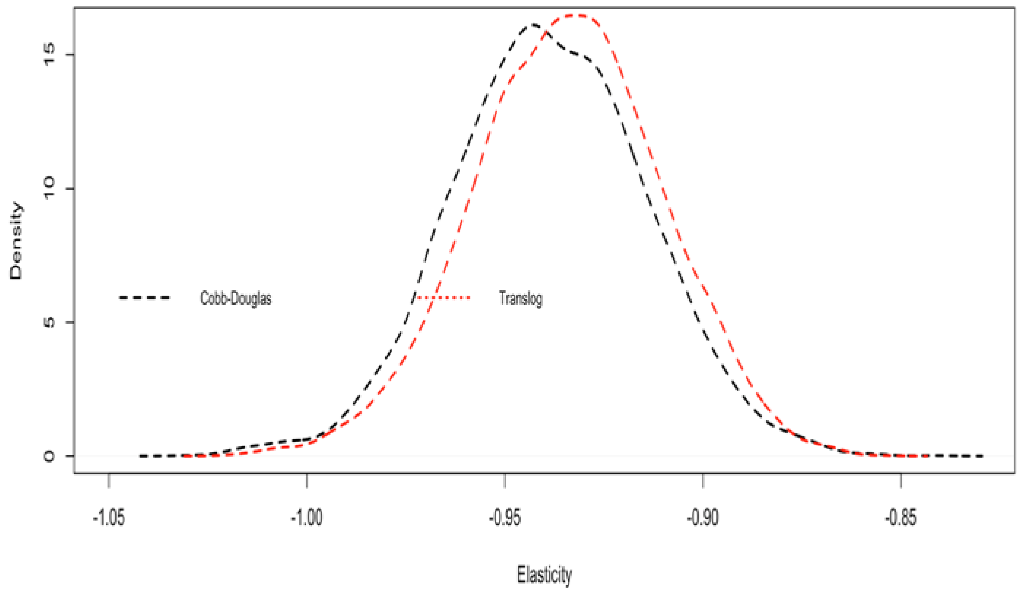
where $\psi_{pq} = \psi_{qp}, \forall\, p \neq q$; **w** contains control variables as defined in section 2, and the vector of variables $M = (A, L, X_3, \dots, X_6)$ contains inputs such as cultivated area, labour, the quantity of herbicide, pesticide, inorganic NPK and organic fertilizer. Note that equation (23) is more general since the translog production function is additively separable if $\psi_{pq} = 0, \forall\, p \neq q$, and reduces to a Cobb-Douglas technology if $\psi_{pq} = 0, \forall p, q$. However, to choose between the results from the specifications (2) and (6), we refer to the likelihood ratio (LR) test. Table 6 collects the results that are obtained when estimating equation (6) with the Bayesian instrumental approach described in section 2.3. The LR test results show that the trans-logarithm specification does better than the Cobb-Douglas one. The results of the trans-logarithm production function show that land size is the factor that significantly improves sorghum production in Burkina Faso with an elasticity of 0.1. As for the Cobb-Douglas specification, the trans-logarithm results also show that a 1% increase in the amount of remittances leads to a 0.934% decrease in the total production of sorghum. The support of the kernel density estimated (Figure 4) is negative for both Cobb-Douglas and trans-logarithm specifications, suggesting that the elasticity of remittances with respect to total sorghum production in Burkina Faso is always negative.

Table 6: Robustness check: Determinants of sorghum productivity

	(a) Cobb-Douglas		(b) Translog
	2LS	Bayesian estimation	Bayesian estimation
	(1)	(2)	(3)
Log of remittances	-4.252	-0.938***	-0.934***
Cultivated area	1.111***	0.023***	0.103***
Log of labour	1.758*	0.100***	-0.084
Herbicide (quantity in log)	-1.518	0.107**	0.179
Organic fertilizer	-0.351	0.017	0.168
Cultivated area			-0.009***
Log of labour			0.034
Herbicide (quantity in log)			0.101
Organic fertilizer			0.010
Cultivated area x labour			0.001
Cultivated area x herbicide			-0.008
Cultivated area x organic fertilizer			0.002
Labour x herbicide			-0.107
Labour x organic fertilizer			-0060
Herbicide x organic fertilizer			-0.004
σ_11		1.821***	1.817***
σ_12		1.963***	1.960***
ρ		0.859***	0.860***
Region fixed effect	yes	yes	yes
Observations	3,335	3292	3,292
Log-likelihood		-463,070.4	-5,807.297
LR test	LR=-2[L_(Cobb-Douglas)-L_Translog]=914,526.206		
Number of estimated parameters		28	38
χ_0.95 (10)-critical value	18.31		

Note: For the Bayesian estimation, we let our chain run for 10,000 iterations discarding the first 4,999 iterations.

Figure 4: Posterior distribution of the elasticity of remittances with respect to total sorghum production



6. Discussion

As our previous results show, the cultivated area and labour inputs are relevant to promoting agricultural productivity. In this section, we discuss the interplay between remittances and the use of these agricultural inputs. The results in Table 7 show the OLS estimates when regressing the remittances amount on each of the following inputs: cultivated area, labour, pesticide, herbicide, inorganic NPK and organic fertilizer. It reveals that each additional FCFA of remittances received significantly decreases the cultivated area and the labour inputs by 0.126 and 0.037, respectively. This finding may be one that helps explain the negative effect of remittances on productivity. Indeed, since remittances are sometimes (perhaps often) used to explain cultivated area, one may think that households are cultivating more hectares yet they are cultivating the increased area less intensively. Moreover, in Burkina Faso, purchases are common for residential plots. Agricultural land is rarely sold, and migrant households usually gain access to it through leases. The migrant households generally improve their access to land mainly through consolidation of their existing land rights, by putting the land into more productive use through hired labour and agricultural inputs, land allocation by the rural council, and land rent.

However, where land is already under cultivation, improved land access for some exacerbates competition and undermines access for others, particularly non-migrant households. This may happen through administrative mechanisms (preference for migrant households in land allocation processes), market dynamics (soaring land prices as a result of remittance-supported demand, making it harder for some to access land) or other reasons (reclaiming plots lent to others by migrant households now better able to cultivate them). These scenarios require a more careful examination of the development outcomes of the linkages between remittances and access to land in terms of economic development. For instance, are migrant households producing more efficiently than non-migrant ones as a result of their access to resources, skills and ideas from abroad? Are benefits “trickling down” to non-migrant households, or are these increasingly marginalized and their livelihoods undermined?

Table 7: Effect of remittances on agricultural inputs

	Cultivated area	Labour	Herbicide	Pesticide	NPK	Organic fertilizer
Remittances	-0.126***	-0.037***	-0.003	-0.000	0.004	-0.001
	(0.016)	(0.010)	(0.004)	(0.001)	(0.003)	(0.007)
Constant	2.751***	3.154***	0.056	0.012	-0.017	0.113*
	(0.165)	(0.104)	(0.036)	(0.012)	(0.030)	(0.067)
Controls	no	no	no	no	no	no
Observation	3,596	3,596	3,596	3,596	3,596	3,596

Note: This table presents the OLS estimates when regressing the remittances amount on agricultural inputs. Heteroscedasticity-robust standard errors are in parentheses. *** p<0.01; * p<0.1

7. Conclusion and policy implications

Burkina Faso is an important country of emigration, and the level of remittances sent by migrants to their families is among the highest in Sub-Saharan Africa. The primary destination of migrants from Burkina Faso is Côte d'Ivoire, which is also the principal source of migrant remittances and significantly influences remittance inflows. This paper analyses the effect of remittances on sorghum production and explores spatial sources of heterogeneity in this effect (by using the region fixed effects). Using micro-level data from Burkina Faso, we find that land size, the number of farm workers, and the quantity of herbicides used are the factors that significantly improve sorghum production in the country. In addition, we find that a 1% increase in the amount of remittances leads to 0.938% decrease in total production of sorghum.

In terms of policy implications, our findings highlight the fact that decisions concerning remittances use are affected by policy and institutional factors at local level. As decentralization is in place in Burkina Faso and local governments have been given land management responsibilities, remittance flows can provide invaluable source of finance for local development, and alter power relations within the community. The transparency of decision-making concerning land allocation and the extent to which it successfully considers the interests of both migrant and non-migrant households are key for local democracy and equitable development. More research is needed to better understand these processes and their outcomes, and ways to improve transparency and representation of different interests. We also think that future work should focus on providing credible empirical evidence concerning the use of farmers' risk preferences and household welfare variables in the analysis of agricultural productivity. For instance, further research can investigate whether the impact of remittances on sorghum productivity differs across income classes.

Notes

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2. After foreign direct investments.

3. OECD (2017)

4. In fact, households may use remittances to help finance the purchase of the labour-saving farming input.

5 Remittances may be mis-measured because they are transitory income unrelated to observable economic activity. Consequently, our empirical strategy must specify conditions under which parameter identification is achieved.

6. Information on how to obtain the LSMS data files of Burkina Faso is available on the World Bank website: http://microdata.worldbank.org/index.php/catalog/2538}{http://microdata.worldbank.org/index.php/catalog/2538 . The previous surveys were conducted in 1994, 1998, 2003, 2007 and 2010.

References

Adams, D.W. and Vogel, R. C. 1984. Rural financial markets in low income countries: Recent controversies and lessons, World Development, 14(4), 477–487.

Adams, R.H. and Cuecuecha, A. 2013. "The impact of remittances on investment and poverty in Ghana". World Development, 50: 24–40.

Adewale, A. R. 2017. "Import substitution industrialisation and economic growth: Evidence from the group of BRICS countries". Future Business Journal, 3(2): 138–158.

Alsharif, N., Bhattacharyya, S. and Intartaglia, M. 2017. "Economic diversification in resource rich countries: History, state of knowledge and research agenda". Resources Policy, 52: 154–164.

Amuedo-Dorantes, C. 2014. The good and the bad in remittance flows. IZA World of Labour, November 1.

Andrews, M. 2006. Microcredit and agriculture: How to make it work. Canada: Mennonite Economic Development Associate, Waterloo, ON.

Angel, S., Brown, E., Dimitrova, D., Ehrenberg, D., Heyes, J., Kusek, P., Marchesi, G., Orozco, V., Smith, L. and Ernesto, V. 2006. Secure tenure in Latin America and the Caribbean: Regularization of informal urban settlements in Peru, Mexico and Brazil. Woodrow Wilson School of Public and International Affairs, Princeton University, New Jersey.

Angrist, J. D. and Pischke, J.S. 2008. Mostly harmless econometrics: An empiricist's companion. Princeton: Princeton University Press.

Antman, F. M. 2013. "The impact of migration on family left behind". International Handbook on the Economics of Migration. Edward Elgard Publishing.

Bachewe, F. N., Berhane, G., Minten, B. and Taffesse, A. S. 2017. "Agricultural Transformation in Africa? Assessing the Evidence in Ethiopia". World Development, 105, 286–298.

Baron, D. P. 1970. "Price uncertainty, utility, and industry equilibrium in pure competition". International Economic Review, 463–480.

Beauchemin, C., Henry, S. and Schoumaker, B. 2007. Côte d'Ivoire-Burkina Faso (1970-2000): Une étude rétrospective des déterminants individuels et contextuels du retour. Les Migrations Internationales. Observation, Analyse et Perspectives. Colloque International de Budapest (Hongrie, 20–24 Septembre 2004). AIDELF. Budapest, 157–177.

Bellemare, C. and Shearer, B. 2010. "Sorting, incentives and risk preferences: Evidence from a field experiment". Economics Letters, 108(3): 345–348.

Berker, A. 2011. "Labour-market consequences of internal migration in Turkey". Economic Development and Cultural Change, 60(1): 197–239.

Besley, T. 1995. "Property rights and investment incentives: Theory and evidence from Ghana". Journal of Political Economy, 103(5): 903–937.

Bettin, G. and Zazzaro, A. 2012. "Remittances and financial development: Substitutes or complements in economic growth?" Bulletin of Economic Research, 64(4): 509–536.

Bound, J., Jaeger, D.A. and Baker, R. M. 1995. "Problems with instrumental variables estimation when the correlation between the instruments and the endogenous explanatory variable is weak". Journal of the American Statistical Association, 90(430): 443–450.

Christiaensen, L., Demery, L. and Kuhl, J. 2011. "The (evolving) role of agriculture in poverty reduction: An empirical perspective". Journal of Development Economics, 96(2): 239-254.

Craig, B. J., Pardey, P. G. and Roseboom, J. 1997. "International productivity patterns: Accounting for input quality, infrastructure, and research". American Journal of Agricultural Economics, 79(4): 1064–1076.

De Haas, H. 2009. "Remittances and social development". Financing Social Policy (pp. 293–318). Springer.

De Soto, H. 2000. The mystery of capital: Why capitalism triumphs in the West and fails everywhere else. Basic Civitas Books.

Deaton, A. and Drèze, J. 2009. "Food and nutrition in India: Facts and interpretations". Economic and Political Weekly, 42–65.

Dercon, S. and Christiaensen, L. 2011. "Consumption risk, technology adoption and poverty traps: Evidence from Ethiopia". Journal of Development Economics, 96(2): 159–173.

Diagne, A., Zeller, M., and Sharma, M. 2000. Empirical measurements of households' access to credit and credit constraints in developing countries: Methodological issues and evidence. No. 583-2016-39550.

Doss, C. R. 2006. "Analyzing technology adoption using microstudies: Limitations, challenges, and opportunities for improvement". Agricultural Economics, 34(3): 207–219.

Duncan, H. and Popp, I. 2017. World Migration Report 2018.

Dupas, P. and Robinson, J. 2013. "Savings constraints and microenterprise development: Evidence from a field experiment in Kenya". American Economic Journal: Applied Economics, 5(1): 163–92.

Field, E. and Torero, M. 2006. Do property titles increase credit access among the urban poor? Evidence from a nationwide titling program. Department of Economics, Harvard University, Cambridge, MA.

Gonzalez-Velosa, C. 2011. "The effects of emigration and remittances on agriculture: Evidence from the Philippines". Job Market Paper, 1–55.

Henry, S., Schoumaker, B. and Beauchemin, C. 2004. "The impact of rainfall on the first out-migration: A multi-level event-history analysis in Burkina Faso". Population and Environment, 25(5): 423–460.

Hiebert, L. D. 1974. "Risk, learning, and the adoption of fertilizer responsive seed varieties". American Journal of Agricultural Economics, 56(4): 764–768.

Hildebrandt, N., McKenzie, D.J., Esquivel, G. and Schargrodsky, E. 2005. "The effects of migration on child health in Mexico [with comments]". Economia, 6(1): 257–289.

Hochet, P. 2014. Burkina Faso: Vers la reconnaissance des droits fonciers locaux. Paris, Comité Technique «foncier et Développement.

Holt, C. A. and Laury, S. K. 2002. "Risk aversion and incentive effects". American Economic Review, 92(5): 1644–1655.

Imai, K. S., Gaiha, R., Ali, A. and Kaicker, N. 2014. "Remittances, growth and poverty: New evidence from Asian countries". Journal of Policy Modeling, 36(3): 524–538.

Islam, M. R., Madsen, J. B. and Raschky, P. A. 2015. "Gold and silver mining in the 16th and 17th centuries, land titles and agricultural productivity". European Journal of Political Economy, 39: 150–166.

Jahjah, M. S., Chami, M. R. and Fullenkamp, C. 2003. Are immigrant remittance flows a source of capital for development? Washington DC: International Monetary Fund.

Jean, S. and Jimenez, M. 2007. The unemployment impact of immigration in OECD countries.

Kaninda Tshikala, S. and Fonsah, E. G. 2014. "Assessing the impact of migration and remittances on technology adoption in rural Senegal". 2014 Annual Meeting, February 1-4, 2014, Dallas, Texas.

Kleibergen, F. and Zivot, E. 2003. "Bayesian and classical approaches to instrumental variable regression". Journal of Econometrics, 114(1): 29–72.

Kniveton, D., Smith, C. and Wood, S. 2011. "Agent-based model simulations of future changes in migration flows for Burkina Faso". Global Environmental Change, 21: S34–S40.

Konseiga, A. 2006. "Household migration decisions as survival strategy: The case of Burkina Faso". Journal of African Economies, 16(2): 198–233.

Konseiga, A. 2003. Seasonal and permanent migration in Burkina Faso. EUDN Workshop on Development Research for Doctoral Students.

Li, L., Wang, C., Segarra, E. and Nan, Z. 2013. "Migration, remittances, and agricultural productivity in small farming systems in Northwest China". China Agricultural Economic Review, 5(1): 5–23.

Lipton, M. 1980. "Migration from rural areas of poor countries: The impact on rural productivity and income distribution". World Development, 8(1): 1–24.

Lopes, H.F. and Polson, N.G. 2014. "Bayesian instrumental variables: Priors and likelihoods". Econometric Reviews, 33(1–4): 100–121.

Massey, D.S. and Parrado, E.A. 1998. "International migration and business formation in Mexico". Social Science Quarterly, 1–20.

Mkwambisi, D. D., Fraser, E. D. and Dougill, A. J. 2011. "Urban agriculture and poverty reduction: Evaluating how food production in cities contributes to food security, employment and income in Malawi". Journal of International Development, 23(2): 181–203.

Mo, M. A. 2011. "Analysis of adoption of improved maize varieties among farmers in Kwara State, Nigeria". International Journal of Peace and Development Studies, 2(1): 8–12.

Mourão, P. 2015. "The complex relation between Belarusian trade openness and the agricultural sector". Land Use Policy, 43: 74–81.

Munshi, K. 2003. "Networks in the modern economy: Mexican migrants in the US labor market". The Quarterly Journal of Economics, 118(2): 549–599.

Nagarajan, G. and Meyer, R. L. 2005. Rural finance: Recent advances and emerging lessons, debates, and opportunities. Ohio State University.

Nalini, K. 2007. World Bank assistance to agriculture in Sub-Saharan Africa: An IEG Review. Washington DC: World Bank Publications.

Ndiaye, A. S., Niang, O. K., Dedehouanou, S. and Ndione, Y. C. 2016. Migration, remittances, labour market and human capital in Senegal.

Ouma, J. and De Groote, H. 2011. “Determinants of improved maize seed and fertilizer adoption in Kenya”. Journal of Development and Agricultural Economics, 3(11): 529–536.

Quinn, M. A. 2009. “Estimating the impact of migration and remittances on agricultural technology”. The Journal of Developing Areas, 199–216.

Ratha, D. 2013. “The impact of remittances on economic growth and poverty reduction”. Policy Brief, 8: 1–13.

Richter, S. M. 2008. “The insurance role of remittances on household credit demand”. 2008 Annual Meeting, 27–29 July.

Rossi, P.E., Allenby, G.M. and McCulloch, R. 2012. Bayesian statistics and marketing. John Wiley and Sons.

Rozelle, S., Taylor, J.E. and DeBrauw, A. 1999. “Migration, remittances, and agricultural productivity in China”. American Economic Review, 89(2): 287–291.

Ruhs, M. and Vargas-Silva, C. 2014. The labour market effects of immigration. Migration Observatory Briefing, University of Oxford.

Sandmo, A. 1971. “On the theory of the competitive firm under price uncertainty”. The American Economic Review, 61(1): 65–73.

Sasin, M. J. and McKenzie, D. 2007. Migration, remittances, poverty, and human capital: Conceptual and empirical challenges. Washington DC: World Bank.

Schumann, N. 2013. Differential labor supply response to remittances with respect to human capital. University of Zurich, Center for International and Comparative Studies (CIS).

Shahbaz, M. 2012. “Does trade openness affect long run growth? Cointegration, causality and forecast error variance decomposition tests for Pakistan”. Economic Modelling, 29(6): 2325–2339.

Simtowe, F. and Zeller, M. 2006. The impact of access to credit on the adoption of hybrid maize in Malawi: An empirical test of an agricultural household model under credit market failure.

Staiger, D.O. and Stock, J.H. 1994. Instrumental variables regression with weak instruments. Massachusetts: National Bureau of Economic Research.

Suri, T. 2011. “Selection and comparative advantage in technology adoption”. Econometrica, 79(1): 159–209.

Taylor, J.E. and Lopez-Feldman, A. 2010. “Does migration make rural households more productive? Evidence from Mexico”. The Journal of Development Studies, 46(1): 68–90.

Taylor, J.E. and Wyatt, T. J. 1996. “The shadow value of migrant remittances, income and inequality in a household-farm economy”. The Journal of Development Studies, 32(6): 899–912.

Thirtle, C., Lin, L. and Piesse, J. 2003. “The impact of research-led agricultural productivity growth on poverty reduction in Africa, Asia and Latin America”. World Development, 31(12): 1959–1975.

Veljanoska, S. 2014. Agricultural risk and remittances: the case of Uganda. 2014 International Congress, August 26-29, 2014, Ljubljana, Slovenia.

Wooldridge, J. M. 2010. Econometric analysis of cross section and panel data. Massachusetts: MIT Press.

World Bank. 2014. Poverty and equity data portal. http://povertydata.worldbank.org/poverty/country/BFA.

Wouterse, F. 2010. "Migration and technical efficiency in cereal production: Evidence from Burkina Faso". Agricultural Economics, 41(5): 385−395.

WouTerSe, F. 2010. "Remittances, poverty, inequality and welfare: Evidence from the Central Plateau of Burkina Faso". The Journal of Development Studies, 46(4): 771−789.

Yang, D. and Choi, H. 2007. "Are remittances insurance? Evidence from rainfall shocks in the Philippines". The World Bank Economic Review, 21(2): 219−248.

Zahonogo, P. 2011. "Migration and agricultural production in Burkina Faso". African Journal of Agricultural Research, 6(7): 1844−1852.

Zeller, M. 2003. Models of rural financial institutions. Paving the way forward conference, pp. 2-4.

Annex

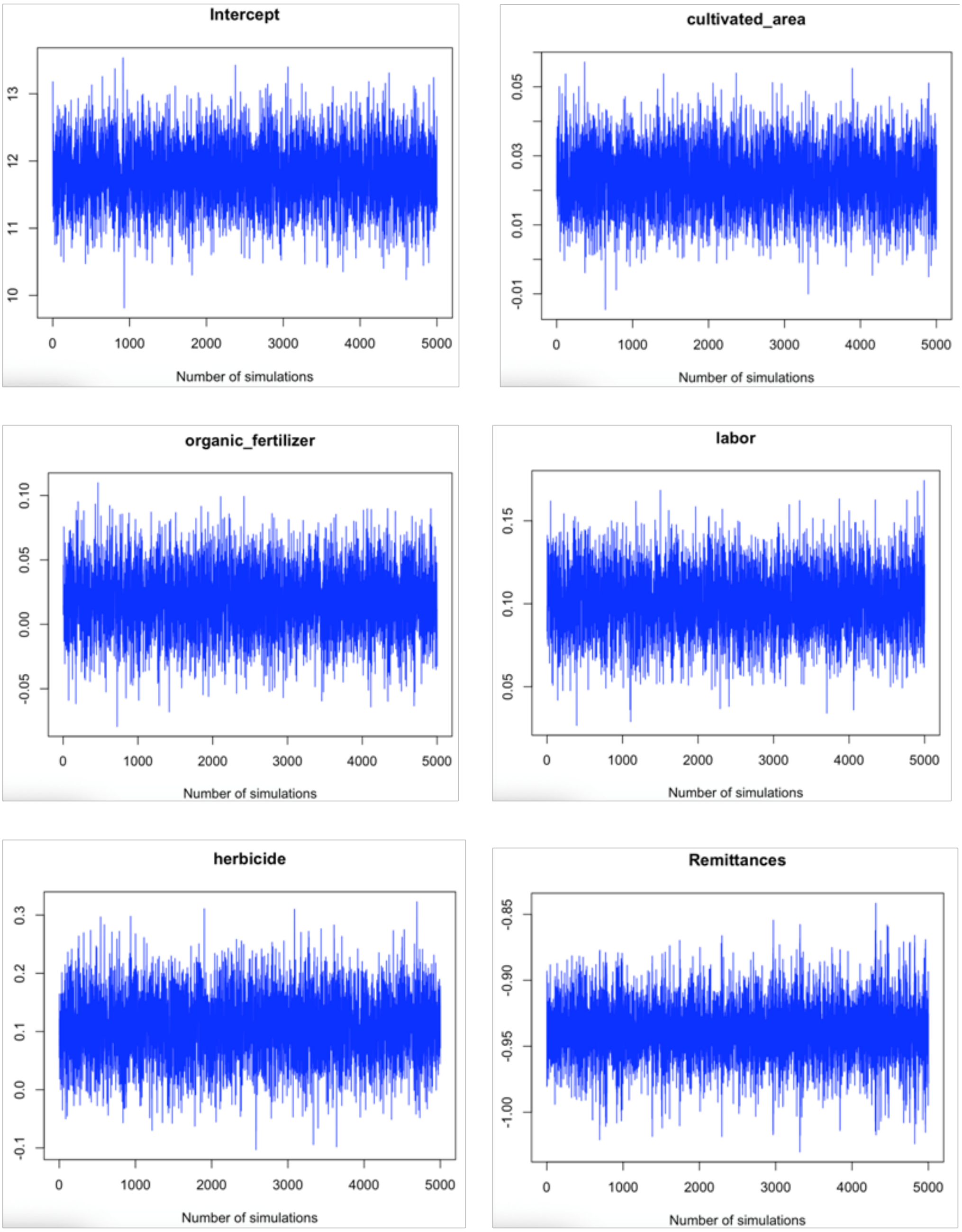
Annex 1: OLS estimation of the effect of remittances (in amount) on sorghum production

Dependent variable is: log of sorghum production						
Variables	**(1)**	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Remittances amount	0.000	0.000**	0.000**	0.000**	0.000*	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cultivated area		0.016***	0.016***	0.016***	0.016***	0.027***
		(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Log of labour		0.081***	0.081***	0.081***	0.080***	0.103***
		(0.009)	(0.009)	(0.009)	(0.009)	(0.010)
Herbicide			0.028**	0.028**	0.029**	0.157***
			(0.012)	(0.012)	(0.012)	(0.038)
Pesticide				0.046*	0.047*	0.468****
				(0.027)	(0.027)	(0.083)
Organic fertilizer					0.016	0.044
					(0.011)	(0.013)
Inorganic NPK						0.201***
						(0.054)
Male		0.189***	0.189***	0.188***	0.188***	0.209***
		(0.027)	(0.027)	(0.027)	(0.027)	(0.027)
Age 15-30		0.177***	0.177***	0.177***	0.177***	0.126***
		(0.020)	(0.020)	(0.020)	(0.020)	(0.021)
Age 31-45		0.071***	0.071***	0.071***	0.070***	0.053***
		(0.018)	(0.018)	(0.018)	(0.018)	(0.019)
Age 46-65		0.099***	0.099***	0.099***	0.099***	0.122***
		(0.018)	(0.018)	(0.018)	(0.018)	(0.019)
No education		0.122***	0.122***	0.122***	0.122***	0.333***
		(0.035)	(0.035)	(0.035)	(0.035)	(0.039)
Primary		0.126***	0.126***	0.126***	0.126***	0.320***
		(0.044)	(0.044)	(0.044)	(0.044)	(0.048)
Welfare		0.044***	0.044***	0.044***	0.045***	0.281***
		(0.014)	(0.014)	(0.014)	(0.014)	(0.005)
Rural		0.105***	0.105***	0.105***	0.104***	0.115***
		(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Risk averse		-0.008	-0.008	-0.008	-0.008	0.025
		(0.022)	(0.022)	(0.022)	(0.022)	(0.023)
Risk tolerant		0.042**	0.042**	0.042**	0.042**	0.052**
		(0.020)	(0.020)	(0.020)	(0.020)	(0.022)
Observations	3,826	3,826	3,826	3,826	3,826	3,826

Annex 2: IV first-stage regressions

Second Stage Regressions: Dependent Variable is Log. of sorghum production			
	(1)	**(2)**	**(3)**
	Region-level migration rate	**Distance railroad**	**Both IVs**
Region-level migration rate	0.001***		0.001***
	(0.000)		(0.000)
Distance railroad		0.146***	0.108*
		(0.055)	(0.055)
Cultivated area	0.019*	-0.008	-0.005
	(0.011)	(0.011°	(0.011)
Log of labour	-0.023	0.005	-0.010
	(0.031)	(0.032)	(0.032)
Herbicide (quantity in log)	0.065	0.060	0.063
	(0.087)	(0.103)	(0.104)
Organic fertilizer	0.006	-0.024	-0.024
	(0.043)	(0.034)	(0.043)
Male	0.127*	0.197***	0.186***
	(0.072)	(0.070)	(0.069)
Age 15-30	-0.130	-0.324***	-0.023
	(0.107)	(0.090)	(0.119)
Age 31-45	-0.203**	-0.309***	-0.101
	(0.079)	(0.072)	(0.089)
Age 46-65	0.012	-0.025	0.088
	(0.064)	(0.062)	(0.069)
No education	-0.048	0.012	0.056
	(0.112)	(0.124)	(0.124)
Primary education	0.313**	0.512***	0.539***
	(0.126)	(0.138)	(0.137)
Welfare	0.064	0.060	0.074
	(0.050)	(0.052)	(0.052)
Rural	-0.606***	-0.548***	-0.553***
	(0.051)	(0.053)	(0.053)
Risk averse	0.339***	0.383***	0.409***
	(0.060)	(0.064)	(0.065)
Risk tolerant	0.329***	0.430***	0.462***
	(0.063)	(0.068)	(0.069)
Constant	9.377***	7.216***	6.466***
	(0.690)	(0.851)	(0.867)
Observations	3,811	3,494	3,479

Annex 3: Posterior distributions for all parameters - Cobb-Douglas



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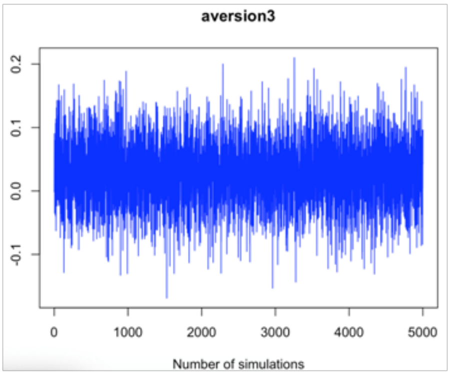
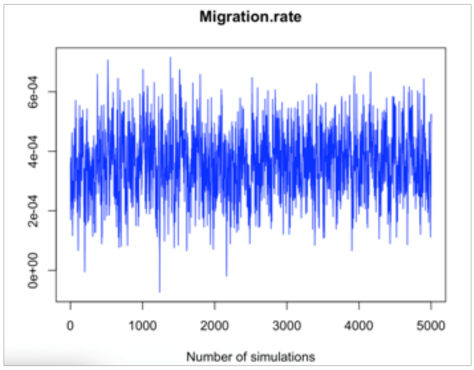
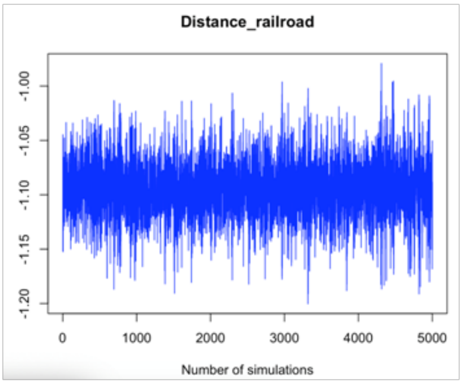
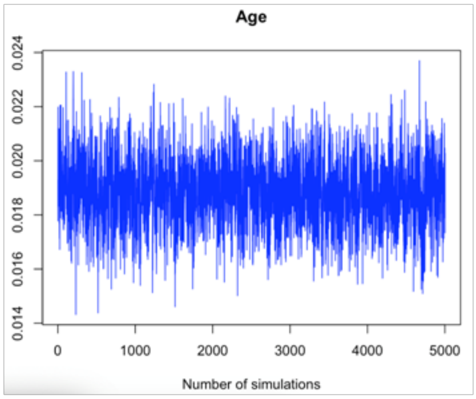
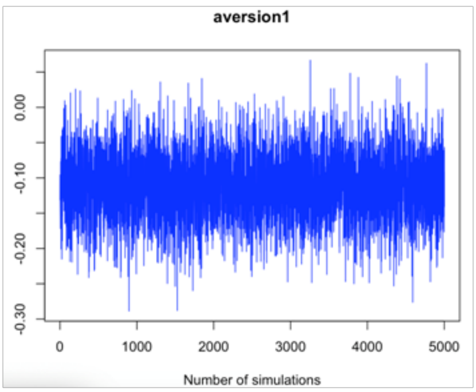
Annex 3 Continued

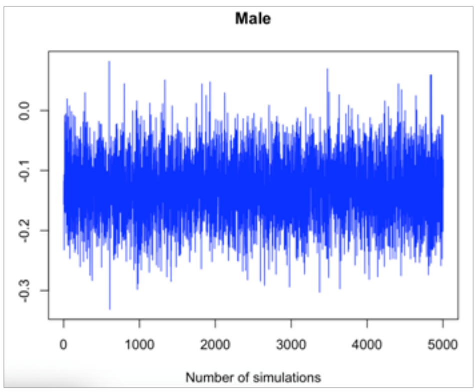












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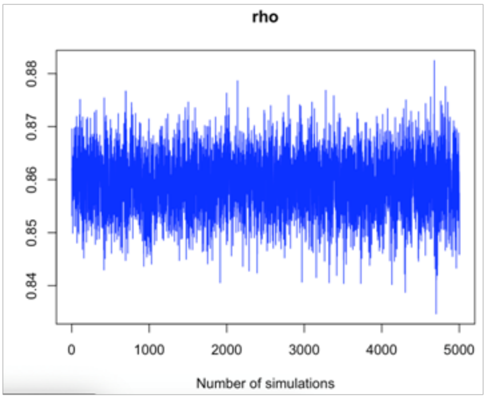

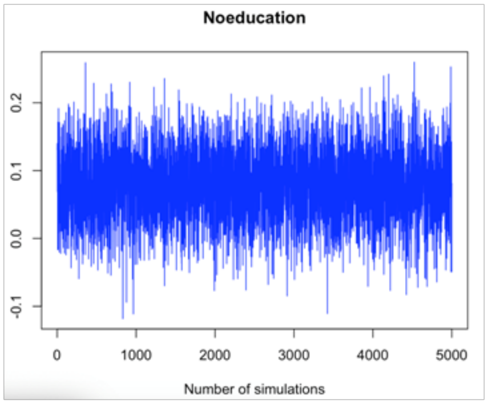

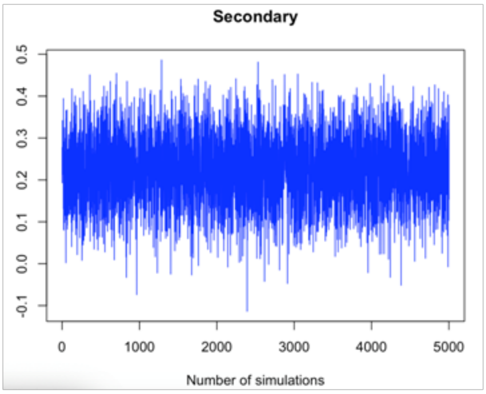

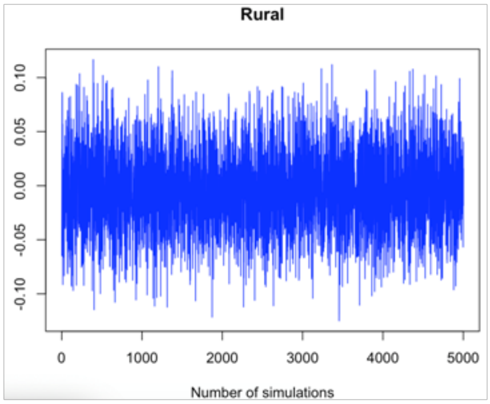

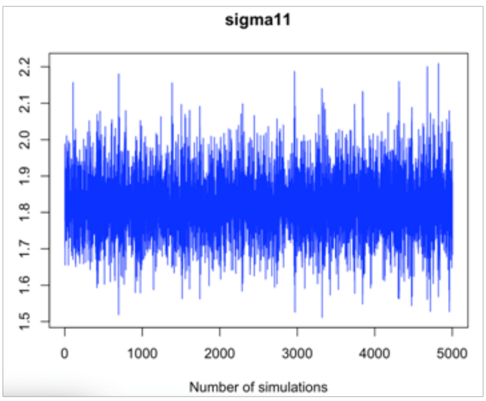

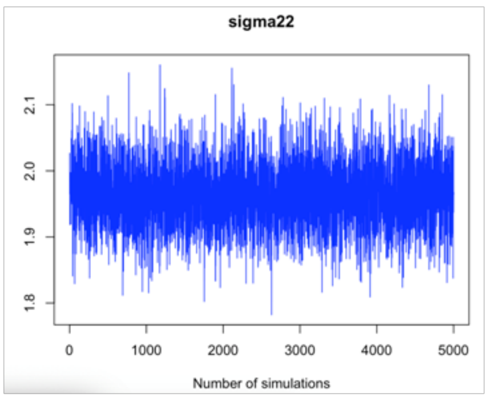

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Mission

To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

The mission rests on two basic premises: that development is more likely to occur where there is sustained sound management of the economy, and that such management is more likely to happen where there is an active, well-informed group of locally based professional economists to conduct policy-relevant research.

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