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Decent Rural Employment and Agricultural Production Efficiency: Empirical Evidence from sub-Saharan Africa

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Abstract

Promoting decent rural employment, by creating new jobs in rural areas and upgrading the existing ones, could be one of the most efficient pathways to reduce rural poverty. This paper systematically investigates the role of decent rural employment on agricultural production efficiency in sub-Saharan African countries, taking Ethiopia and Tanzania as case countries. The analysis applies an output-oriented distance function approach with an estimation procedure that accounts for different technological, demographic, socio-economic, institutional and decent rural employment indicators. Data of the most recent round of Living Standards Measurement Study-Integrated Surveys on Agriculture (LSMS-ISA) for the two countries are used, and a set of indicators are derived to proxy core dimensions of decent rural employment. The findings of our analysis support the idea that integrating decent rural employment aspects in rural development policies and strategies can contribute to improve agricultural production efficiency in sub-Saharan Africa.

Keywords: decent rural employment, distance function, efficiency, poverty reduction

1. Introduction

Recent work around the employment-economic growth nexus emphasizes the importance of the quality of employment and working conditions, as coined by the very concept of decent work and its policy agenda. There is greater emphasis not only on generating more employment opportunities but also on improving the quality of new and existing jobs, for example, by ensuring that fundamental rights at work are respected. The implications of decent employment on productivity, living standards, social justice and sustainable development are increasingly acknowledged (Anker et al., 2002; Ghai, 2002; Dorward, 2013; Burchell et al., 2014).

At the empirical level, the concepts and theoretical formulations often encounter issues related to data availability and lack of universal indicators (Anker et al., 2002; Ghai, 2002; Burchell et al., 2014). Despite that, there is some analytical evidence on the role of employment and decent work on economic performance in some sectors, especially in manufacturing and, more recently, services. Many of those studies focus on the impact of specific employment dimensions, such as length of the labour contract and tenure stability, or shared profit and management on productivity of manufacturing firms (see Yao, 1997; Conyon and Freeman, 2002; Ortega and Marchante, 2010). There exists also some empirical evidence on the role of "fair", "efficient" and higher wages on the level of productivity and improvement of service provision (Akerlof and Yellen, 1990; Levine, 1992).

However, the decent work literature becomes scarcer when applied to developing and transition countries, and especially to agriculture and rural areas. Yet it is precisely in these contexts where the link between employment (both in terms of quality and quantity of jobs) and productivity or economic performance has more relevance. As the majority of the rural poor depend on agriculture, improving agricultural production conditions will be pro-poor, and contribute to food security (World Bank, 2008). At the policy level, the ILO and FAO have increasingly paid attention to decent work in agriculture and rural areas to reduce rural poverty and enhance food security (FAO, 2012, 2014). By providing access to income, employment is crucial for ensuring food access, and for the poor this is even more crucial, as their labour is often the main asset that they can rely upon for income generation. Furthermore, it is precisely the rural poor who are often most exposed to pervasive decent work deficits, in terms of insecure and low incomes, poor health and safety conditions, child labour, gender inequality, inadequate social protection and lack of social dialogue (FAO, 2012, 2014).

In this context, various empirical research works have analysed the sources of agricultural productivity and efficiency in the developing world, including sub-Saharan Africa (e.g., Coelli and Fleming, 2004; Irz and Thirtle, 2004; Rahman, 2009). Nonetheless, to our knowledge, empirical works that explicitly analyse the implications of decent rural employment on agricultural production efficiency are at their infant stage. The aim of this paper is filling this existing shortfall in the literature, by shedding empirical light on the relationship between decent rural employment and efficiency of agricultural production, taking Ethiopia and Tanzania as case studies.

2. Conceptual overview

The concept of decent work, introduced by the ILO and endorsed by the UN system as a whole, goes a step beyond in the relationship between employment and growth, and thus towards poverty reduction. ILO has defined decent work as "a condition which promotes opportunities for work, freedom of choice, equal treatment, security of job, and dignity for both men and women" (ILO, 1999). However, the multi-dimensional nature of decent work, and thus of decent rural employment, poses many challenges with regards to its measurement (Anker et al., 2002) and studies opt to develop contextual definitions for the concept. For example, Pollin et al. (2007) in a study in Kenya translate decent work into empirical terms as "a work situation with a return that enables the worker and his/her family to live above the defined poverty line". These measurement challenges become particularly pungent when applying decent work to the specific features of the agricultural sector and the rural settings in developing countries. Agricultural wage workers are often exposed to informal or casual work arrangements, also as these activities often remain subject to the performance and seasonal calendar of agriculture (FAO, 2012). Ghai (2002) highlighted that it difficult to find a unique and best indicator for decent employment, and an index of combination of some indicators could rather be robust.

With the aim of addressing all these dimensions, ILO developed the "Decent Work Agenda" with four core pillars: (i) employment creation and enterprise development, (ii) social protection, (iii) standards and rights at work, and (iv) governance and social dialogue. Empirical analysis on decent rural employment needs to incorporate these elements, while allowing adaptive conceptualization of it to the heterogeneous circumstances of rural work across diverse agricultural systems and regions. Hence, for this paper, we have identified a number of indicators to capture the core dimensions of decent rural employment. The choice of indicators has also been conditioned by data availability, as well as the sample size and technical requirements of our empirical analysis.

Under pillar one of decent work, on the availability of employment opportunities, we use the ratio of employed household members to total household workforce. For pillar two (social protection), indicators capturing access to cash and food transfers are used in the model. We have accounted for differences in the social protection systems of the two countries, and also for the limited social protection coverage in rural areas that both systems have. Hence, for Tanzania, we have used receipt of cash and food transfers; and for Ethiopia, informal transfers and payments from the Productive Safety Net Programme (PSNP) and participation in food for work. Pillar three on standards and rights to work is proxied through two indicators capturing forms of employment deemed non desirable or 'non-decent' in agriculture, namely ratio of child labour and precarious forms of work to total labour used for agriculture activities by a given household.

3. Theoretical Framework

The role of decent rural employment in agricultural production efficiency is here examined in the context of small-scale farming, characterized by multiple crop and livestock production. The construction of the production possibility frontier, either with parametric assumptions or piecewise constructions, is the fundamental step in efficiency estimation (Farell, 1957; Coelli et al., 2005). The role of decent rural employment in agricultural production efficiency is examined here in the context of smallholder farming, characterized by multiple crop and livestock production. Hence, a multi-output, multi-input production technology specification is required.

In a parametric setting with more than one output, a Stochastic Distance Function (SDF), either input or output oriented can be employed for efficiency analysis. The Stochastic Distance Function approach has a number of advantages over the deterministic approach as it can better differentiate noise (e.g. weather variation, measurement error etc. which are relatively common in agriculture and in rural labor data) from technical inefficiency effects, can be used for multi-output case which is quite common in sub-Saharan Africa and thus enables single-step efficiency estimation (Kumbhakar and Lovell, 2000; Coelli et al., 2005; Rahman, 2009).

Distance function can be represented in a mathematical model as:

$$d_i^I = d^I(x_{1i}, x_{2i} \dots x_{Ni,} y_{1i,} y_{2i} \dots x_{Mi}) \quad (1a)$$

$$d_i^o = d^o(x_{1i}, x_{2i} \dots x_{Ni,} y_{1i,} y_{2i} \dots x_{Mi}) \quad (1b)$$

Where equation (1a) and (1b) illustrate input oriented and output oriented representation of distance function in a technological set of producing M number of outputs (y) using N number of inputs (x). According to Kumbhakar and Lovell (2000), with an underlying homogeneity concept and with an output oriented distance function approach, the relationship can be specified as:

$$D_0(x, \mu y) = \mu D_0(x, y) \quad (2)$$

This implies that if we choose one of the outputs, for example M^{th} output of farms, and setting $\mu=1/y_M$, we will reach to:

$$D_0(x, y/y_M) = D_0(x, y)/y_M \quad (3)$$

In a logarithmic form, the right hand side of equation (3) can be concisely specified in a functional form as:

$$\ln(D_{0i}(x, y)/y_{Mi}) = lnf\left({}^{y_{mi}}/_{y_{Mi}}, x, \beta\right) \quad (4)$$

By replacing the distance parameter with the error term (a composition of the noise component v_i and inefficiency parameter u_i), this coincides with the classic stochastic specification of input-output relationship.

$$-\ln y_{Mi} = lnf\left({}^{y}/_{y_M}, \mathrm{x}, \beta\right) + v_i + u_i \quad (5)$$

One of the relevant questions regarding this estimation procedure could be the possibility of simultaneous equation bias, which results from the incorporation of output terms in the right-hand side of the equation. Such a case could lead to biased estimates of both coefficients and the inefficiency term (Coelli et al., 2005). However, as presented in equation (10), only the ratios of the outputs are used as explanatory variables in the specification and are assumed exogenous. The estimation of inefficiency is estimated based on the output ratios and not with the output measure itself, and these are uncorrelated with the residual (Coelli and Perelman, 1999; 2000). Kumbhakar and Lovel (2000) noted that the output ratio as a regressor in the distance function is less susceptible to endogeneity problem.

With the distributional assumption of Aigner et al. (1977) for the two error components, v and u, and a follow-up application of maximum likelihood technique, we can single out the efficiency estimates. They assume the error term (v) is iid N(0, δ_v^2) - independently and identically distributed with mean zero and standard deviation δ^2. According to Battese and Coelli (1995), with a more generalized assumption of truncated normal distribution, u are iid $N^+(\mu, \delta_u^2)$ – independently and identically distributed half normal random variables with a scale parameter δ_u^2. Finally, technical efficiency of farm households can be calculated as:

$$TE_0 = \exp(-U_i^+) \tag{6}$$

Using a single step maximum likelihood procedure by Battese and Coelli (1995) we integrate the following equation to the estimation procedure.

$$\mu_i = \alpha_0 + \sum \alpha_n Z_{ni} + \varepsilon_i \tag{7}$$

Where μ_i is the conditional mean of u_i from the first estimation procedure, Z_i´s are vectors household parameters to explain the inefficiency parameter, ε_i is the statistical noise, and α´s are the unknowns will be estimated in the procedure.

4. Data and Empirical Model

Ethiopia and Tanzania are the case studies used to test the hypothesis. While the two countries are diverse in many ways, their agriculture sectors are deemed representative of many sub-Saharan African countries. Namely, predominantly rural realities where agriculture is the mainstay of the economy, and is mainly composed of smallholder, subsistence-oriented farming activities as well as significantly dominated by crop-livestock mixed production systems. For the study, we use the cross-section data of the Living Standards Measurement study-Integrated Surveys on Agriculture (LSMS-ISA) collected by the Development Research Group of the World Bank in 2011. After taking out those which can't fit to the estimation procedure, 1346 observations in Ethiopia and 931 observations in Tanzania are used in this paper. The total crop harvest (all crop production activity) and annual livestock production (livestock products) aggregated with its value in *Birr* in Ethiopia and *Shilling* in Tanzania are outputs in the mixed crop-livestock production system, and are considered in the production function. Cultivated land per household (in hectares), family labor (as adult equivalent), and the intermediate input expenditure (in local currency *Birr and Shilling* in Ethiopia and Tanzania respectively) are the common inputs in the production process and are used as explanatory sets in the estimation process (see table 1 for the descriptive statistics).

(Table 1 around here)

Building up on equation (10), the empirical model with translog specification (which is quite common in agriculture due to flexibility in form (Aigner et al., 1977; Coelli and Perelman, 1999; Sauer et al., 2006) will look like:

$$\begin{aligned} -\ln Crop = {} & \beta_0 + \beta_1 \ln\left({}^{livest}/_{crop}\right) + \beta_2 \ln(Land) + \beta_3 \ln(intinput) + \beta_4 \ln Labor \\ & + 0.5\alpha_1(\ln Land)^2 + 0.5\alpha_2(\ln intinput)^2 + 0.5\alpha_3(\ln Labor)^2 + \alpha_4(\ln Land * \ln intinput) \\ & + \alpha_5(\ln Land * \ln Labor) + \alpha_6(lninterinput * lnLabor) + \alpha_7(\ln\left({}^{livest}/_{crop}\right) * \ln land) \\ & + \alpha_8(\ln\left({}^{livest}/_{crop}\right) * \ln labbor) + \alpha_9(\ln\left({}^{livest}/_{crop}\right) * \ln intinput) + v_i + u_i \end{aligned} \tag{8}$$

Using the empirical extensions of the model by Battese and Coelli (1995), the technical inefficiency function (equation 7) will be integrated with the output oriented distance function, presented in equation (8).

Regional dummy (used as an explanatory variable to capture unobservable characteristics), age and sex of the household head, age dependency ratio, livestock holding in tropical livestock unit (TLU), access to extension services, diversification index, access to credit, distance to the nearest market, and the set of decent rural employment indicators (as defined in section 2, table 1) are used in the estimation to explain technical efficiency of the households in the use of inputs in the production process. Almost all of the covariates are used in the estimation procedure for both countries, except for some variables with too few observations in the respective country.

The indicator used to explore the effect of specialization in production activities on the overall technical efficiency of farms, referred to as concentration index in the literature, is specified by the Ogive index. This index was developed by Ali et al. (1991) and measures the deviation from full diversifications (equal distribution of output shares) among production activities (Coelli and Fleming, 2004).

$$Ogive = \sum_{n=1}^{N} \frac{\left(X_n - \left(1/_N\right)\right)^2}{1/_N} \quad (9)$$

N is the total production activities and X_n is the share of the income from production activities (crop, livestock production and off and non-farm activities).

5. The production function estimation

The maximum likelihood (ML) results of the Output Oriented Distance Frontier estimation are presented in Table 2. Prior to the estimation, all the respective output and input variables are standardized (corrected by the geometric mean) so that the first order coefficients can be interpreted as distance elasticity evaluated at the geometric mean (Kumbhakar et al., 2007; Solis et al., 2009). A likelihood ratio test has been applied comparing commonly used specifications, and the Cobb-Douglas specification was rejected and we use the translog specification. The residuals of our estimation results are negatively skewed[1] and likelihood ratio test rejects the null hypothesis of absence of inefficiency component. Hence, the technical inefficiency component is a statistically significant addition to the model. One of the crucial steps after estimating the production function is to check whether the fitted model violates any major assumption of parametric approaches, which can otherwise lead to a misleading interpretation of the findings (Kumbhakar and Lovell, 2000; O'Donnell and Coelli, 2005; Sauer et al., 2006). According to O'Donnell and Coelli (2005), stochastic output distance function should behave in a certain way to meet the assumptions of monotonicity[2]. The variables for land, labour and cost of intermediate inputs used are significant and have the expected signs at the geometric mean, fulfilling the assumption of monotonicity.

There is a wide variation in the technical efficiency of smallholder farms in both countries, with mean efficiency estimate of about 70% in Ethiopia and 75% in Tanzania. This finding is in line with technical efficiency scores estimated by many empirical researches in the developing world (69.4% for Bangladesh by Coelli et al., 2002; 78% in Central America by Solis et al., 2009; or 78% in Papua New Guinea by Coelli and Fleming, 2004) and also in sub-Saharan Africa (85% in

[1] However, since u_i is positive, the presence of negatively skewed residuals reveal the presence of inefficiency component in the estimation (Coelli, 1995).
[2] Monotonicity in this case is interpreted as the non-decreasing property of the function.

Botswana by Irz and Thirtle, 2004; or 79% in Eastern Ethiopia by Alene and Zeller, 2005). Overall, our results indicate that there is potential to improve the farms' technical efficiency with the available resources and technology.

The scale elasticity can be estimated from the coefficients in the SDF, using the estimation procedure introduced by Fare and Premont (1995) and commonly used in relevant empirical literature (Coelli and Perelman, 1996; Kumbhakar et al., 2007). The negative of the sum of the input elasticity (coefficients) in the model, 0.52 for Ethiopia and 0.72 for Tanzania respectively, reveals the presence of decreasing returns to scale (DRTS) in agricultural production. There are a number of empirical findings that support the presence of decreasing returns to scale in sub-Saharan Africa. The only question that might arise in our estimation is on the magnitude of (the) scale elasticity. Such sub-optimal level of scale efficiency might be the result of the overuse of some of the resources in the production process and/or presence of imperfect market conditions both in factor and product market (Chavas et al., 2005; Anriquez and Daidone, 2010). Chavas et al. (2005) on smallholder farms in Africa, Gonzalez and Lopez (2007) and Solis et al. (2009) in South America have found DRTS in multi-input and output estimation procedure. They argued that this sub-optimality can arise from the use of some of the inputs in the production process (such as surplus labour) beyond the optimal level. Anriquez and Daidone (2010) on the other hand found increasing returns to scale (IRTS) in Ghana which again could be associated with the existence of imperfect markets, where farmers lack flexibility of allocating resources to alternative production activities. From our analytical perspective, the availability of productive employment (both in quantity and quality terms) for the working age population in Tanzania and Ethiopia is limited. This might imply an excess of labour employed in agricultural activities, due to limited availability of options outside the farm. Hence, there may be also underemployment, where the available labour is underutilized within the production unit. Despite the low level of marginal contribution of such an extra labour, they might have limited options than to engage in precarious employment, as casual and seasonal workers.

(Table 2 around here)

6. Decent rural employment and technical efficiency

Overall, in the parametric estimation, most of the variables explaining the technical efficiency of farm households are similar for both Ethiopia and Tanzania. There are, nonetheless, few variables that influence technical efficiency of agricultural production in only one of the two countries. Farm technical efficiency is significantly different across regions in both Ethiopia and Tanzania, which differs from preliminary analysis based on partial productivity estimates. We expect that these differences across regions play a role in terms of diverging decent employment conditions across regions in both countries, which need to be accounted for in agricultural and rural development policy interventions aiming at poverty reduction.

Literate household heads are more likely to be technically efficient in agricultural production than the illiterate counterparts. This relationship would refer to the role of human capital in the decision making process about resource use in agricultural production. Solis et al. (2009) in their empirical work in Central America have found a similar relationship between human capital measured with education levels and production efficiency. Coelli and Fleming (2004) however got contrasting results, where the education level of the household head was negatively associated with technical efficiency. In Ethiopia and Tanzania, with the prevailing low educational levels, farmers lack the ability to efficiently use resources and to translate skills and knowledge to improve production.

In both Ethiopia and Tanzania, a higher household specialization is associated with greater efficiency in agricultural production. Coelli and Fleming (2004) found that the concentration of output shares significantly explains inefficiency and argued that the benefits that smallholder farmers could realize through diversification in production outweigh the benefits from specialization. Conversely, Mugera and Langemeier (2011) in a study on diversification in the USA found that crop farms were more technically efficient than diversified farms. Hence, the trade-off between specialization in one type of production and on-farm diversification (crop or livestock in our case) depends on the specific features of the farm context. From our findings, smallholder farms in Ethiopia and Tanzania can gain relatively more by specializing in one type of production than by diversifying their on-farm production activities. Furthermore, for those farms with already some level of on-farm diversification, additional diversification could lead to lower efficiency levels.

In Ethiopia, increased livestock ownership has a statistically significant negative influence on the household productive efficiency. The larger the flock size of the household, the lesser the family can monitor the operation of the farm that in turn lead to lower productivity levels. Chavas et al. (2005) in Gambia have also found that herding negatively influences the technical efficiency of crop production activities, as there are trade-offs in terms of labour availability between livestock and crop production, which ultimately leads to lower farming efficiency. When the size of the farm increases (e.g., expansion in livestock ownership and/or production levels beyond subsistence), a competition over resources develops across on-farm activities, including labour costs (time intensity of family workers, and hiring costs for non-family wage work) and increased demand for managerial capacity and supervision; all of which can ultimately compromise farm efficiency.

The paper has analysed whether there is an empirical relationship between decent rural employment and efficiency in agricultural production. The relationship has been verified, and the empirical findings show a significant relationship, as captured by a set of decent rural employment indicators. In the case of Ethiopia, employment to family available for work ratio has positively contributed to the household production efficiency. Rao et al. (2004) have found similar results in their study of productivity and productive employment relationship from a macro perspective using data from 111 countries. In the case of Ethiopia, transfers received from social protection programs significantly contribute to improved agricultural efficiency. This is in line with existing evidence around the positive impacts of PSNP and in-kind and cash transfers to rural households in Ethiopia (Gilligan, 2008; Hoddinott et al., 2012). Such positive effects could be explained in two ways: either the cash transfer is used for agricultural investments or otherwise the transfer is used for consumption smoothing which in turn improves the production capacity of farm households. In contrast, as the proportion of precarious employment from the total employment increases, the efficiency of farms will more likely be decreasing. Given the inherent labour characteristics of smallholder agriculture in sub-Saharan Africa (e.g., labour intensive technologies, farms operated by household members), employment options in the agricultural sector are largely limited to peak seasons, and are often casual. Such employment opportunities are mainly undertaken by the landless and other resource poor workers. Since the wage rate for these seasonal workers has little association with their contribution to the production process, there is little motivation for them to work. Such a labour arrangement at least requires serious control and monitoring mechanism which in turn increases the cost of production. Furthermore, considering limited opportunities available for off and non-farm employment in rural areas of Ethiopia and Tanzania, we would argue that there are major issues in terms of availability of productive employment all year long, and when available, employment (especially wage employment) is of low quality. As Ethiopia and Tanzania share many characteristics similar with other sub-Saharan realities, this finding may also prove relevant in those contexts, and much of the developing world

7. Concluding Remarks and Policy Implications

The paper has analyzed whether there is a causal relationship between decent rural employment and efficiency in agricultural production. The empirical work verified the relationship and some of the indicators (i.e. employment to workforce available ratio, proportion of precarious employment to the total employment available, transfers from social protection programs, for instance, productive safety net and food for work programs) contribute to agricultural production efficiency. The results support the notion that addressing decent rural employment issues (e.g., increasing work participation by working-age family members on on-farm activities, expanding social protection in rural areas, and improving the quality of employment) can make a positive contribution both in terms of increasing efficiency in the smallholder subsistence agriculture sector and in providing and improving the livelihood of the poor. Our empirical analysis in Ethiopia and Tanzania finds that there is a room for improving farm efficiency with the given technology and available resources. From the mean technical efficiency score of the farm households, 25% improvement in the efficiency of use of resources can be achieved. Farms, on average, are operating in Decreasing Returns to Scale (DRTS) which would imply that, on average, some of the inputs are beyond the optimal level. Considering agricultural resource constraints and high population growth rates in Ethiopia and Tanzania, it would seem advisable to look at the use of inputs in the production process. Therefore, there would be a room for policy interventions that aim to promote labor demand in the rural areas of sub-Saharan Africa, favoring rural entrepreneurship and labor recruitment, complemented with public employment programs and labor supply side interventions including skills development.

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i. Appendices

Table 1: Descriptive statistics of the sample

Variables	Ethiopia (N=1346)		Tanzania (N=931)	
	Mean	Std. dev.	Mean	Std. dev.
Age of the Household head	44.19	14.20	47.58	14.32
Age dependency ratio	1.25	0.91	1.14	0.82
Land (hectare)	1.21	1.93	3.34	5.19
Cost of intermediate inputs	463.21	812.03	1.41e+05	2.66e+05
Labour in adult equivalent	122.54	150.95	164.36	156.72
Value of crop harvest	7989.74	16169.94	4.58e+06	1.05e+08
Value of livestock	3068.23	8909.06	1.45e+06	1.56e+07
Livestock in TLU	5.82	4.68	1.84	6.56
Diversification index	1.58	0.55	1.06	0.56
PSNP and food for work	41.19	391.65	-	-
Cash and food transfers			3889.67	9594.71
Informal transfers	214.71	1192.86		
Employment ratio	0.80	0.25	0.81	0.26
Precarious employment ratio	0.07	0.17	0.09	0.17
Women labour ratio	0.14	0.27	0.48	0.22
Child labour ratio	-	-	0.06	0.12
Distance to major road	18.43	18.91	14.81	23.05
Annual precipitation	942.39	373.38	1061.16	221.02
Wettest quarter precipitation	613.93	240.51	570.45	128.08
Value of crop harvest	7989.74	16169.94	4.58e+06	1.05e+08

Table 2: Maximum likelihood estimate of translog specification

	Ethiopia		Tanzania	
Variables	Coeff. (std.err)	z	Coeff. (std.err)	z
*ln*Value of total crop harvest				
ln land	-0.26 (0.04)	-6.33***	-0.24 (0.03)	-7.70***
*ln*Labour	-0.13 (0.03)	-4.52***	-0.30 (0.04)	-8.09***
*ln*intermediate inputs	-0.12 (0.03)	-4.56***	-0.18 (0.02)	-8.81***
*ln*livestock_crop	0.28 (0.01)	18.98***	0.18 (0.02)	10.56***
$(ln\text{land})^2$	0.05 (0.02)	2.30***	-0.01 (0.01)	-0.74
$(ln\text{labour})^2$	-0.01 (0.02)	-0.12	0.01 (0.02)	0.64
$(ln\text{intermediateinputs})^2$	-0.04 (0.01)	-3.33***	-0.03 (0.00)	-3.61***

(*ln*land)(*ln*labour)	-0.05 (0.03)	-0.78	-0.01 (0.03)	-0.18
(*ln*land)(*ln*int_input)	0.02 (0.03)	0.68	-0.02 (0.02)	-1.06
(*ln*labour) (*ln*int_input)	0.03 (0.02)	1.45	0.05 (0.02)	2.29**
Input-output				
*(lnland)(ln*Livestock_crop)	-0.02 (0.01)	1.51	0.02 (0.01)	1.36
*(lnlabour)(ln*Livestock_crop)	0.04 (0.01)	3.12***	-0.03 (0.01)	-2.24**
*(lnint_input)(ln*Livestock_crop)	-0.02 (0.01)	1.63	0.00 (0.00)	0.03
_cons	-0.41 (0.06)	-6.22***	-0.49 (0.10)	-5.49***
lnsig2v				
_cons	-0.31 (0.05)	-5.87***	0.50 (0.06)	7.88***
Inefficiency determinants				
Region	0.13 (0.05)	2.36**	-0.03 (0.02)	-1.84*
Annual precipitation	-0.00 (0.01)	-0.77	-5.71e-04(1.33e-03)	-0.43
Precipitation of wettest quarter	0.00 (0.01)	0.80	1.78e-03(2.27e-03)	0.78
Sex of the household head	-0.49 (0.37)	-1.34	-0.27(0.37)	-0.72
Age of the household head	-0.01 (0.01)	-1.01	0.01 (0.01)	0.59
Household head literacy	-0.41 (0.24)	-1.74*	-0.22 (0.07)	-2.95***
Age dependency ratio	0.05 (0.11)	0.41	0.02 (0.16)	0.11
Livestock in TLU	0.31 (0.05)	5.21***	0.69 (0.64)	1.06
Concentration index	-0.52 (0.21)	-2.53**	-0.59 (0.27)	-2.19**
PSNP and food for work	-0.00 (0.00)	-2.56***		
Cash, food and in-kind transfer			0.00 (0.00)	1.43
Informal transfers	0.00 (0.00)	1.04		
Extension service (crop)	-0.03 (0.23)	-0.13		
Extension service (livestock)	0.88 (1.38)	0.64		
Advisory service			0.49 (0.42)	1.17
Access to credit	-0.04 (0.22)	-0.19	0.04 (0.98)	0.00
Distance to the major road	0.00 (0.00)	0.08	0.00 (0.00)	0.29
Employment to workforce ratio	-0.90 (0.50)	-1.78*	0.52 (0.48)	1.08
Precarious employment ratio	9.05 (3.73)	2.43**	8.29 (3.56)	2.33**
Women to total labour ratio	0.22 (0.43)	0.50	-0.17 (0.68)	-0.25
Child labour ratio			0.23 (1.75)	0.13
_cons	1.77 (0.87)	2.02**	1.47 (1.11)	1.32
Other parameters				
Sigma_v	-0.87 (0.02)		-0.78 (0.02)	
Lambda	0.85 (0.18)		1.25 (0.12)	
Log likelihood	-1812.49		-1141.82	
Wald chi2 (12)	936.48		637.44	
Prob > chi2	0.00		0.00	
N	1346		931	