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Decent Rural Employment

Decent rural employment in different farming systems in Sub-Saharan Africa

Decent Rural Employment, Productivity Effects and Poverty Reduction in sub-Saharan Africa

Elisenda Estruch, Peter Wobst
Food and Agricuture Organization of the United Nations

Lena Schickramm, Johannes Sauer, Getachew Abate-Kassa, Habtamu Y. Ayenew
Technical University Munich, Germany

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Abstract

The present paper focuses on how the relationship between decent rural employment and agricultural productivity vary across production systems. The focus is on sub-Saharan Africa, taking Ethiopia and Tanzania as case studies and using data from the respective Living Standards Measurement Studies (LSMS) 2010-2011.

Different farm production systems and technologies for a sample of farms in the two countries are identified using a statistical method known as latent class analysis. Latent classes identified are representative of two production systems in each of the two countries. Subsequently, we estimate the production efficiency of these systems and finally investigate whether our selected indicators of decent rural employment differ across such farm systems and respective production efficiencies.

According to our findings, key decent rural employment indicators, like employment ratio, child labour, and access to social protection, have effects on agricultural productivity which are specific to a given farm production system. The paper concludes that deficits in decent rural employment could be better addressed if countries in sub-Saharan Africa implement policies and programs to explicitly promote decent rural employment which account for such differences across production systems.

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

Introduction

This empirical paper focuses on how the relationship between decent rural employment and agricultural productivity varies across production systems. The focus is on sub-Saharan Africa (SSA), taking Ethiopia and Tanzania as case studies. To distinguish between the different farming systems in the two countries, we look at the diversification on the farm, the number of livestock they are keeping and other variables to characterize market access or environmental characteristics.

Agriculture remains an important sector in the economies of sub-Saharan Africa (SSA). In 2010, it employed 54.3 percent of the total male labour force and 45.7 percent of the total female labour force, generating 11.2 percent of the GDP (World Bank, 2013). About 80 percent of farms in SSA are of small size, with an average of 1.6 ha and often present low productivity levels (Wiggins, 2009). Most of those farms are rain-fed, and most likely will continue to be so (Cooper et al., 2008). There is diversity across farming systems in terms of performance. The three most common farming systems are crop-based farming systems, livestock-based farming systems and diversified[1] farming systems (Seo, 2010). According to this classification, the first two systems are specialized, while the diversified system is a mix of crop and livestock production.

Productive work, either in a form of self-employment or in a paid job, is an essential element towards improving rural livelihoods. The income from the labour is often the main asset that the rural poor can rely upon (Ayenew et al., 2015). In particular, FAO underlines the relevance of decent rural employment as a key part of rural poverty reduction strategies (FAO, 2010, 2012). Ayenew et al. (2015) looked at the influence of decent rural employment indicators on the farm productivity. The paper finds there is overall influence of decent rural employment on farm productivity, but for some indicators does not yield significant influence on productivity. We suspect this could be due to the fact that the farm is treated in a generalized form, failing to capture diversity in performance across different farm production systems. The present paper extends the analysis and groups farms into similar production systems (Otte and Chilonda, 2002) to find out whether decent rural employment indicators have different effects on productivity depending on the farming system. The present paper, to the best of our knowledge, is the first to establish an empirical relationship between decent rural employment indicators and technical efficiency for different farm production systems.

In a first analytical step, we identify different production systems and technologies for a sample of farms in the two countries using a statistical method known as latent class analysis. We follow by estimating the productive efficiency of these systems, and finally we investigate whether our selected indicators of decent rural employment differ across such farm systems and respective production efficiencies. The data for the two countries comes from the Living Standards Measurement Study (LSMS) 2010-2011.

The paper is structured as follows. After the introduction, section 2 provides a short overview of the concepts of decent rural employment and farming systems, and it describes how the two concepts are related, while discussing the main hypotheses that the paper will test empirically. Section 3 introduces the model and the methodology that will be used. The different latent classes of the representative farm

1 A diversified system is an integrated mixed farming system, which includes livestock and crop production at the on-farm level.

production systems for the two countries are presented in Section 4. Finally, section 5 closes with a discussion of the findings while highlighting the main implications in terms of decent rural employment for the existing policy debates about rural poverty reduction and the future role of farming systems in SSA.

Conceptual overview

1

1.1 Decent rural employment: definition and measurement

Most poor people in rural areas depend on their labour for their livelihoods and thus spent a considerable amount of time at work. Hence, both the quantity and quality of work are an important determination for their quality of life. The International Labour Organisation (ILO) argues that it is not only about generating productive and gainful employment opportunities, but also better and decent work opportunities. The ILO defines decent work as "opportunities for women and men to obtain decent and productive work in conditions of freedom, equity, security and human dignity" (International Labour Organization, 1999).

The FAO translates this into the rural context in their applied definition of decent rural employment[2] and establishes six dimensions (FAO, 2015). The first is that rural employment should respect core labour standards as defined by the ILO conventions. This means it should not include child labour, forced labour, guarantee freedom of association and the right to bargain, and there should be no discrimination at the work place. The second dimension is that rural employment should provide an adequate living income. The third dimension states that the employment should provide an acceptable degree of employment security and stability. Fourth, decent rural employment should adopt minimum occupational safety and health (OSH) measures, which need to be adapted according to the sector of work. Fifth, excessive working hours should be avoided and a sufficient time for rest should be given. And lastly it should promote access to technical or vocational training.

Promoting decent rural employment, FAO operates across the four pillars of the Decent Work Agenda,[3] with gender equality as a crosscutting objective. The first pillar is employment creation and enterprise development. Applied to a rural context, this pillar puts its focus on employment in agriculture and related rural economic activities. It includes efforts to promote agricultural productivity and the creation of small and medium agro-enterprises. It foresees skills development of the rural workforce with a focus on youth and women. The second pillar is about extending social protection and promoting occupational safety and health (OSH) measures. It also encourages the use of labour-saving technologies to reduce the double and triple burden of rural women, in view of their productive, domestic and care tasks. Maternity protection and minimum wage in agriculture also fall under this pillar. The third pillar, standards and rights at work, promotes labour contracts and the elimination and prevention of child labour and forced labour,

2 In FAO's definition, rural employment refers to any activity, occupation, work, business or service performed for pay or profit by women and men, adults and youth, in rural areas. It applies to waged and salaried workers as well as self-employed workers (including contributing family workers).

3 The Decent Work Agenda was developed by the ILO and endorsed by the international community to pursue full and productive employment and decent work for all at the global, regional, national, sectoral and local levels. It comprises four pillars, namely: Pillar I (employment creation and enterprise development); Pillar II (social protection); Pillar III (standards and rights at work); Pillar IV (social dialogue).

as well as the abolishment of any form of discrimination, especially against vulnerable groups such as women, migrants, ethnic minorities, and youth. In rural contexts, the fourth pillar on social dialogue favours the collective action and group cooperation of rural workers in social dialogue and policy making, with a special focus again on youth, women, informal workers and other vulnerable groups (FAO, 2011).

The four pillars of decent work are very diverse and complex, and thus they are hard to measure. For the same indicator different measurements can be applied. While quantitative or qualitative indicators could be used, the present analysis will focus on quantitative indicators. Another problem will be that there are often differences in measuring between countries, as even on the most common indicators in social statistics there are often discrepancies. This may yet be more the case concerning data about work and working conditions.

The definitions used in data collection vary not only between countries but also within one country over time, so that comparisons of data across countries and over time may be subject to measurement errors. It is thus unrealistic to assume that indicators for decent work can give a better picture of performance in individual countries, albeit less powerful for the purposes of cross-country comparisons. The indicators used here for different components of decent work should therefore be regarded as providing an approximate measure of performance (Ghai, 2003; Anker *et al.*, 2003).

This paper builds on the set of indicators used in Ayenew *et al.* (forthcoming), and we extend their work by further exploring the relationship across different latent classes. The indicators, the expected effect and the outcome that they yielded in the paper by Ayenew *et al.* (2015) can be found in Table 1.

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

Pillar of decent work	Indicators used	Measurement	Outcomes in Ayenew *et al.* (2015)	Expected sign
Pillar1: Employment creation	Employment to total workforce ratio*	Proportion of employed HH members to total HH workforce available	+ve for Ethiopia	+ve
Pillar 2: Social protection	Share of government transfer to income *	Total transfer from government and NGOs or PSNP in Ethiopian Birr and Tanzanian Shilling from the total income	+ve for both countries	+ve(-ve)
	Informal transfers to total income‡	Total informal cash, food and in-kind transfers in Ethiopian Birr from the total income	Not significant	+ve(-ve)
Pillar 3: Standards and rights at work	Child labour ratio†[4]	Proportion of child labour from the total labour used for agriculture activities by the HH	-ve	-ve
	Precarious employment ratio*	Proportion of HH seasonal and casual labour from the total HH agricultural workforce	-ve for both countries	-ve

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

4 Child labour ratio as an indicator is used only for Tanzania due to low response rates in Ethiopia.

Under pillar one of decent work, on the availability of employment opportunities, the ratio of employed household members to total household workforce[5] is used. The expectation is to have a positive influence on the productivity of the farm. Findings in Ayenew *et al.* (2015) confirmed this hypothesis for Ethiopia, albeit for Tanzania results were not significant. For pillar two, on social protection, indicators capturing access to cash and food transfers are used. Differences in the social protection systems of the two countries are accounted for, as well as the limited social protection coverage in rural areas that both systems have. 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, cash and in-kind transfers, which capture more informal forms of social protection through which households get support from relatives, neighbours and friends,[6] were also considered. While these informal transfers mostly yielded insignificant results, Ethiopia's PSNP program had a positive influence on agricultural productivity as had the governmental program of Tanzania. 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 agricultural activities by a given household. Prevalence of child labour and precarious employment in agriculture are expected to influence the efficiency of production negatively. In the earlier paper, child labour results were significant, as where indicators for precarious employment. Both reported a negative effect on efficiency. Child labour only in Tanzania, as there was not sufficient data available for Ethiopia, precarious employed was significant for both countries.

1.2 Farming systems

The farming system of the individual farm is characterised by resource endowments, family or household circumstances and the resource flow and interaction among the biophysical, socio-economic and human factors (Dixon *et al.*, 2001). This set of characteristics varies greatly from farm to farm. In order to group different farming systems together one can define production systems as "a population of individual farm systems that have broadly similar resource bases, enterprise patterns, household livelihoods and constraints, and for which similar development strategies and interventions would be appropriate" (Dixon *et al.*, 2001).
The approach of how to define farming systems changed greatly over the last 50 years.
The focus began very narrow only focusing on the farm itself, the crops and the household's food security. Over time, there was a shift towards a more holistic approach, which includes, among others, the household, community and district level as well as different forms of livelihood strategies. Attention to gender and productivity has also increased over time (Dixon *et al.*, 2001). Jayne *et al.* (2014) discuss the increased pressure on farming systems due to rising rural population density that Sub-Saharan Africa is experiencing, which they relate as well to a decreasing size of smallholder farms over time. This is reinforced by investment in land from urban-based people and foreign companies. Some countries, like Ethiopia, have already witnessed such increasing pressure over land, others have not yet, such as Tanzania. When (land) scarcity develops, there are different ways in which smallholders may deal with the situation. Jayne *et al.* (2014) point out five different options, which are not mutually exclusive: (i) intensification of land use (increasing

5 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 the last 7 days as reference period, includes those who were employed over the last 7 days reference period as self-employed, 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).

6 It constitutes cash, food and in-kind transfers/gifts from friends, neighbours and relatives (in Ethiopian Birr).

input use per piece of land, including labour); (ii) shifting labour to rural non-farm activities; (iii) migrating to other rural areas; (iv) migrating to urban areas; and (v) reduction of fertility rates. Which, if any, of those options will be employed, depends on the type of farm and the context circumstances. While there is an increase in the rural population in Africa, simultaneously the urban population is growing as well, demanding an increase in the agricultural productivity for the increased urban demand (Giller *et al.*, 2011). This increased demand asks for strengthening of intensification of production. When analysing farming systems one is confronted with an enormous variety of different and complex systems. Ultimately, decreasing availability of land will call for an intensification of land use in all farming systems.

The present paper follows Seo (2010) and classifies African agricultural households in three main farming systems. Those are: i) specialised crop farms, ii) specialised livestock farms and iii) a diversified farm that owns both crop and livestock. This approach has been chosen as the most relevant for classifying the farming systems in the study countries.

Using different types of farms for the measurement of efficiency is not a new approach. For example, Tzouvelekas *et al.* (2001) used a stochastic production frontier methodology and a translog functional specification to evaluate the efficiency across different farming systems, which was in their case conventional and organic olive farms in Greece.
A similar study by Bremmer *et al.* (2002) looked at conventional and organic farmers in Finland and found that the productivity in organic agriculture was lower in terms of capital, land and labour, relative to more conventional forms of farming. Sauer and Morrison-Paul (2013) used a latent class approach to divide a sample of Danish farms into three distinctive production systems. And Sauer *et al.* (2012) did a similar analysis for Kosovo. Those were established through various farm characteristics, like production and input intensity, organic or conventional production method and specialization of the farm. All of these examples deal with labour as an input component, however, none of these papers distinguish among different kinds of labour and explicitly look at quality aspects of employment.

1.3 Conceptual hypotheses

When looking at decent rural employment across different farming systems, we would expect effects of some decent rural employment indicators to differ depending on the farm system characteristics. The hypotheses are summarized in table 2. While we expect the employment to workforce ratio to have a positive effect on efficiency despite differences in farming systems, other indicators may be expected to perform differently. For instance, the informal and government transfers are expected to have also a positive effect, as they may help by smoothing consumption and providing alternative source of income in case of loss of earnings from agriculture or even be used for investment opportunities. Moreover, we could expect the effect of those payments to play a more important role in more specialised production systems, which may be more prone to a complete loss of earnings. While in a diversified production strategy earnings are already spread over several activities and an income loss from one activity would have a less severe effect on the total household income.
The effect of knowledge transfer and learning that those programs might foster should also not be ignored.

We might expect effects of child labour to differ across production systems. Child labour is often used in herding activities, which makes it difficult for children to attend formal school. Not going to school might yield negative effects in the long run (FAO, 2013). In the short run, poor families could gain from child labour (World Bank, 2007). However, there is often a trade-off between time spent at school (an investment in future benefits) and working (an investment in short run benefits)

(Adhvaryu and Nyshadham, 2012).
Long term effects of child labour are, for example, the foregone education, which in the future can have negative effects on productivity. This can be indirectly observed as the literacy of the household head is an important determination of the efficiency. Children involved in child labour might not have the opportunity to learn how to read and write and hence have less chances of affecting efficiency than the children not involved in child labour. Short run effects on productivity reflect the fact that child labour is frequently a low cost substitution for adult labour. In Malawi, for example, there is the perception that using adult labour for herding activities would not be a good use of labour potential (FAO, 2013). However, the use of child labour may depend on the type of livestock, flock size, etc. in crop production, children could be substituting for adult labour in those activities which may be perceived as requiring less skills or physical ability. Hence, in both livestock and crop production systems, we could expect a positive or negative effect of child labour on productivity (in the short run). In the diversified system, the effect is unclear, as it will depend upon activities undertaken by children in such settings.

Precarious employment is expected to have a negative effect in all three production systems. As most of the farm job is taken by the family members in rural areas of SSA, there are only limited seasonal and casual jobs left for the rural landless and other resource poor workers. These low paid and hired with precarious forms of employment do have little incentives and lower motivation to improve the farm efficiency.

Table 2. Decent rural employment indicators and expected relationship with efficiency for the different production systems.

Pillar of decent work	Indicators used	Crop- based production system	Diversified production system	Livestock-based production system
Pillar1: Employment creation	Employment to total workforce ratio*	+ve	+ve	+ve
Pillar 2: Social protection	Share of government transfer to income *	+ve	+ve/	+ve
	Informal transfers to total income‡	+ve	+ve/	+ve
Pillar 3: Standards and rights at work	Child labour ratio†[7]	+ve/-ve	+ve/-ve	+ve/-ve
	Precarious employment ratio*	-ve	-ve	-ve

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

7 Child labour ratio as an indicator is used only for Tanzania due to low response rates in Ethiopia.

Analysis

2

2.1 Methodology

The paper uses a parametric approach, as it has the necessary technical features[8] to empirically evaluate the relationship between decent rural employment and technical efficiency of farms (Orea and Kumbhakar, 2004; Coelli *et al.*, 2005; Newman and Matthews, 2006; Rahman, 2009).

To analyse decent rural employment across different farm systems, the parametric setting used is an extension of the classical Stochastic Frontier Analysis (SFA), namely the: Stochastic Distance Function (SDF) (see Annex 1 for a more detailed description of the methodology). The latter allows us to have more than one output, and to perform either input or output oriented efficiency analysis. Furthermore, 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 (Battese and Coelli, 1995).

In most economic sectors, including agriculture, productive units (farms, in our case) operate with different technologies or production systems. This is important to understand structural change and varying technical change patterns. One method to distinguish farms by different technologies is by categorizing them according to exogenous categories (Kumbhakar *et al.*, 2009; Chambers *et al.*, 2011; Tzouvelekas *et al.*, 2001; Lansink *et al.*, 2002; Latruffe and Nauges, 2013). However, as such a grouping may be both arbitrary and incomplete, a clustering procedure may be a more suitable approach. We apply a multivariate latent class model (LCM) to our stochastic frontier estimation procedure, as LCM is based on discrete unobserved variables (Magidson and Vermunt, 2001; Sauer and Paul, 2013) and can be applied to different regression type modelling procedures. Moreover, Orea and Kumbhakar (2004) suggested an approach to allow farms to use of a combination of technologies. Moreover, we use separate functions for Ethiopia and Tanzania to account for the inclusion of livestock as an output in the latter, as farm data at disposal show that the large majority of farms do not use livestock for production.

To explain the variation of technical inefficiency over different farms, we use a variety of potentially significant factors (Ayenew et al. (forthcoming)): a regional dummy, weather characteristics, age and sex of the household head, age dependency ratio, livestock holding in tropical livestock unit (TLU), access to extension services, concentration index, access to credit, distance to the nearest road, and the set of decent rural employment indicators (as defined in section 2, table 1). 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.

2.2 Latent classes

Both countries are divided into two distinct latent classes. To construct the two latent classes, three

8 The technical features we require are: factoring out the noise and a multi-output setting in mixed crop-livestock production.

variables are used to distinguish between the different production technologies. For Tanzania, the tropical livestock unit, concentration index and annual precipitation are used. While tropical livestock unit per adult labour equivalent of the household, concentration index and distance to the road are used for Ethiopia. In both countries we include a variable to capture livestock. In Ethiopia only, we use the ratio to capture livestock, instead of the index, as the latter was included in the country's production estimation. It was only included in the production function of Ethiopia, as in Tanzania not all households had livestock. In both countries, we include a variable to capture diversification of farm production, the concentration index. The third variable, distance to the road, is used to capture key market-access differences, while in Tanzania we used an environmental variable to account for the surroundings. We used different variables for the different countries, as the variables used to determine the latent classes had to have sufficient variation within the variable. In Ethiopia, the market access variable had sufficient variation and the environmental variable not, while in Tanzania it was the other way around. Those three key features are used to cluster the latent classes.

The detailed summary statistics for the two latent classes and countries are displayed in Table 3 and 4 respectively in Annex 2.

In Tanzania, the first latent class (T1) consists of 303 farms, while the second one holds 628 farms. The first latent class has very little livestock, less land and labour than the second class and is less diversified. Hence, we can classify it as a **specialised crop based production system** (T1) with a low number of farm animals. The limited resource availability in terms of land and labour (household as well as hired labour), together with the concentrated nature of crop production, may also explain the challenges of keeping large number of farm animals in such kinds of farming systems.

In Tanzania's second latent class (T2), farm households have a higher livestock index. The lower concentration index indicates that farm households in this latent class are less concentrated or more specialized than the households in the first latent class. Also, in this production system higher farm animal keeping activity is combined with higher land and labour resource availability. The system can be viewed as **a diversified production system** (T2).

The first latent class, the crop based farming system, relies less on precarious employment, but more on child labour relative to the diversified production system. Employment to workforce ratio is similar in both production systems.

For Ethiopia, both latent classes are diversified production systems. This could be due to the fact that Ethiopia experiences pressure on land (Jayne *et al.*, 2014) . The average farm size is considerably smaller in Ethiopia with 1.5 hectares in comparison with 3.3 hectares in Tanzania. Although both systems are diversified the first latent class (E1) is characterised by relatively less livestock and more land and labour available, than the second one (E2). Variations in the average concentration index and the tropical livestock index distinguish the level of diversification between the two production systems. The two latent classes in Ethiopia do not show large variation in terms of land. The first latent class has 329 farm households and the second latent class has 820 farm households.

Like in Tanzania, the first latent class (E1) is characterised by a more concentrated or less diversified production system with less livestock activities, and relatively more crop-related activities. The second latent class (E2) is a more diversified production system with more livestock production activities and less adult labour. Compared to Tanzania, Ethiopia's farm systems seem to be less labour intensive and farms seem to be generally smaller in terms of land size. Precarious employment is also lower in Ethiopia.

2.3 Maximum likelihood estimates

Two different production functions and efficiency estimates were calculated for the two respective latent classes, using the posterior class probabilities as a weighting factor. The maximum likelihood estimates with translog specifications for both latent classes are presented in Table 5 and 6 respectively. The variables land, labour, intermediate inputs and livestock crop ratio are significant and these variables have the expected signs.

In Tanzania (table 5 in Annex 3), in the concentrated crop based production system (T1), precarious employment plays a significant role in determining efficiency of production. Precarious employment in this latent class contributes significantly to inefficiency. In T2, precarious employment, literacy of the household head, distance to the road and child labour play a significant role in the determination of inefficiency. Precarious employment and child labour are associated with higher inefficiency levels in agricultural production, while the literacy of the household head contributes significantly to efficiency. While precarious employment plays a role in both systems, the coefficient is 20 times higher in the crop based production system (T1) than in the diversified production system (T2). This could be due to a relatively higher seasonality of production in T1.

Different findings across farm systems are also obtained in Ethiopia (Table 6 in Annex 3). In the less diversified production system (E1), the employment to workforce ratio contributes significantly to efficiency. Precarious employment, on the other hand, contributes significantly to inefficiency, as expected. Also, household literacy contributes significantly to efficiency in E1. In the more diversified production system (E2), precarious employment contributes significantly to inefficiency and household head literacy to efficiency, as well. Compared to Tanzania, the size of the coefficients is more similar here between the two systems.

In the more diversified production system (E2), cash, food and in-kind transfers and participation in the PSNP program contribute significantly to the efficiency of the farm. Participation in such programs, in addition to short term gains, may have long term asset building and knowledge enhancement effects. Farm households can expand their resource and asset base from the cash transfers they receive. There is also an implicit knowledge that farmers could gain from participating in the PSNP programs. It appears that such social protection mechanisms play significant roles in production systems that are more diversified and livestock oriented. Such programs could also be used as consumption smoothing in periods of shocks. In case of shock, social programs can help to overcome difficult periods.

In Ethiopia's less diversified production system (E1), the employment to workforce ratio is significantly contributing to efficiency. This significant relationship could be seen in relation to the more crop based and relatively specialized nature of the production activities in this latent class. The more family labour is employed the more efficient is the crop based production system. It appears that participation of family labour has a more positive impact on efficiency if this labour is used in crop production activities.

Discussion and conclusion

3

The link between technical efficiency and decent rural employment considering the specific production systems within the smallholder agricultural sector in developing countries has not been addressed in the literature so far. The present paper, to the best of our knowledge, is the first to fill this gap by establishing an empirical relationship between selected decent rural employment indicators and technical efficiency for different production systems. The four latent classes of smallholder farms identified in the present study for Ethiopia and Tanzania provide the opportunity to compare two different country realities. In Tanzania, we observe a clear cut distinction between a specialised crop production system and a diversified production system. In Ethiopia, two different diversified production systems can be found: a more diversified production system and a less diversified production system. Livestock production seems to be one of the differentiating factors being more relevant in diversified production systems. We note that in this paper, due to data constraints, diversification refers exclusively to on-farm diversification, and that we leave to future research to deepen the implications in terms of off-farm diversification.

With regard to the decent rural employment indicators, in both countries household head literacy contributed significantly to efficiency while precarious employment always led to higher inefficiency. In all farming systems, precarious on-farm employment is a major challenge to be addressed in order to increase farm productivity, and especially in those farm systems more reliant on crop production. The low quality and casual nature of work with low wage rates for unskilled labourers, which are the main characteristics of precarious employment, contribute to low levels of production efficiency.

Moreover, farm household head literacy tends to be a key contributing factor to enhance agricultural productivity in almost all types of production systems. A higher literacy level allows farm household heads to make better decisions in terms of production and marketing decisions, the role of skill development and education cannot be overemphasized in all production systems of these countries. Building human capital and expanding the education system in rural areas and within all types of agricultural production systems would be a key strategic approach that has to be closely pursued to enhance agricultural productivity.

In addition to this significant association of the aforementioned two decent rural employment indicators with technical efficiency/inefficiency across all production systems, there are some correlations which are specific to the different production systems in each of the two countries. In Tanzania, child labour contributed significantly to inefficiency for the diversified production system. In such production systems, due to an expanded livestock activity and limitations in family labour availability, child labour might have been used in keeping farm animals and in providing help in other farm activities. Children are commonly used in herding activities. However, while the percentage of child labour was on average higher in the specialized crop based farming system, results are not significant

in terms of inefficiency. The negative impact of child labour on efficiency in the diversified system is an important finding as it shows that child labour does not only have negative effects in the long run, but also direct short term effects on the production efficiency. We also experience a data gap, as in Ethiopia child labour data was very limited.

Overall, precarious employment seems to be a challenge in all types of production systems in both countries. This requires policy actions and institutional support in order to reduce the casual and unproductive nature of the labour force within the agriculture sector of these countries. Agricultural policy makers should not just focus on technological approaches in increasing agricultural productivity. Providing adequate attention to precarious employment and implementing appropriate policy and institutional frameworks would help improve the employment situation and create a better quality agricultural labour force. In addition, skill development and education are key factors to improve farm household head decision making activities within most types of production systems. This would require the implementation of production system targeted skill development and education in both countries.

The findings from the present paper also indicate the need for a differentiated and production system oriented policy approach to deal with some of the decent rural employment deficits and productivity issues. Productive self-employment opportunities for farm household family members tend to be significant in less diversified production systems that are also less livestock oriented. Agro-ecological related technologies to enhance agricultural productivity (e.g., intercropping or agro-forestry systems, etc.), for example, would help absorb an increasing number of farm household family members reducing decent rural employment deficits and at the same time help increase agricultural productivity in such production systems.

The effects of social protection programs in terms of participation in PSNP and cash and food transfer programs in Ethiopia also tend to be production system specific. These programs are implemented to some extent in a coordinated and structured way by public organizations. The results may indicate that such public social protection programs may likely have different effects on agricultural productivity in different production systems. In the case of child labour, it appears that more policy attention could be given to production systems that are relatively dominated by livestock production. It would not mean, however, that child labour may not be an issue in other production systems. Further empirical research in various production systems may provide better information for policy makers in these countries on the various decent rural employment issues. It appears that decent rural employment deficits in the agriculture sector of developing countries could be better addressed if these countries implement production system oriented employment policies and strategies.

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Annex 1 – Methodology

The paper uses a parametric approach, as it has the necessary technical features[9] to empirically evaluate the relationship between decent rural employment and technical efficiency of farms (Orea and Kumbhakar, 2004; Coelli *et al.*, 2005; Newman and Matthews, 2006; Rahman, 2009).

To analyse decent rural employment across different farm systems, the parametric setting used is an extension of the classical Stochastic Frontier Analysis (SFA), namely the: Stochastic Distance Function (SDF). The latter allows us to have more than one output, and to perform either input or output oriented efficiency analysis. Furthermore, 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.

Distance function can be represented in mathematical terms as:

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

$$d_i^O = d^O(x_{1i}, x_{2i} \ldots x_{Ni}, y_{1i}, y_{2i} \ldots x_{Mi}) \quad (2)$$

Where equation (1) and (2) 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).

9 The technical features we require are: factoring out the noise and a multi-output setting in mixed crop-livestock production.

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

$$1 = \mathrm{f}(\mathrm{y}, \mathrm{x}, \beta) \exp(\mathrm{v} + \mathrm{u}) \quad (3)$$

Or in logarithmic expression

$$0 = ln\,\mathrm{f}(\mathrm{y}, \mathrm{x}, \beta) + \mathrm{v} + \mathrm{u} \quad (4)$$

where y is the observed outcome, $ln\,\mathrm{f}(\mathrm{y}, \mathrm{x}, \beta)$ is the frontier goal pursued by the individual farm, and $v \sim N[0, \sigma_v^2]$ is the stochastic part.
The inefficiency, the amount by which the farm fails to reach the optimum (the frontier) is u. Here u is $u = |U|$ and $U \sim N[\alpha' z, \sigma_u^2]$, it is a normal–truncated normal model, which relaxes the restriction in the normal-half normal model of a zero mean of the underlying inefficiency (Greene, 2012).

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 in the estimation procedure.

$$\mu_i = \alpha_i Z_{ni} + \varepsilon_i \quad (5)$$

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. In most economic sectors, including

agriculture, productive units (farms, in our case) operate with different technologies or production systems. This is important to understand structural change and varying technical change patterns. One method to distinguish farms by different technologies is by categorizing them according to exogenous categories (e.g., Kumbhakar *et al.*, 2009). For instance, Mester (1993) and Grifell and Lovell (1997) grouped banks into private and savings banks. Kolari and Zardkoohi (1995) estimated separate costs functions for banks grouped in terms of their output mix. Mester (1997) grouped sample banks in terms of their location. Polachek and Yoon (1987) allowed for different regimes in estimating the earning frontier functions of employers and employees. Distinguishing farms is relatively new, for example Chambers *et al.* (2011) classified farms based on the rainfall amount. A number of empirical works are also done by classifying farms in to organic and conventional agriculture typologies (Tzouvelekas *et al.*, 2001; Lansink *et al.*, 2002; Latruffe and Nauges, 2013).

However, such a grouping may be both arbitrary and incomplete, as it only takes into account observed variables. Alternatively, a clustering procedure may be a more suitable approach. In particular, a multivariate latent class model (LCM) can be applied to our stochastic frontier estimation procedure, as LCM is based on discrete unobserved variables (Magidson and Vermunt, 2001; Sauer and Paul, 2013) and can be applied to different regression type modelling procedures.

In contrast to the standard stochastic frontier approach which fits one frontier for the whole sample, the latent class stochastic frontier approach estimates a unique frontier for each latent class. In this approach, the basis of assigning to each latent class is the highest probability (Orea and Kumbhakar, 2004). The posterior class probability is defined as follows:

$$P_j(\delta_j) = \frac{exp(\delta_j' q_i)}{\sum_{J=1}^{J} exp(\delta_j' q_i)}, j = 1, \ldots, J, \delta_J = 0 \quad (6)$$

with the class probabilities are parameterized as a multinomial logit model, where q_i is a vector of farm-specific variables. Based on the posterior probabilities from the latent class function we define as a conditional likelihood function (Lf)

$$Lf(\theta,\delta) = \sum_{j=1}^{J} LF_j(\theta_j) * P_j(\delta_j),\ 0 \le P_j \le 1,\ \sum_j P_j = 1 \quad (7)$$

Orea and Kumbhakar (2004) suggested an approach to deal with possible technological mixes. This approach allows a farm the use of a combination of technologies, and the inefficiency of the farm can be weighted by the relative performance of the farm measured against all possible technological frontiers. Hence, we do not have one single reference technology, but take into account the technologies from every class.

Equation (8) depicts Tanzania's production function, while equation (9) shows Ethiopia's. We use separate functions to account for the inclusion of livestock as an output in the latter, as farm data at disposal show that the large majority of farms do not use livestock for production. It is noted that for readability, equations (8) and (9) display the production function of each country without the latent class vector.

$$\begin{aligned} -\ln Crop \mid j = {} & (\beta_0 + \beta_1 \ln(liv/crp) + \beta_2 \ln lan + \\ & \beta_3 \ln int + \beta_4 \ln lab + \beta_5 \ln tlu + 0.5\,\alpha_1 \ln lnd^2 + \\ & 0.5\,\alpha_2 \ln int^2 + 0.5\,\alpha_3 \ln lab^2 + 0.5\,\alpha_4 \ln tlu^2 + \\ & \alpha_5 \ln lan * \ln int + \alpha_6 \ln lan * \ln lab + \alpha_7 \ln lan * \ln tlu + \\ & \alpha_8 \ln int * \ln lab + \alpha_9 \ln int * \ln tlu + \alpha_{10} \ln lab * \ln tlu + \\ & \alpha_{11} \ln(liv/crp) * \ln lan + \alpha_{12} \ln(liv/crp) * \ln int + \\ & \alpha_{13} \ln(liv/crp) * \ln lab + \alpha_{14} \ln(liv/crp) * \ln tlu + v_i + \\ & u_i) \mid j \end{aligned} \quad (8)$$

$$\begin{aligned} -\ln Crop \mid j = {} & (\beta_0 + \beta_1 \ln(liv/crp) + \beta_2 \ln lan + \\ & \beta_3 \ln int + \beta_4 \ln lab + 0.5\,\alpha_1 \ln lnd^2 + \\ & 0.5\,\alpha_2 \ln int^2 + 0.5\,\alpha_3 \ln lab^2 + \alpha_4 \ln lan * \ln int + \\ & \alpha_5 \ln lan * \ln lab + \alpha_6 \ln int * \ln lab + \\ & \alpha_7 \ln(liv/crp) * \ln lan + \alpha_8 \ln(liv/crp) * \ln int + \\ & \alpha_9 \ln(liv/crp) * \ln lab + v_i + u_i) \mid j \end{aligned} \quad (9)$$

To explain the variation of technical inefficiency over different farms, we use a variety of potentially significant factors, which are the same as in the paper by Ayenew *et al.* (forthcoming): a regional dummy (used as an explanatory variable to capture unobservable characteristics with respect to space), weather characteristics, age and sex of the household head, age dependency ratio, livestock holding in tropical livestock unit (TLU), access to extension services, concentration index, access to credit, distance to the nearest road, and the set of decent rural employment indicators (as defined in section 2, table 1) are used. 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.

Annex 2 – Latent Classes in Tanzania and Ethiopia

Table 3. Summary statistics of the latent classes and the overall sample in Tanzania

Latent Class	Variable	Mean	Std. dev	Minimum	Maximum	Cases
T1	Tropical livestock index	0.151	0.597	0.000	570.000	303
	Land	2.842	3.590	0.0405	284.292	303
	Labour	155.425	141.278	240.000	887.000	303
	Concentration index	1.483	0.468	0.098	199.774	303
	Precarious Employment ratio	0.074	0.159	0.000	0.872	303
	Employment to workforce ratio	0.791	0.290	0.000	1.000	303
	Child labour ratio	0.065	0.127	0.000	0.612	303
T2	Tropical livestock index	2.672	7.866	0.000	118.800	628
	Land	3.607	5.811	0.0445	655.307	628
	Labour	170.342	163.523	200.000	1236.40	628
	Concentration index	0.860	0.480	0.032	199.615	628
	Precarious Employment ratio	0.101	0.180	0.000	0.985	628
	Employment to workforce ratio	0.817	0.251	0.000	1.000	628
	Child labour ratio	0.057	0.115	0.000	0.668	628
All	Tropical livestock index	1.840	6.561	0.000	118.800	931
	Land	3.338	5.199	0.040	655.307	931
	Labour	164.360	156.718	200.000	1236.40	931
	Concentration index	1.064	0.558	0.003	199.774	931
	Precarious Employment ratio	0.093	0.174	0.000	0.985	931
	Employment to workforce ratio	0.808	0.265	0.000	1.000	931
	Child labour ratio	0.0596	0.119	0.000	0.668	931

Table 4. Summary statistics of the latent classes and the overall sample in Ethiopia

Latent Class	Variable	Mean	Std.dev	Minimum	Maximum	Cases
E1	Tropical livestock index	4.594	3.390	0.013	290.450	329
	Land	1.724	3.494	0.085	416.813	329
	Labour	145.804	158.483	120.000	1194.00	329
	Concentration index	1.360	0.550	0.046	200.000	329
	Precarious Employment ratio	0.030	0.104	0.000	0.995	
	Employment to workforce ratio	0.819	0.244	0.200	1.000	329
E2	Tropical livestock index	6.489	4.849	0.013	459.720	820
	Land	1.437	1.683	0.0312	304.752	820
	Labour	125.886	156.980	100.000	1484.60	820
	Concentration index	0.975	0.550	0.003	200.000	820
	Precarious Employment ratio	0.062	0.161	0.000	0.992	820
	Employment to workforce ratio	0.791	0.256	0.111	1.000	
All	Tropical livestock index	5.946	4.560	0.013	459.720	1149
	Land	1.519	2.350	0.031	416.813	1149
	Labour	131.590	157.601	100.000	1484.60	1149
	Concentration index	1.085	0.577	0.003	200.000	1149
	Precarious Employment ratio	0.052	0.148	0.000	0.995	931
	Employment to workforce ratio	0.799	0.253	0.111	1.000	931
	Employment to workforce ratio	0.799	0.253	0.111	1.000	931

Annex 3 – Maximum likelihood estimates for the Latent Classes in Tanzania and Ethiopia

Table 5. Maximum likelihood estimates for the two latent classes – Tanzania (cont.)

Variable	Latent class T1 Crop based production system		Latent class T2 Diversified production system	
	Coefficient	Standard error	Coefficient	Standard error
Constant	0.880***	0.077	0.317***	0.087
Land	-0.160***	0.032	-0.238***	0.021
Labour	-0.394***	0.035	-0.253***	0.028
Intermediate Inputs	-0.121***	0.019	-0.199***	0.016
Livestock crop ratio[10]	0.309***	0.013	0.130***	0.011
Land²	0.042**	0.021	-0.014	0.013
Labour²	0.001	0.026	-0.014	0.021
Intermediate Inputs²	-0.032***	0.008	-0.018**	0.007
Land x Labour	0.019	0.035	-0.005	0.026
Land x Intermediate inputs	-0.060***	0.019	-0.0004**	0.014
Land x Labour	0.022	0.020	-0.005**	0.017
Land x Livestock crop ratio	0.131***	0.016	-0.022	0.010
Labour x Livestock crop ratio	-0.066***	0.014	-0.010*	0.013
Intermediate inputs x livestock crop ratio	-0.028***	0.008	0.011	0.007

10 Amount of income gained from livestock divided by the amount of income gained from crop production.

Table 5. Maximum likelihood estimates for the two latent classes – Tanzania (cont.)

Inefficiency Determinants	Latent class 1		Latent class 2	
Variable	Coefficient	Standard error	Coefficient	Standard error
Age of the household head	-0.243	0.200	0.003	0.003
Employment to workforce ratio	-6.301	6.189	0.124	0.154
Precarious employment ratio	21.234*	11.479	1.270***	0.305
Precipitation of the wettest quarter	0.007	0.007	0.0005	0.0003
Age dependency ratio	-4.215	3.453	-0.0486	0.064
Women to total labour ratio	1.048	6.587	0.162	0.239
Distance to the major road	0.0394	0.050	0.004**	0.002
Sex of the household head	-7.666	7.023	-0.228	0.153
Household head literacy	-5.685	5.348	-0.388***	0.148
Region	-0.609*	0.366	-0.019**	0.009
Advisory service	-2.072	9.723	0.0223	0.226
Share of government transfer to income	-194.290	379.775	-37.893	21.014
Access to credit	-12.162	21.616	-0.175	0.378
Child labourer to total labour ratio	27.518	32.129	0.812**	0.413
Other Parameters	0.131***	0.016	-0.022	0.010
Lambda	4.987	3.442	163.131	0.232
Sigma	3.293	2.177	0.816	0.043

Table 6. Maximum likelihood estimates for the two latent classes – Ethiopia (cont.)

Variable	Latent class E1 Less diversified farm system		Latent class E2 More diversified farm system	
	Standard error	Coefficient	Standard error	Coefficient
Constant	1.382***	0.050	0.388***	0.0454
Tropical livestock ratio	-0.076**	0.034	-0.245***	0.0293
Intermediate Inputs	-0.220***	0.019	-0.039**	0.0156
Labour	-0.081***	0.024	-0.161***	0.0193
Livestock crop ratio	0.073***	0.010	0.295***	0.0101
Land	-0.041	0.029	-0.108***	0.0294
Land²	-0.009	0.019	0.103***	0.0158
Intermediate Inputs²	-0.112***	0.011	0.017**	0.0070
Labour²	-0.013	0.019	0.036***	0.0129
Tropical Livestock²	-0.017	0.012	-0.009	0.0129
Livestock crop ratio²	-0.036***	0.003	0.020***	0.0034
Land* Tropical Livestock	0.0975**	0.042	-0.016	0.0386
Labour x Livestock crop ratio	0.0313***	0.010	0.070***	0.0109
Land x Labour	0.0739**	0.035	-0.024	0.0253
Land x Livestock crop ratio	-0.029**	0.014	0.013	0.0167
Land x Intermediate inputs	0.0530**	0.023	-0.059***	0.0196
Tropical Livestock x Intermediate inputs	-0.067***	0.020	-0.018	0.0168
Livestock x Labour	-0.062**	0.033	-0.059**	0.0287
Livestock x Livestock crop ratio	-0.018	0.013	0.018	0.0153
Intermediate inputs x Labour	-0.036*	0.020	0.002	0.0175
Intermediate inputs x livestock crop ratio	-0.004	0.008	-0.006	0.0099

Table 6. Maximum likelihood estimates for the two latent classes – Ethiopia (cont.)

Inefficiency Determinants	Latent class 1		Latent class 2	
Variable	Coefficient	Standard error	Coefficient	Standard error
Age of the household head	-0.005	0.006	0.003	0.003
Employment to workforce ratio	-0.719**	0.369	-0.294	0.190
Precarious employment ratio	1.036**	0.511	1.499***	0.297
Annual precipitation	-0.002*	0.001	-0.001	0.001
Precipitation of wettest quarter	0.002*	0.001	0.001	0.001
Age dependency ratio	-0.111	0.097	-0.012	0.061
Women to total labour ratio	0.062	0.408	0.266	0.274
Distance to the major road	0.000	0.005	0.006**	0.003
Sex of the household head	-0.209	0.312	-0.257	0.222
Household head literacy	-0.299*	0.172	-0.332***	0.117
Region	0.075**	0.034	0.033	0.020
Advisory service	0.247	0.170	-0.127	0.121
Share of informal transfers to income	-0.634	0.887	-1.181***	0.260
Access to credit	-0.274	0.195	-0.157	0.135
Share of government transfer to income	-2.300	2.400	-5.242*	3.005
Other Parameters				
Lambda	2.876	0.414	3.718	0.392
Sigma	1.029	0.122	0.982	0.064

Abstract

The present paper focuses on how the relationship between decent rural employment and agricultural productivity vary across production systems. The focus is on sub-Saharan Africa, taking Ethiopia and Tanzania as case studies and using data from the respective Living Standards Measurement Studies (LSMS) 2010-2011.

Different farm production systems and technologies for a sample of farms in the two countries are identified using a statistical method known as latent class analysis. Latent classes identified are representative of two production systems in each of the two countries. Subsequently, we estimate the production efficiency of these systems and finally investigate whether our selected indicators of decent rural employment differ across such farm systems and respective production efficiencies.

According to our findings, key decent rural employment indicators, like employment ratio, child labour, and access to social protection, have effects on agricultural productivity which are specific to a given farm production system. The paper concludes that deficits in decent rural employment could be better addressed if countries in sub-Saharan Africa implement policies and programs to explicitly promote decent rural employment which account for such differences across production systems.

Keywords

Decent work, rural employment, agricultural productivity, farming systems, sub-Saharan Africa.

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Decent-Work@fao.org

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