Decent Rural Employment and Agricultural Production Efficiency in sub-Saharan Africa: A Stochastic Multi-output Distance Function Approach

Habtamu Yesigat Ayenew**, Elisenda Estruch*, Johannes Sauer **, Getachew Abate-Kassa **, Lena Schickramm**, Peter Wobst*

* FAO, Rome, Italy, ** Technical University Munich, Germany

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 work, rural employment, distance function, efficiency, poverty reduction*

1. Introduction

Unfolding the complex relationship between employment, labour supply, factor markets and productivity is a crucial aspect in development research and policy design (Alic, 1997; Rao et al., 2004; Barrett et al., 2008; Satch and Temple, 2009; Todaro and Smith, 2012). Uncertainties regarding the interdependence of economic and population growth, sustainability, labour, poverty, as well as working and living conditions brought a great deal of discussions since the first economic development theories came to play (Harris and Todaro, 1970; Alic, 1997; Ortega and Marchante, 2010).

Classical development theories and empirical works in applied economics highlight that productivity gains can have an impact on wage rates and employment conditions, as well as on the overall functioning of the labour market (Harris and Todaro, 1970; Todaro and Smith, 2012). Much attention went to empirically explain low/high wage rates in small or large enterprises with their respective productivity levels (Harris and Todaro, 1970; Satch and Temple, 2009). 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; Vandenberg, 2004; Buchanan, 2006; Evans and Gibb, 2009; Dorward, 2013; Burchell et al., 2014).

At the empirical level, the concepts and theoretical formulations often encounter issues related to data availability (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; Auer et al., 2004; 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 (Katz, 1986; Akerlof and Yellen, 1990; Levine, 1992; Mas, 2006).

However, the decent work literature becomes scarcer when applied to developing and transition countries, and especially to agriculture and rural areas. And yet it is precisely in these contexts where the link between (quantity and quality of) employment and productivity has more relevance in regard to an effort towards reducing poverty. In sub-Saharan Africa and South Asia, where the majority of the poor and food insecure people live, rural poverty is mostly related to the lack of productive employment in agriculture and poor performance of the rural non-farm economy (Haggblade et al., 2010; FAO, 2012). Therefore, rural poverty reduction is no longer conceived as a matter of just being employed or generating some type of income, but as holding a productive and decent job both in rural farm and non-farm activities (Rao et al., 2004, ILO, 2006; Dorward, 2013).

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. In particular, the FAO considers the promotion of decent rural employment as a key component of integrated strategies to reduce rural poverty and enhance food security (FAO, 2010, 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. The key hypothesis is that there is a causal link between decent rural employment and technical efficiency in smallholder agriculture in sub-Saharan Africa. The paper is structured as follows: the second section defines key concepts and decent work related indicators used in the paper. The data and empirical approach used in the paper are illustrated in the third section. The subsequent section discusses the findings and, section five concludes and describes the main policy implications.

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. Decent work is about not only job creation and labour productivity, but it is human-rights based and acknowledges the importance of the quality attributes associated with employment. The ILO defines 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, p.3). Hence, decent work comprises fair pay levels, safe working conditions, non-discrimination, job security and social protection, as well as satisfaction of the worker or employee (Anker et al., 2002; Ghai, 2002; Buchanan, 2006). 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.

The term decent work is considered as one of the fundamental aspects of quality of life, though used with varying definitions and conceptualizations (Vandenberg, 2004; Burchell et al., 2014). The term has gone through historical transitions, from former academic conceptualizations that relay on subjective judgments of employees themselves (Slocum, 1981) till gradual inclusion of some objective indicators to capture the quality attributes of employment (ILO, 1999; Anker et al., 2002; Burchell et al., 2014). Although decent work is universally recognized, the priority attached to its multiple dimensions inevitably varies across countries, regions, and sectors (Anker et al., 2002; Bell and Newitt, 2010).

Using the ILO definition as a reference point, there have been efforts to translate the concept and its multiple dimensions into empirical terms. For instance, Anker et al. (2002) developed six essential components of decent work (i.e., availability, acceptability, dignity, social relation and quality of employment), which they used to develop regional (macro) and household (micro) level statistical indicators.

However, the multi-dimensional nature of decent work comes with many measurement challenges. Some studies opt for empirical definitions adapted to the specific research questions and many of the choices seem dictated by the nature of the dataset at hand. For example, Pollin et al. (2007, p.3) in a work in Kenya translate decent work into empirical terms as “a work situation that enables the worker and his/her family to live above the defined poverty line”. This definition is based on the premise that unless workers receive enough money to pay for the minimum living condition, there is less incentive and capability to invest their potential towards productivity. However, there arise questions related to the application of such measures in empirical work. For instance, one can argue that higher income does not necessarily reflect the quality of the job. The family might generate its income from more than one source, or the income earners in a family may do so with differences in quality of work. Ghai (2002) highlighted that it is rare and impractical to find a unique and best indicator for decent employment, and an index of combinations of some indicators could rather be robust. With the same token, prioritizing of indicators of decent work is much more complex than its theoretical inception, since those indicators are influenced by the social, economic and political conditions of the region on the one hand, and complications due to (uncertain) relationships of indicators on the other (ibid).

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. In many developing countries, especially in sub-Saharan Africa, agriculture and rural non-farm activities have a significant potential to promote employment opportunities for the rural poor. Whilst acknowledging on-going processes of structural transformation, agriculture is the main sector of employment for a large share of the workforce of developing countries, including both on-farm self-employment and wage employment (World Bank, 2008; Davis et al., 2014), and it has a strong pro-poor potential (World Bank, 2008). In particular, smallholder agriculture constitutes the largest proportion of output in sub-Saharan Africa (Davis et al., 2014). As rural economies diversify and transform, off-farm jobs in commercial farms are gaining relevance, as well as in modern agro-industries and the distribution and retail segments of food markets (World Bank, 2008; Haggblade et al., 2010; FAO, 2012). And yet 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 (Haggblade et al., 2010; FAO, 2012; ILO, FAO, IUF, 2007). Rural workers also suffer from other challenges and exclusions in the form of: unemployment or underemployment, poor quality and unproductive jobs, unsafe working conditions and insecure income, denial of rights, gender inequality, and inadequate protection at work, at times of disability and old age.

These decent work deficits contribute to the vicious circle of rural poverty and food and nutrition insecurity (ILO, 2008; Fields, 2011; FAO, 2012, 2014).

Conversely, decent rural employment is employment that will contribute to break this cycle (FAO, 2012; 2014). The concept includes both agricultural and non-agricultural employment, as well as self-employment and wage employment[1]. And it is employment that complies with core labour standards[2], provides sufficient income, reasonable working conditions, respects occupational safety and health standards and guarantees some level of protection, thereby empowering rural workers and their families to live a productive, healthy and dignified life.

Empirical analysis on decent rural employment needs to incorporate all these elements, while allowing adaptive conceptualization of it to the heterogeneous circumstances of rural work across diverse agricultural systems and regions. Overall, when translating these complex concepts into empirical terms, it is important to note that the conceptual discussion, specifically with regard to measurement and indicators, is still open and quite vivid.

Hence, for this paper, we have identified a number of indicators to capture several of the core dimensions of decent rural employment. The general presumption is that the more decent rural employment opportunities are - both in quantity and quality terms - the more likely there will be an improvement in the efficiency of employing resources in the agricultural production. The indicators used in the estimation procedure are selected also due to their appropriateness to the region in consideration (sub-Saharan Africa). In practice, the choice of indicators has also been conditioned by data availability, as well as the sample size and technical requirements of our empirical analysis. The analysis relies on Living Standards Measurement study-Integrated Surveys on Agriculture (LSMS-ISA) datasets, which include mainly household level data and a relatively limited set of questions on employment, for which indicators ought to be defined at the household level. Hence, exploiting the LSMS-ISA datasets in the two countries, we derive indicators for three out of four pillars of the decent work agenda[3].

[1] Rural employment covers any activity, occupation, work, business or service performed by rural people, for remuneration, profit, social or family gain, in cash or in kind, including both agricultural and non-agricultural activities. It therefore applies to waged and salaried workers as well as self-employed workers (including contributing family workers).

[2] Core labour standards include: freedom of association and the effective recognition if the right to collective bargaining; the elimination of all forms of forced or compulsory labour; the effective abolition of child labour; and the elimination of discrimination in respect to employment and occupation.

[3] Data at disposal do not allow for capturing indicators for the fourth pillar of decent work, on social dialogue, nor the other dimensions of decent rural employment (such as occupational health and safety). Future research could enrich the analysis as new waves of datasets are released with richer information on rural labour.

Table (1) summarizes the decent rural employment indicators used in the paper, indicating the respective pillar of decent work, and the expected relationship with respect to the efficiency of agricultural production.

Table 1: Decent rural employment indicators and expected relationship with efficiency

Pillar of decent work	Indicators used	Measurement	Expected sign
Pillar1: Employment creation	Employment to total workforce ratio*	Share of employed HH members to the household members active and in the working age[4]	+ve
Pillar 2: Social protection	Receipt of cash and food transfers†	Total transfer from government and NGOs in Tanzanian Shilling	+ve(-ve)
	PSNP and food for work‡	Total transfer from the government in Ethiopian Birr	+ve
	Informal transfers‡	Total informal cash, food and in-kind transfers in Ethiopian Birr	+ve(-ve)
Pillar 3: Standards and rights at work	Child labour ratio†[5]	Proportion of child labour from the total labour used for agricultural[6] activities by the HH	-ve
	Precarious employment ratio*	Proportion of HH seasonal and casual labour from the total HH agricultural workforce	-ve

*Notes: HH = household; * Ethiopia & Tanzania;* † Tanzania; ‡ Ethiopia

Under pillar one of decent work, on the availability of employment opportunities, we use the ratio of employed household members to total household workforce[7]. Although it does not explicitly address the work conditions and income generated, this ratio captures the proportion of household members involved in productive work, either in terms of self-employment or in some kind of wage employment, from the total workforce available in that given household.

[4] Family members aged between 15 and 64 years.
[5] Child labour ratio as an indicator is used only for Tanzania due to low response rates in Ethiopia.
[6] It is only referred to agricultural activities of the household here, as for the other sectors there is no information provided in the dataset. To build the indicator, we use information on labour use for agricultural production activities (crop or tree management, livestock).
[7] We have built this indicator adapting the "employment-to-population" ratio to our analytical setting and data at disposal. Hence, employment-to-total workforce ratio is measured using as numerator all those who were employed over the last 7 days reference period as self-employed, family work, part-time, casual or seasonal work on farm/off/ or non-farm, after controlling for those who are inactive (too young and too old, went for schooling, ill and physically incapable) to the total household workforce available as denominator.

For pillar two, on 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. We note as well the paucity of data in this domain. Hence, for Tanzania, we have used receipt of cash and food transfers[8]; and for Ethiopia, payments from the Productive Safety Net Programme (PSNP) and participation in food for work. In both countries, such programmes provide significant protection to smallholder producers and rural dwellers, especially given the limited outreach of insurance markets in rural areas of sub-Saharan Africa. In addition, for Ethiopia, we also consider cash and in-kind transfers, which are capture more informal forms of social protection through which households get support from relatives, neighbours and friends[9]. 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. Prevalence of child labour and precarious employment in agriculture are expected to influence the efficiency of production negatively.

3. Methodology

3.1. Theoretical Framework

A single step approach integrating the production function and decent rural employment indicators is used in our estimation. In a poor smallholder farm context, however, it is not easy to integrate the concepts of labour supply in the production analysis. This could arise, according to Barrett et al. (2008), from the fact that, in a smallholder farm context, the major share of family labour is self-employed. This makes it difficult to estimate or to attach an economic value to labour. In addition, this could be associated to the rigidity of the rural labour market (expressed in terms of, for example, high search and transaction costs, locational preferences, etc.). Hence, we have assumed each household has an endowment of labour which can be used for household production activity in the form of self-employment, or it can be supplied to off and non-farm activities. Despite the possible differences in skill, experience and opportunity cost on the type of labour used, hired labour and family labour can be considered substitutes in agriculture (Sadoulet et al., 1998). In our analytical

[8] It is an aggregate measure of free food distribution, food, cash and input for work, scholarships or bursaries for primary or secondary school from the government or NGOs (in Tanzanian Shilling).
[9] It constitutes cash, food and in-kind transfers/gifts from friends, neighbours and relatives (in Ethiopian Birr).

framework, labour is treated as an important input in the production process, and thus is used in the production frontier estimation. The distance function approach builds a framework on the demand of labour, without any implicit or explicit assumption to limit the source (either family labour or hired labour) used in the production process. Labour supply and labour demand might not necessarily be equal, excess labour can be offered for employment and the household can hire labour in times of shortage. The decent rural employment indicators will be included as covariates in the efficiency component.

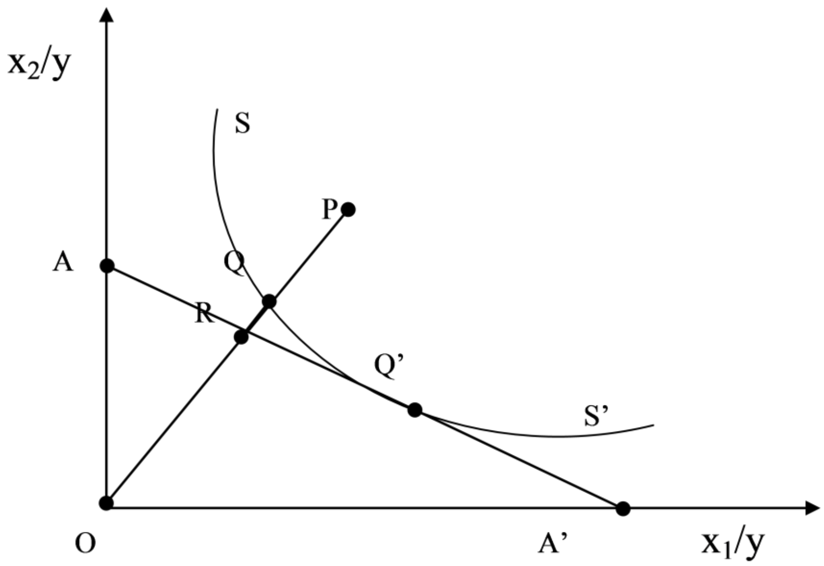
The construction of the production possibility frontier, either with parametric assumptions or piecewise constructions, is the fundamental step in efficiency estimation (Farell, 1957; Coelli et al., 2005). The role of decent rural employment in agricultural production efficiency is examined here in the context of smallholder farming, characterized by multiple crop and livestock production. Hence, a multi-output, multi-input production technology specification is required. Based on Farrell's (1957) work, the input-output transformation equation is adapted to the agricultural sector (e.g. Newman and Matthews, 2006; Rahman, 2009) as:

$$S = \{(x, y): x \; produces \; y\} \tag{1}$$

Where *S* is a certain technology, using input vector x to produce output vector y.

Figure 1 further illustrates the distance function using farms involved in the production of output (y) using two inputs (x_1 and x_2) and assuming constant returns to scale.

Figure 1: Production and efficiency



Source: Coelli et al., 2005, p. 52

SS' represents the isoquant of fully efficient farms. If a farm uses combination of inputs represented by point P, it is considered technically inefficient. The distance QP represents such technical inefficiency, which empirically proxies the amount of all inputs that the farm could (proportionally) reduce without a reduction in output. The technical efficiency (TE) of a farm can be measured by the ratio (TE= OQ/OP), which takes values between 1 and 0, and where value one implying the farm is fully technically efficient. In the figure, point Q is technically efficient.

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 SDF approach has a number of advantages over the deterministic approach as it can better differentiate noise (e.g., weather variation, measurement error etc.) - which is relatively common in agriculture and in rural labour data - from technical inefficiency effects and thus enables single-step efficiency estimation. It also extends the classical Stochastic Frontier Analysis (SFA) with the accommodation of more than one output in the estimation procedure (Kumbhakar and Lovell, 2000; Coelli et al., 2005). The input oriented approach is based on the radial contraction of the input use of firms (farms, in this paper) that brings the farm to the isoquant. The output approach on the other hand tries to find the radial expansion of the outputs while keeping the level of input use.

This parametric approach has the necessary technical features[10] to empirically evaluate the relationship between decent rural employment and technical efficiency of farms (Kumbhakar and Lovell, 2000; Coelli et al., 2005; Newman and Matthews, 2006; Rahman, 2009).

Distance function can be represented in a mathematical model as:

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

$$d_i^o = d^o(x_{1i}, x_{2i} \dots x_{Ni}, y_{1i}, y_{2i} \dots x_{Mi}) \tag{3}$$

Where equation (2) and (3) illustrate the respective representations of input and output oriented distance function (d_i) in a technological set of producing M number of outputs (y) using N number of inputs (x).

According to Kumbhakar et al. (2007), technology with distance function representation can be defined as:

[10] For example, factoring out the noise, multi-output setting in mixed crop-livestock production etc.

$$1 = \mathrm{f}(\mathrm{y}, \mathrm{x}, \beta).\exp(\mathrm{v} + \mathrm{u}) \tag{4}$$

Or in logarithmic expression

$$0 = ln\mathrm{f}(\mathrm{y}, \mathrm{x}, \beta) + \mathrm{v} + \mathrm{u} \tag{5}$$

Where x and y are vectors of inputs and outputs respectively, β is a vector of technological coefficients, v is the classical noise component and u is the one sided random term representing inefficiency. Lovell et al. (1994), with an underlying homogeneity concept, specified an output oriented distance function approach as:

$$D_0(x, \mu y) = \mu D_0(x, y) \tag{6}$$

This implies that by choosing one of the outputs arbitrarily (Coelli and Perelman, 1996; Irz and Thirtle, 2004) to normalize the equation, for example M^{th} output of farms, and setting $\mu = 1/y_M$, we will reach to:

$$D_0(x, y/y_M) = D_0(x, y)/y_M \tag{7}$$

By integrating it with the functional relationships presented in equation (4) and (5), the right hand side of equation (7) can be concisely specified in a functional form as:

$$\ln(D_{0i}(x, y)/y_{Mi}) = lnf({}^{y_{mi}}/_{y_{Mi}}, x, \beta) \tag{8}$$

After simple mathematics and rearrangement of the terms in the equation, the specification can finally be reduced in to:

$$\ln\big(D_{oi}\ (x, y)\big) - \ln(y_{Mi}) = lnf\ ({}^{y_{mi}}/_{y_{Mi}}, x, \beta) \tag{9}$$

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

$$-\ln y_{Mi} = ln\mathrm{f}({}^{y}/_{y_M}, \mathrm{x}, \beta) + v_i + u_i \tag{10}$$

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 equation (10) shows, in 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. In the formulated specification, we are dealing with radial expansion or contraction of outputs and inputs respectively, and these ratios are constant for each term (Coelli and Perelman, 1996).

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. Aigner et al. (1977) assume that the error term (v) is independently and identically distributed 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 (iid) half normal random variables with a scale parameter δ_u^2.

Finally, technical efficiency of farm households in the production of mixed outputs will be calculated as:

$$TE_0 = \exp(-u_i^+) \tag{11}$$

Battese and Coelli (1995) developed a single step maximum likelihood procedure to estimate both the parameters of distance function frontiers and factors that determine the technical efficiency of farms. Accordingly, this can be done by integrating the following equation to the estimation procedure.

$$\mu_i = \alpha_0 + \sum \alpha_n Z_{ni} + \varepsilon_i \tag{12}$$

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

3.2. 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 have used 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.

The LSMS-ISA data were collected from randomly selected farm households (3,890 from Ethiopia and 3,924 from Tanzania) using a multi-stage sampling procedure. The dataset comprises of households living in small towns, who based their livelihood on non-farm activities and shows missing values with respect to key input and output components. Some farmers in the sample might not supply their produce (one or more products, or the entire harvest) to the market and they fail to respond to questions related to selling prices of the commodities in their production schedule. In such cases, we have used the opportunity cost approach to estimate the value of production using regional averages of prices of commodities. After taking out those cases that cannot fit in the estimation procedure, the respective country samples used in this paper total, respectively, 1,346 observations, in Ethiopia; and 931 observations, in Tanzania.

Existing analytical work on the empirical efficiency of peasant (smallholder) agriculture provides various approaches to classify the output from the production process. For example, Chavas et al. (2005) in their work in Gambia used a very detailed classification of outputs (vegetables, fruits, rice, sorghum and millet, groundnut, maize and cassava, and off-farm income from wages or self-employment), while ignoring livestock production due to lack of data. Conversely, Coelli et al. (2004) used a more aggregated approach that included the value of subsistence crops, cash crops and coffee production. The empirical choice of outputs and aggregation levels is determined by the type of production technology, availability of data, sample size (to keep some level of degree of freedom) and the requirements of the estimation procedures (Coelli et al., 2004; Chavas et al., 2005).

In our estimation procedure, we have aggregated the outputs as the annual value of crop harvest and value of livestock production per household[11], valued in the respective local currencies (*Birr* in Ethiopia and *Shilling* in Tanzania). The value of these outputs is calculated using an opportunity cost method, by using the price of the sold proportion to calculate the return of the unsold items. Cultivated land per household (in hectares), labour use[12] (both family labour and hired labour as adult equivalent), and the intermediate input[13] expenditure

[11] Value of livestock production is the sum of the total cash received from live animal net sales, animals for home consumption and the value of other products sold and used by the household.
[12] Labour use is measured in terms of the number of days worked on the farm.
[13] Intermediate inputs include here seeds, fertilizer, chemicals, feed, medication for livestock, etc; and we include both purchased and self-consumption (the latter being own production used as an input for other activities).

(in *Birr and Shilling* in Ethiopia and Tanzania respectively) are the common inputs directly used in the production process, for which there are observations in the datasets at disposal, and are used as explanatory sets in the estimation procedure.

The most commonly used production function in agricultural production estimation is a translog function. One of the most important reasons is that this functional form is preferred for the flexibility in its form. This helps to capture the transformation relationship of inputs and outputs (Aigner et al., 1977; Coelli and Perelman, 1999; Sauer et al., 2006). In addition to this empirical importance, some of the functions, such as Cobb-Douglas violate important curvature properties (e.g., convexity) (Coelli and Perelman, 2000; Fare et al., 2005).

Building upon equation (10), the empirical model with translog specification looks like:

$$
\begin{aligned}
-\ln Crop = {} & \beta_0 + \beta_1 \ln\left({}^{livest}/{}_{crop}\right) + \beta_2 \ln(Land) + \beta_3 \ln(intinput) + \beta_4 \ln Labor \\
& + 0.5\alpha_1(\ln Land)^2 + 0.5\alpha_2(\ln intinput)^2 + 0.5\alpha_3(\ln Labor)^2 + \alpha_4(\ln Land * \ln intinput) \\
& + \alpha_5(\ln Land * \ln Labor) + \alpha_6(lninterinput * lnLabor) + \alpha_7(\ln\left({}^{livest}/{}_{crop}\right) * \ln land) \\
& + \alpha_8(\ln\left({}^{livest}/{}_{crop}\right) * \ln labbor) + \alpha_9(\ln\left({}^{livest}/{}_{crop}\right) * \ln intinput) + v_i + u_i
\end{aligned}
\tag{13}
$$

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.

Using the empirical extensions of the model by Battese and Coelli (1995), the technical inefficiency function (equation 12) will be integrated with the output oriented distance function, presented in equation (13).

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).

$$Ogive = \sum_{n=1}^{N} \frac{\left(X_n - \left(1/_N\right)\right)^2}{1/_N} \quad (14)$$

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).

4. Results and Discussions

4.1. Descriptive statistics

Table 2 presents the descriptive statistics of the whole sample to give an overall picture of the households in the two countries included in the analysis. The average landholdings in Ethiopia and Tanzania are 1.2 and 3.34 hectares, respectively. The sample includes crop-livestock mixed production system, which has been practiced by most of the farm households. There is diversity in the production systems across regions of both countries. For instance, such diversity is clearly observed in differences in terms of livestock ownership: in mixed crop-livestock production systems few animals seem to be kept primarily for draft power requirements and risk coping strategy; whereas agro-pastoral households keep quite a relatively larger number of livestock (cattle) as their primary (and sometimes single) income source. Around 86% and 83% of the sample households are male headed; and about 40% and 26% of the household heads in the sample are illiterate (i.e., cannot read and write), in Ethiopia and Tanzania, respectively.

The availability of productive and gainful employment is captured through the ratio of employed members in the household to total household members available for work. The average value for this ratio is around 80% in both countries, which is a little lower than the average labour force participation rate of about 86% in Ethiopia and 90% in Tanzania (World Economic Forum Report, 2013). As described in table 1, the indicator for the prevalence of precarious employment includes casual (short term contracts) and seasonal work to total workforce engaged in the agricultural production activities of the household. Participation of women in agricultural activities ranges from 14% in Ethiopia to 48% in Tanzania. Based on the data at disposal, child labour in the sample for Tanzania is around about 6% of the total agricultural labour used by the household. The average proportion of employment in the precarious category to the total labour is 0.06 in Ethiopia and 0.09 in Tanzania. These low values may be explained by the limited use of hired labour among smallholders in the sample, who are mainly subsistence producers and may rely on family members, and thus only limited labour is outsourced.

In terms of social protection, participation in PSNP and food for work program in Ethiopia and cash, food and in-kind transfers from the government and NGOs in Tanzania are social protection schemes captured through this analysis. In addition, cash, food and in-kind transfers from relatives, friends and neighbours in Ethiopia are considered as informal social protection options.

Table 2: Descriptive statistics of the sample

Variables	Units	Ethiopia (N=1346)		Tanzania (N=931)	
		Mean	Std. dev.	Mean	Std. dev.
Age of the Household head	Years	44.19	14.20	47.58	14.32
Age dependency ratio	%	1.25	0.91	1.14	0.82
Land	Hectares	1.21	1.93	3.34	5.19
Cost of intermediate inputs	Monetary	463.21	812.03	1.41e+05	2.66e+05
Labour	adult equivalent	122.54	150.95	164.36	156.72
Value of crop harvest	Monetary	7989.74	16169.94	4.58e+06	1.05e+08
Value of livestock	Monetary	3068.23	8909.06	1.45e+06	1.56e+07
Livestock	TLU	5.82	4.68	1.84	6.56
Concentration index	Index	1.58	0.55	1.06	0.56
PSNP and food for work	Monetary	41.19	391.65	-	-
Cash, food and in-kind transfer	Monetary	-	-	3889.67	9594.71
Informal transfers	Monetary	214.71	1192.86	-	-
Employment to workforce 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	kilometres	18.43	18.91	14.81	23.05
Annual precipitation	mm	942.39	373.38	1061.16	221.02
Wettest quarter precipitation	mm	613.93	240.51	570.45	128.08
Value of crop harvest	Monetary	7989.74	16169.94	4.58e+06	1.05e+08

Dummy variables

		Ethiopia	Tanzania
	Group	Percent	Percent
Sex of the household head	Male	86.26	82.71
	Female	13.74	17.29
Household head literacy	Illiterate	39.52	25.99
	Literate	60.48	74.01
Access to credit	With	26.15	3.11
	Without	73.85	96.89

Extension service (crop)	With access	31.28	-
	No access	68.72	-
Extension service (livestock)	With access	1.86	-
	No access	98.14	-
Advisory services	With access	-	19.23
	No access	-	79

In a smallholder agricultural production system, access to timely, reliable and affordable input and technical advisory services is crucial. Ethiopia and Tanzania have public agricultural extension systems that provide both input and consultancy services. In both countries, a significantly small share of the sample households has access to the agricultural extension services both in the crop and livestock sector. The importance of (micro) credit services in smallholder agriculture is widely acknowledged, given prevailing liquidity constraints that condition the overall production process. However, only less than a quarter of the households in Ethiopia and only a few households in Tanzania have access to those services[14]. Infrastructure development is another crucial element in enhancing production and productivity of smallholder farmers, but rural areas in Ethiopia and Tanzania have poor functional linkages with the input and output markets due to existing poor infrastructure condition. The average distance to the nearest main road in the sample is about 14 km and 18 km in Tanzania and Ethiopia, respectively.

We acknowledge the fact that differences in production systems may condition the diversity in gross margins generated from agricultural production per household across regions. In order to evaluate whether there exists a significant difference in the mean partial productivity estimates across regions, a multivariate test of means was applied, using a generalized form of mean comparison using chi-square statistics. For that purpose, partial productivity measures, such as production per hectare of land or production per labour use in adult equivalent are often used to get some picture of the production system. In particular, we have calculated and tested for differences across regions for measures of productivity per hectare of land for the agricultural production activity, and production per used labour in adult equivalent. These values show statistically significant differences in Ethiopia, while no significant heterogeneity across regions is found in Tanzania (see Appendix 1). The variability across regions in Ethiopia could be explained by many factors, including differences in the production system,

[14] A household is considered to have access to credit if it received loans, either from informal or formal sources, in the year.

production orientation, population and settlement conditions, agro-ecological and climatic conditions, market or other institutional arrangements.

Nonetheless, due care should be given when drawing a conclusion from partial productivity measures, since they do not completely reflect the whole picture of the production process. The overall production efficiency, which captures the combined input-output transformation effects of the production process, is discussed in the following sections.

4.2. The production function estimation

The maximum likelihood (ML) results of the Output Oriented Distance Frontier estimation are presented in Table 3. 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). In the estimation, a translog specification was applied, which is more flexible and most preferred in empirical specifications for agricultural production efficiency estimation in comparison to the more restrictive Cobb-Douglas production function. A likelihood ratio test has been applied comparing commonly used specifications, and the Cobb-Douglas specification was rejected.

The residuals of our estimation results are negatively skewed[15] 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 (Coelli and Fleming, 2004). 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[16]. 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. In other words, our estimated output oriented distance function is non-decreasing in output.

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

<u>Table 3:</u> 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*land)^2	0.05 (0.02)	2.30***	-0.01 (0.01)	-0.74
(*ln*labour)^2	-0.01 (0.02)	-0.12	0.01 (0.02)	0.64
(*ln*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	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	

Note: *, **, and *** represents 10, 5, and 1% level of significance

4.3. 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. They substantiated their findings with the premise that better educated household heads may have better access to non-farm employment, which limits their efficiency in agricultural production. In Ethiopia and Tanzania, prevailing low educational levels seem to condition the adoption of improved agricultural technologies and farm management strategies. They lack the ability to efficiently use resources and to translate skills and knowledge to improve production.

In both Ethiopia and Tanzania, a higher household concentration or specialization is associated with greater efficiency in agricultural production. In this paper, specialization or concentration index is mainly referring to on-farm specialization in crop and livestock production. This is due to the fact that few households participate in off and non-farm income-generating activities, on the one hand, and the share of income out of those activities is quite low, on the other. 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. Farms in our sample are likely to adopt mixed crop livestock agricultural activities to manage risk and wealth accumulation, given less developed financial markets and the natural complementarity of such practices. In a small farm context, crop and livestock activities could be a complementary joint production scheme. However, 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. This also in some way in line with findings supporting some on-farm specialization, as the benefits of concentrating in a production activity are worth more compared to combining crop production with a relatively sizeable livestock activity.

In the case of Ethiopia, an interesting result is that 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 (see also Asfaw et al., 2014; Boon et al., 2013).

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 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 significantly limited to seasonal and casual forms of agricultural wage work, which is mainly undertaken by the landless and other resource poor workers. In an overall low productivity setting, these low paid and precarious forms of employment could be detrimental to the overall agricultural efficiency. This could be due to limited incentives for investing in more capital intensive technology or in acquiring skills specific to a given farm or farming practice. In addition, 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. This 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.

4.4. Scale and Technical Efficiency in Ethiopia and Tanzania

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 a low 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. These authors have 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, and they interpreted the result as an indication of the existence of imperfect markets, where farmers lack flexibility of allocating resources to alternative production activities. In sub-Saharan Africa, factor market are less developed and weakly functional and hence they pose limits to the flexibility that farm operators have for resource allocation (Chavas et al., 2005; Barett et al., 2008; Anriquez and Daidone, 2010). 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 supply that is employed in agricultural activities, mainly due to limited availability of options outside the farm. 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.

The technical efficiency of farms was estimated using the output oriented stochastic distance function approach. 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 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.

5. Concluding Remarks and Policy Implications

This paper has substantiated the importance of decent rural employment for more effective rural development policies and strategies. Our literature review confirms that, while there are conceptual and policy discussions around the topic, a major gap prevails at the empirical level. The paper contributes to fill this gap through an analysis of the implications of decent rural employment on agricultural production 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 (i.e., employment to workforce available ratio, proportion of precarious employment to the total employment available, payments from productive safety net and food for work) and technical efficiency of farms.

The positive effect of the employment ratio on technical efficiency proves the importance of creating and expanding productive jobs for farmers and their working-age family members in rural areas. In particular, the findings emphasize that supporting more productive and decent on-farm employment (i.e., self-employment of farm household heads), and creating more productive and decent employment opportunities for the rural workforce by and large can lead to a win-win situation for sub-Saharan Africa smallholder agriculture in terms of efficiency gains in farm production and job creation.

Given high population growth in rural areas of sub-Saharan Africa, investing in the creation of employment opportunities for the available labour force is particularly pertinent. The limited availability of off- and non-farm employment opportunities negatively influences the efficiency of the labour force in agricultural production. Availability of employment is indeed essential but not a sufficient condition to improve the overall agricultural efficiency and hence the economic transformation of the sector. The available options should on the one hand, be productive to the producers and employers, and on the other hand, should help in improving the living conditions of the workers and their families.

Our empirical analysis in Ethiopia and Tanzania finds that there is a room for improving the productive capacity of smallholder producers 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 could be achieved. Our findings also indicate that, under certain circumstances, certain forms of specialization in farm production can contribute to increase on-farm technical efficiency. Farms in our sample have a relatively small scale of production and seem to be diversified within a given production activity, such as producing a wide range of crop types or engaging in different livestock activities. In such contexts, additional on-farm diversification might require farmers to have a certain level of managerial skills and might also create competition over labour and other resources. Hence, the advantages from specializing in one production activity can outweigh the benefits of involving in more than one production activities. Furthermore, farms in the sample are operating in decreasing returns to scale (DRTS) which would imply that, on average, some of the inputs are used beyond the optimal level. Considering agricultural resource constraints and high population growth rates in Ethiopia and Tanzania, it would seem advisable to look deeper at the use of inputs in the production process. Possible reasons could be the excess labour supply that is directed to agricultural production due to limited employment opportunities in other off and non-farm activities. Therefore, there would be a room for policy interventions that aim to promote labour demand in the rural areas of sub-Saharan Africa, such as favouring rural entrepreneurship, complemented with public employment programs and labour supply side interventions, like skills development.

Skills development and education emerges as an important area for policy intervention, as the empirical findings confirm that adequate agro-technical skill levels are vital in the decision making process in resource allocation for agricultural production. In our sample, literacy of household heads is associated with higher technical efficiency. More advanced farming technologies are more demanding in terms of skills from farm workers. We would also expect entrepreneurial skills, such as in management and marketing, gain increasing relevance as the farm units become more commercially-oriented. As the rural economy diversifies, rural workers may be required to gain a more varied set of skills. Given the low levels of observed educational attainment among the rural adult population, technical efficiency in the countries could benefit from improving their technical skill and general educational levels. In that regard, though not explicitly analyzed in this paper, prevailing demographic patterns in SSA countries underline the need to look at skills development programmes for young farmers, in view of their key role in the rejuvenation and modernization of the sector. In addition, it is important to strengthen the outreach of agricultural extension services, also by supporting other ways for transferring of agricultural knowledge, such as farmer field schools and experience sharing visits.

To our knowledge, this paper has been the first in its type to explicitly raise the issue and role of precarious employment in the efficiency of smallholder agriculture. Low level of employees' motivation related to the seasonality and casual nature of the work, dissatisfaction with wage payments or the employees' low skill and experience could contribute to low levels of production efficiency. The productive capacity and motivation of agricultural workers can be improved by supporting more stable contractual arrangements, and improved access to social protection.

Access to social protection in Ethiopia has contributed to the improvement of agricultural production efficiency. Improved social protection in the rural areas of the developing world might contribute towards improving liquidity constraints and prevent families from falling into poverty trap, which is the classical problem in the study areas. PSNP and food for work programs do not only support the households in coping with shocks, but also add to the resource base of subsistence farmers. These programs can also serve as a mean to transfer implicit knowledge, skills and experience. This cash or food transfer from the productive safety net and food for work programs can either be used for consumption or could otherwise be invested in agriculture for the production purpose.

Overall, our empirical findings verified the implication of decent rural employment to improve the levels of agricultural production efficiency in two case countries in sub-Saharan Africa (Ethiopia and Tanzania). 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, providing access to skill development and formal education, 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. Governments and other organizations should support policies and programs that increase decent rural employment opportunities in sub-Saharan Africa to reduce rural poverty by simultaneously improving agricultural production efficiency and rural livelihoods. As our findings suggest, there are significant differences across farm units and rural settings, which need to be accounted for in the design of such interventions. Finally, future research could further elaborate the findings of this paper with improved rural labour data, especially using panel datasets, and thus enrich the analysis by expanding to other dimensions of decent rural employment.

6. References

Aigner D., C. Lovell and P. Schmidt, 1977. Formulation and Estimation of Stochastic Frontier Production Function Models, *Journal of Econometrics*, 6:21-37.

Akerlof, G. A., & Yellen, J. L. (1990). The fair wage-effort hypothesis and unemployment. *The Quarterly Journal of Economics*, 255-283.

Alene, D. A., and M. Zeller, 2005. Technology Adoption and Farmer Efficiency in Multiple Crops Production in Eastern Ethiopia: A Comparison of Parametric and Non-parametric Distance Functions, *Agricultural Economics Review,* 6 (1):5-18

Ali, R., Alwang, J., Siegel, P.B., 1991. Is Export Diversification the Best Way to Achieve Export Growth and Stability?: A Look at Three African Countries, Working Papers Series 729, Policy, Research and External Affairs, Agriculture Operations, World Bank, Washington, D.C.

Alic, J.A, 1997. Technological Change, Employment, and Sustainability. *Technological Forecasting and Social Change* 55, 1-13

Anker, R., I. Chernyshev, P. Egger, F. Mehran and J. Ritter 2002. Measuring Decent Work with Statistical Indicators, International Labour Organization, Policy Integration Department, Working Paper No. 2 Geneva, Switzerland

Anriquez, G. and S. Daidone, 2010. Linkages between Farm and Non-Farm Sectors at the Household Level in Rural Ghana: A Consistent Stochasitc Distance Function Approach, *Agricultural Economics*, 41(1):51-66

Asfaw, S., B. Davis, J. Dewbre, S. Handa, and P. Winters, 2014. Cash Transfer Programme, Productive Activities and Labour Supply: Evidence from a Randomised Experiment in Kenya, Journal of Development Studies, Volume 50, Issue 8.

Auer, P., J. Berg and I. Coulibaly, 2004. Is a Stable Workforce Good for the Economy? Insights into the Tenure-Productivity-Employment relationship, Employment Analysis and Research Unit Working Paper 15

Barrett, C.B., T. Reardon, P. Webb, 2008. Shadow Wages, Allocative Inefficiency, and Labour Supply in Smallholder Agriculture, *Agricultural Economics*, 38: 21–34

Battese, G. and T. Coelli, 1995. A Model for Technical Inefficiency Effects in a Stochastic Frontier Production Function for Panel Data, Empirical Economics, 20: 325–332.

Bell, S. and K. Newitt, 2010. Decent Work and Poverty Eradication: Literature Review and Two-country Study, A Study for the Decent Work and Labour Standards Forum, Ergon Associates Limited, London, UK

Boone, R., K. Covarrubias, B. Davis, and P. Winters, 2013, Cash transfer programs and agricultural production: the case of Malawi. Agricultural Economics, 44: 365–378

Buchanan, J., 2006. From ´Skill Shortage´ to Decent Work: The Role of Better Skill Ecosystems, A Policy Research Paper Prepared for the NSW Board of Vocational Education and Training, Workplace Research Center, University of Sydney, Australia

Burchell, B., K. Sehnbruch, A. Piasna and N. Agloni, 2014. The Quality of Employment and Decent Work: Definitions, Methodologies and Ongoing Debates, *Cambridge Journal of Economics* 38: 459-477.

Chavas, J.P, Petrie, R. and M. Roth, 2005. Farm Household Production Efficiency: Evidence From the Gambia, *American Journal of Agricultural Economics,* 87(1): 160–179

Coelli, T., 1995. Estimators and Hypothesis Tests for a Stochastic Frontier Function: A Monte Carlo Analysis, *The Journal of Productivity Analysis,* 6:247-268

Coelli, T. and S. Perelman, 1996. Efficiency Measurement, Multiple-output Technologies and Distance Functions: with Application to European Railways, C*entre de Recherche en Economie Publique et en economie de la Population (CREPP),* 96(05)

Coelli, T. and S. Perelman, 1999. A comparison of parametric and non-parametric distance functions: With application to European railways, *European Journal of Operational Research*, 117: 326–339.

Coelli, T. and S. Perelman, 2000. Technical Efficiency of European railways: a Distance Function Approach, *Applied Economics,* 32:1967-1976.

Coelli, T., S. Rahman and C. Thirtle, 2002. Technical, Allocative, Cost and Scale Efficiencies in Bangladesh Rice Cultivation: A Non-parametric Approach, *Journal of Agricultural Economics*, 53 (3): 607-626

Coelli, T. and E. Fleming, 2004. Diversification Economies and Specialization Efficiencies in a Mixed Food and Coffee Smallholder Farming System in Papua New Guinea, *Agricultural Economics* 31: 229-239

Coelli, T. J., P. Rao, J. O´Donnell and E. Battese, 2005. An Introduction to efficiency and Productivity Analysis, Second Edition, Springer

Conyon, M. J. and R. B. Freeman, 2002. Shared Modes of Compensation and Firm Performance: UK Evidence, Centre for Economic Performance London School of Economics and Political Science, London, UK

Davis, B., Di Giuseppe, S. and A. Zezza, 2014. Income Diversification Patterns in Rural Sub-Saharan Africa: Reassessing the Evidence, World Bank, Policy Research Working Paper 7108, November 2014, World Bank, Washington D.C., USA.

Dorward, A., 2013. Agricultural Labour Productivity, Food Prices and Sustainable Development Impacts and Indicators, *Food Policy*, 39:40-50

Evans, J. and E. Gibb, 2009. Moving from Precarious Employment to Decent Work, International Labour Organization, Global Union Research Network (GURN), Discussion Paper No. 13, Geneva, Switzerland.

FAO (Food and Agriculture Organization), 2010. Guidance on How to Address Decent Rural Employment in FAO Country Activities, Gender, Equity and Rural Employment Division, Second Edition, Rome, Italy.

FAO (Food and Agriculture Organization), 2012. Decent Rural Employment for Food Security: A Case for Action, Gender, Equity and Rural Employment Division, Rome, Italy.

FAO (Food and Agriculture Organization), 2014. Turning family farm activity into decent work, Information Material, July 2014, http://www.fao.org/fileadmin/user_upload/fao_ilo/pdf/FF_DRE.pdf accessed Feb. 26, 2015

Fare, R. and D. Primont, 1995. Multi-output Production and Duality: Theory and Applications. Kluwer Academic Publishers, Norwell, Massachusetts.

Fare, R., S. Grosskopf, D. W. Noh, and W. Weber, 2005. Characteristics of a Polluting Technology: Theory and Practice, *Journal of Econometrics*, 126:469-492

Farell, M.J., 1957. The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society Series A (General)*, 120: 253–81

Fields, G., 2011. Labour Market Analysis for Developing Countries, Labour Economics, 18:16-22

Ghai, D., 2002. Decent Work: Concepts, Models and Indicators, International Institute for Labour Studies, Discussion paper 139/2002, Geneva, Switzerland.

Gilligan, D. O., J. Hoddinott, A. Seyoum Taffesse, 2008. The Impact of Ethiopia's Productive Safety Net Programme and its Linkages, IFPRI Discussion Paper 00839, , Washington D.C., USA.

Hoddinott, J., Guush Berhane, D. O. Gilligan, N. Kumar, A. Seyoum Taffesse, 2012. The Impact of Ethiopia's Productive Safety Net Programme and Related Transfers on Agricultural productivity, *Journal of African Economies*, 21(5): 761-786

Haggblade, S., P. Hazell, and T. Reardon, 2010. The Rural Non-Farm Economy: Prospects for Growth and Poverty Reduction, *World Development*, 38 (10): 1429-1441.

Harris, J.R., and M.P. Todaro, 1970. Migration, unemployment and development: A two-sector analysis, *American Economic Review* 60 (1), 126–142.

International Labour Organization (ILO), 1999. Decent work, Report of the Director-General, Geneva, Switzerland.

International Labour Organization (ILO), 2006. Decent work FAQ: Making Decent Work a Global Goal, Geneva, Switzerland.

Irz, X. and C. Thirtle, 2004. Dual Technological Development in Botswana Agriculture: A Stochastic Input Distance Function Approach, *Journal of Agricultural Economics* 55(3):455-478

Katz, L. F. (1986). Efficiency wage theories: A partial evaluation. In *NBER Macroeconomics Annual 1986, Volume 1* (pp. 235-290). MIT Press.

Kumbhakar, S. and C. Lovell, 2000. Stochastic Frontier Analysis, Cambridge: Cambridge University Press.

Kumbhakar, S., L. Orea, A. Alvarez E. Tsionas, 2007. Do We Estimate an Input or an Output Distance Function? An Application of the Mixture Approach to European Railways, *Journal of Productivity Analysis* 27:87–100

Levine, D., 1992. Can Wage Increases Pay for Themselves? Test with a Production Function. *Economic Journal* 102: 1102–115.

Mas, A., 2006. Pay, Reference Points and Police Performance, *The Quarterly Journal of Economics*, 121(3):783-821

Mugera, A.W. and M.R. Langemeier, 2011. Does Farm Size and Specialization Matter for Productive Efficiency? Results from Kansas, *Journal of Agricultural and Applied Economics*, 43(4):515–528

Newman, C. and A. Matthews, 2006. The Productivity Performance of Irish Dairy Farms 1984-2000: A Multiple Output Distance Function Approach, *Journal of Productivity Analysis* 26:191–205

Ng, Y. C., & Li, S. K. (2003). Training and productive efficiency in transition economies. *Oxford Economic Papers*, *55*(4), 607-624.

O'Donnell, C. and T. Coelli, 2005. A Bayesian Approach to Imposing Curvature on Distance Functions, *Journal of Econometrics*, 126: 493–523

Ortega, B. and A. J. Marchante, 2010. Temporary contracts and Labour Productivity in Spain: a Sectoral Analysis, *Journal of Productivity analysis* 34:199–212

Pollin, R., M. W. Githinji and J. Heintz, 2007. An Employment-Targeted Economic Program for Kenya, Political Economy Research Institute (PERI), Massachusetts-Amherst, USA.

Rahman, S., 2009. Whether Crop Diversification is a Desired Strategy for Agricultural Growth in Bangladesh, *Food Policy* 34: 340-349

Rao, P., T.J. Coelli and M. Alauddin, 2004. Agricultural Productivity Growth, Employment and Poverty in Developing Countries, 1970-2000. World Employment Report 2004-05, Employment, Productivity and Poverty Reduction, Employment Strategy Department, Employment Strategy Papers.

Sadoulet, E., De Janvry, A., and Benjamin, C., 1998. Household Behavior with Imperfect Labour Markets, *Industrial Relations: A Journal of Economy and Society*, 37(1): 85-108

Satch, M. and J. Temple, 2009. Labour markets and productivity in developing countries, *Review of Economic Dynamics* 12:183–204

Sauer, J., K. Frohberg and H. Hockmann, 2006. Stochastic Efficiency Measurement: The Curse of Theoretical Consistency, *Journal of Applied Economics* 9(1): 139-165

Slocum, J. W., 1981. Job Redesign: Improving the Quality of Work Life, *Journal of Experimental Learning and Simulation* 3:17-36

Solis, D., B. Ureta and R. E. Quiroga, 2009. Technical Efficiency among Peasant Farmers Participating in Natural Resource Management Programs in Central America, *Journal of Agricultural Economics*, 60 (1): 202–219

Todaro, M. and S. Smith, 2012. Economic Development, 11th Edition. Addison-Wesley publisher, USA

Vandenberg, P., 2004. Productivity, decent employment and poverty: Conceptual and practical issues related to small enterprises, SEED Working Paper No. 67, International Labour Office, Geneva, Switzerland.

World Bank, 2008. Agriculture for Development, World Development Report, Washington DC.

World Economic Forum, 2013. The Human Capital Report, Vol. 5 (2013), Geneva, Switzerland.

Yao, S., 1997. Profit Sharing, Bonus Payment, and Productivity: A Case Study of Chinese State-Owned Enterprises, *Journal of Comparative Economics* 24:281-296

Appendix 1

	Gross margin	Land productivity[17]	Labour prod.		Gross margin	Land prod.	Labour prod.
Ethiopia	10082.91	18817.55	206.08	Tanzania	9.83e+06	7.91e+06	1.84e+05
Tigray	9576.04	12213.28	135.79	Region 1	3.3e+06	1.4e+06	3.35e+04
Afar	16037.60	57438.40	644.43	2	6.2e+06	7.4e+06	1.43e+05
Amhara	7522.31	9057.41	146.36	3	6.4e+06	1.32e+07	8.56e+05
Oromia	12786.61	15810.56	245.60	4	7.05e+06	1.96e+06	6.24e+05
Somalie	9533.74	63548.43	440.13	5	2.8e+06	2.9e+06	5.81e+04
Benshangul	13370.21	7522.68	152.09	6	5.1e+06	5.7e+06	1.99e+05
SNNP	9843.83	18093.62	206.39	7	1.33e+06	1.83e+07	1.85e+05
Gambella	10509.44	50916.45	382.04	8	5.5e+06	3.5e+06	3.53e+04
Harari	18997.98	38778.59	243.54	9	6.2e+06	6.6e+06	1.93e+05
Diredawa	6610.48	12455.60	76.11	10	5.0e+06	7.7e+06	7.96e+04
				11	3.9e+06	4.1e+06	1.22e+05
				12	6.7e+06	5.3e+06	9.78e+04
				13	3.1e+06	1.3e+06	1.88e+04
				14	6.2e+06	2.1e+06	351e+04
				15	1.3e+06	3.2e+06	2.37e+04
				16	5.1e+06	2.48e+06	2.69e+05
				17	8.8e+06	2.6e+06	9.93e+05
				18	6.4e+06	9.1e+06	6.05e+04
				19	8.4e+06	2.28 e+07	2.28e+05
				20	2.6e+06	4.2e+06	2.20e+04
				21	2.19e+07	2.98 e+07	6.08e+05
Wald chi2 (x^2)	47.37***	76.35***	55.06***		0.75	1.22	0.67

[17] Productivity is measured as value of production per hectare