Smallholder Agricultural Commercialization and Poverty: Empirical Evidence of Panel Data from Kenya

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Contributed Paper prepared for presentation at the 91th Annual Conference of the Agricultural Economics Society, Royal Dublin Society in Dublin, Ireland
24 – 26 April 2017

Acknowledgement
This research is funded by the Australian Centre for International Agricultural Research (ACIAR) and Australian International Food Security Research Centre (AIFSRC) through the International Maize and Wheat Improvement Center (CIMMYT) and the UK aid from the UK government. The views expressed here are those of the authors and do not necessarily reflect the views of the donors or the authors' institution. The usual disclaimer applies.

Abstract
Despite inconclusive evidence of the impact of agricultural commercialization on smallholder welfare, many developing countries with majority of their population engaged in smallholder agriculture continue to pursue this agricultural transformation process. Past empirical studies have been criticized for methodological flaws and where real negative evidence existed, then this has been attributed to policy failures rather than commercialization process per se. Using panel data collected from Kenya, this study fits an endogenous switching regression model in a correlated random effects framework to analyze impacts of agricultural commercialization on household poverty proxied by annual household per capita expenditure on food and non-food items including own produced and consumed crops and livestock products. The results show that agricultural commercialization significantly increases annual per capita household expenditure among commercialized and non-commercialized had they commercialized. The annual per capita expenditure gap existing between commercialized and non-commercialized households emanates from their differences in amounts of resources owned (57%) and efficiency of using these resources (43%). Closing this expenditure gap (poverty gap) require improving the amount of resources owned and resource use efficiency among non-commercialized households. Therefore, policy options geared toward stimulating and/or enhancing smallholder agricultural commercialization are encourages as a poverty reduction strategy.

Key Words: Smallholder, Agricultural Commercialization, Poverty, Kenya, Switching Regression, Correlated Random Effects

JEL Code: Q130 Agricultural Markets and Marketing; Cooperatives; Agribusiness

1. Introduction

By the turn of the 21st century, poverty in sub-Saharan Africa (SSA) had increased from 42% in the 1980s to 46% while in Asia it had dropped from about 50% to 15% over the same period (Ravallion & Chen, 2004; Christiaensen & Demery, 2007). Majority of the poor people in SSA (over 70%) reside in rural areas mainly dependent on smallholder agriculture to earn their livelihoods (Hazell, 2005; World Bank, 2008). Reversing this increasing rural poverty trends in SSA will require transforming the agricultural sector from its current subsistence or semi-subsistence dominated system to a more commercialized system (Mathenge *et al.*, 2010; Kirsten *et al.,* 2012). Furthermore, the changing global demographic and economic environment mainly driven by increasing population, urbanization and income coupled with food industry restructuring (i.e. proliferation of supermarkets) and climate change have presented enormous opportunities for smallholders to commercialize their farm enterprises (Zhou *et al.*, 2013).

However, though it seems attractive to promote smallholder commercialization, past empirical studies have found inconclusive impacts of agricultural commercialization especially on the welfare of the poor (Binswanger and von Braun 1991). At household level, early IFPRI led studies in developing countries found that agricultural commercialization increased significantly household income and welfare in general (von Braun *et al.,* 1994). Similar positive impacts of commercialization on household incomes have been documented empirically in Kenya (Muriithi & Matz 2015), Zimbabwe (Govereh & Jayne 2003), Botswana (Timan *et al.*, 2004) and Malawi (Poulton *et al.,* 2004). On the other hand, smallholder agricultural commercialization has been criticized for the widening household income inequalities (Pingali & Rosegrant, 1995) and being an expensive undertaking especially for the poorest of smallholder farmers (Pingali *et al.*, 2005). It is based on these inconclusive empirical findings that Zhou *et al.,* (2013) have recommended further empirical research on the effects of agricultural commercialization to come up with more convincing results.

The inconclusive impact assessment results of agricultural commercialization on household welfare could be due to lack of standardized definition and measurement of this concept. It could also arise from probably the type of data available and the analytical methods used in past studies. While some authors have considered agricultural commercialization as growing of cash crops, others have defined agricultural commercialization as not limited to cash crops only because some proportions of the so-called food crops are sold for cash, and similarly, some proportions of the so-called cash crops are consumed at home (von Braun *et al.,* 1994). Agricultural commercialization also goes beyond marketing of agricultural outputs because it can also occur on the input side when farmers use purchased farm inputs (von Braun *et al.,* 1994). On the other hand, other authors have defined agricultural commercialization as production that purposively targets markets rather than being simply related to the amount of product that producers are likely to sell due to surplus production (Pingali & Rosegrant 1995; Pingali 1997). Lastly, Gebremedhin & Jaleta (2010) defined agricultural commercialization as a combination of both market orientation (agricultural production decision based on market signals) and market participation (produce offered for sale and use of purchased inputs). This study adopts the definition by Gebremedhin & Jaleta, (2010) i.e. produce offered for sale and use of purchased inputs in the production process. However, the later component of this definition (use of purchased inputs) is beyond the scope of this study due to data limitations. Based on this adopted definition, a more comprehensive household commercialization index (HCI) that incorporates all crop enterprises on the farm is developed and used.

Despite the pessimistic arguments about smallholder commercialization, many SSA national governments and donors have prioritized commercialization of smallholder agriculture as a means of achieving poverty reduction (Leavy & Poulton, 2007). For example, in Kenya, the government has in the last one and half decades developed two economic blueprints (Economic Recovery Strategy and Kenya Vision 2030) that identified agriculture as the main economic pillar with agricultural commercialization as the main transformation driver of this sector (Republic of Kenya, 2010). The assumption in this kind of development approach is that agricultural commercialization is a “pro-poor” rural development strategy. However, empirical studies to ascertain this assumption in Kenya are very few. In fact, most of the past empirical studies in Kenya on impact assessment of agricultural commercialization either considered just one main crop on the farm or a few selected crop enterprises (Mathenge *et al.*, 2010; Zhou *et al.*, 2013; Muriithi & Matz 2015). Also, most of these past studies used cross sectional data and even those that used panel data like Muriithi & Matz (2015), were based on pooled regression models. Pooled regression models assume that the treatment variable (commercialization) is just an intercept shifter of the outcome variable (household welfare). This might not be true if the outcome variable is correlated with other household individual characteristics (observed and unobserved) thus leading to biased estimates. In the current study, we analyze the impact of smallholder agricultural commercialization on household poverty using not just panel data but also endogenous switching regression (ESR) that estimates two outcome equations for each treatment group of households alongside the selection model.

The rest of the paper is organized as follows: - Section 2 outlines data and methods used in assessing the impact of agricultural commercialization on household poverty. Results are presented and discussed in section 3. Section 4 gives the summary and conclusions.

2. Data and methods

2.1 Data

The current study is based on balanced two period panel data collected from 457 rural farming households (914 observations). The first-round data was collected in 2011 and the second round collected in 2013. The surveyed households were randomly selected from villages in Bungoma and Siaya counties in western Kenya and Embu, Tharaka Nithi and Meru counties in eastern Kenya. A semi-structured questionnaire was used by trained enumerators to collect data on household socioeconomic characteristics, crop production and utilization including consumption and marketing, total household cash expenditure on food and non-food items and sources of other household incomes including credit and savings among many more variables.

2.2 Conceptual framework and estimation techniques

Impact evaluation using non-experimental data is challenging because of the difficulty involved in establishing a counterfactual against which impact can be assessed. That is, it is not possible to observe the treatment outcome variable on the treated group had it not been treated and the vice versa. In experimental studies, this problem can be addressed by randomly assigning the treatment to a given sample from the population of interest (Kassie *et al.*, 2014). However, if the treatment is not randomly assigned, then the outcome variable observed on the treated and untreated groups is likely to be influenced by observed and unobserved characteristics of each sample. In our current study, the treatment is not randomly assigned because households self-select themselves into commercialized and non-commercialized regimes thereby introducing self-selection bias in the outcome variable. This means that there could be a systematic difference between the treated and untreated samples that influences both their treatment decisions and outcome variables.

Econometric approaches have been developed to deal with these impact assessment methodological problems. They include propensity score matching (PSM) in a binary treatment framework, generalized propensity score (GPS) matching method in a continuous treatment framework, instrumental variable (IV) approaches and switching regressions. PSM and GPS approaches control for observed but not unobserved heterogeneity. On the other hand, though IV frameworks control for both observed and unobserved heterogeneity, their treatment effect models with one selection equation and one outcome equation assumes that the treatment impact can be represented as a simple parallel intercept shift with respect to the outcome function (Kassie *et al.*, 2014). However, the impact of the treatment on household welfare for treated and non-treated households could be different because the two groups of households may have different characteristics (Kassie *et al.*, 2014; Shiferaw *et al.*, 2014). The two-step switching regression frameworks on the other hand control for both observed and unobserved heterogeneity while at the same time relaxing the stringent IV assumptions by estimating two separate treatment outcome equations alongside the selection model. These switching regressions have been applied substantially in labour economics (Oaxaca, 1973; Lokshin & Sajaia, 2004; Lokshin & Glinskaya 2009) and agricultural technology adoption studies (Asfaw & Shiferaw, 2010; Di Falco *et al.*, 2011; Kassie et al., 2014) with limited application in agricultural commercialization studies.

The factors affecting the choice to participate or not to participate in the market can then be estimated using several variants of selection models in which selection into the treatment (commercialization) is made based on expected utility (Bellemare & Barrett 2006; Boughton *et al.*, 2007; Alene *et al.*, 2008). The expected utility from commercialization for household *i* at time *t* is determined by two sets of variables i.e. those observed by the researcher (X_{it}) and those that are unobservable (D_{it}). Household *i* is expected to commercialize at time *t* if the expected utility from commercialization (U_{it1}) is greater than expected utility from non-commercialization (U_{it0}). This means that the difference between utility derived from commercialization and non-commercialization (U_{it}^{*}) is greater than zero i.e.: -

$$U_{it}^{*} = U_{it1} - U_{it0} > 0 \qquad \text{Eqn. (1)}$$

Since these utilities are unobservable, then they can explicitly be expressed as a function of observable characteristics (X_{it}) and the error term (η_{it}) in the following latent variable model: -

$$T^*_{it} = \alpha_{it} X_{it} + \eta_{it}; \quad \text{With } T_{it} = \begin{cases} 1 \text{ if } & T^*_{it} > 0 \\ 0 \text{ Otherwise} \end{cases} \qquad \text{Eqn. (2)}$$

Where:

T_{it} = Binary indicator variable for agricultural commercialization (market participation) that equals to 1 if a household is commercialized and 0 if otherwise

α_{it} = Vector of parameters to be estimated

X_{it} = Vector of observable explanatory variables

η_{it} = Error term

Due to the potential endogeneity of the treatment variable (agricultural commercialization), we specify a two-step endogenous switching regression (ESR) model to assess the impact of agricultural commercialization on household poverty following Kassie et al., (2014), Shiferaw et al., (2014) and Lokshin & Sajaia (2004). The first step involves estimation of the binary selection model of commercialization decision based on Eqn. (2). The second step involves estimation of two OLS regressions describing the outcome variable of each group of households in the two treatment regimes as follows: -

$$\text{Regime 1: } Y_{1it} = \beta_1 X_{1it} + \varepsilon_{1it}: \quad \text{If } T_{it} = 1 \qquad (3a)$$

$$\text{Regime 2: } Y_{0it} = \beta_0 X_{0it} + \varepsilon_{0it}: \quad \text{If } T_{it} = 0 \qquad (3b)$$

Where:

Y_{1it} = Outcome indicator variable for commercialized household *i* at time *t*

Y_{0it} = Outcome indicator variables for non-commercialized household *i* at time *t*

X_{1it} = Observed vectors of covariates determining outcome variable for commercialized household *i* at time *t*

X_{0it} = Observed vectors of covariates determining outcome variable for non-commercialized household *i* at time *t*

β_1 and β_0 = Vectors of parameters to be estimated

ε_{1it} and ε_{0it} = Error terms that are normally distributed with zero mean and constant variance

The actual expected poverty outcomes for commercialized and non-commercialized households are computed using Eqn. 4a and Eqn. 4b, respectively. On the other hand, the counterfactual expected poverty outcomes are estimated using Eqn. 5a and Eqn. 5b for commercialized and non-commercialized households, respectively.

Actual scenarios (observed from the sample data):

Commercialized: $E(Y_{1it} \backslash T = 1; X) = \beta_1 X_{1it} + \gamma_{1\varepsilon}\lambda_{1it}$ $\qquad Eqn.(4a)$

Non-commercialized: $E(Y_{0it} \backslash T = 0; X) = \beta_0 X_{0it} + \gamma_{0\varepsilon}\lambda_{0it}$ $\qquad Eqn.(4b)$

Counterfactual scenarios:

Commercialized if they didn't commercialize: $E(Y_{1it} \backslash T = 0; X) = \beta_1 X_{0it} + \gamma_{1\varepsilon}\lambda_{0it}$ $\qquad Eqn.(5a)$

Non-commercialized if they commercialized: $E(Y_{0it} \backslash T = 1; X) = \beta_0 X_{1it} + \gamma_{0\varepsilon}\lambda_{0it}$ $\qquad Eqn.(5b)$

Applying these conditional expectations and using commercialization as the treatment variable, we compute treatment effects among the sampled households. We also extend this analysis by decomposing observed poverty gap between commercialized and non-commercialized households (Eqn. 3a less Eqn. 3b) following Oaxaca (1973) as shown in Table 1.

[Table 1 about here]

We follow theoretical and empirical literature to hypothesize that the selection model (agricultural commercialization decision) and outcome models (per capita annual household expenditure on food and non-food items) are functions of household demographic characteristics, physical and financial assets, social capital and transaction costs. The definition and measurement scales of the variables used in the estimations are as indicated in Table 2. However, it is important to note that for ESR model to be identified, the X_{it} variables in the selection model need to contain at least one selection instrument in addition to those automatically generated by the non-linearity of the selection model of commercialization (Kassie *et al.*, 2014; Shiferaw *et al.*, 2014). These instrument variables should affect directly the endogenous selection variable but not the outcome variables. In this study, we hypothesize that transaction costs variables (ownership of cellphone, average cost of transport costs to nearest main market and ownership of local transportation means) are best candidates for instrument variables in our estimation though they are subjected to tests to ascertain their suitability as instruments. The suitability of these instrumental variables is assessed using a simple falsification test following Di Falco *et al.*, (2011) and Kassie *et al.*, (2014). Only average transport costs to nearest main market passed this test and was excluded in the outcome models of ESR.

[Table 2 about here]

Finally, the two wave balanced panel data that is used in this study offers an analytical advantage of controlling for unobserved time invariant individual households characteristics. Therefore, we employ correlated random effects (CRE) approach using the *Mundlak–Chamberlain* device (Mundlak, 1978; Chamberlain 1982) to estimate all the empirical models in this study. Traditionally, these unobserved heterogeneities have been estimated using the fixed effects (FE) and random effects (RE) models. However, RE models have strong assumptions like no correlation between unobserved heterogeneities and observed explanatory variables in the model. If this RE assumption holds, then across-sectional analysis employing OLS estimation would also consistently estimate the model parameters (Wooldridge, 2010). On the other hand, while FE approach looks attractive because it assumes arbitrary correlation between unobserved heterogeneity and observed explanatory variables, its biggest weakness is that the transformation it uses to eliminate this correlation also removes completely the time invariant observed explanatory variables from the model as these are differenced out in the estimation process (Wooldridge 2010; Cameron & Trivedi 2009). This becomes very problematic in cases where a researcher intends to investigate the effects of time invariant explanatory variables. CRE approach preserves the advantages of FE approach while at the same time enabling the inclusion of time invariant explanatory variables in the analysis and thus adopted in this study.

Therefore, CRE approach allows for correlation between unobserved heterogeneity (Γ_i) and the vector of explanatory variables across all time periods (X_{it}). Following Wooldridge (2010) and Cameron & Trivedi (2009), in this CRE framework, the assumption is that there is a linear relationship between unobserved time varying individual heterogeneity and observed explanatory variables that can be modeled as follows: -

$$\Gamma_i = \varphi + \bar{X}_\iota \lambda + a_i) \qquad \text{Eqn. (6)}$$

Where:-

φ is a scalar

$\bar{X}$ is the averages of time varying explanatory variables

λ is a vector of coefficients to be estimated

a_i is the error term assumed to have zero mean conditional on the entire history of the covariates (X_{i1}, X_{i2}, ------, X_{iT}) i.e. a_i is uncorellated with X_{it} for all t and therefore X_i

The reduced form of the model in which φ is absorbed into the intercept term and $\overline{X}_i$ are added to the set of explanatory variables including time invariant variables is estimated as follows: -

$$Y_{it} = a_t^* + X_{it}\beta + \overline{X}_i\lambda + Z_i\gamma + a_i + \varepsilon_{it} \qquad Eqn. (7)$$

Where:

Y_{it} is the outcome variable

Z_i is a vector of time invariant explanatory variables

Following Schunck (2013) and Burke & Jayne (2014), β are estimated parameters that are interpreted as "within-household" or "within-cluster" effect. It is important to note that these "within-household" estimates are like the FE estimates i.e. these coefficients are the effect of a given time varying variable's effect of deviation from its overall average or "permanent" level (Burke & Jayne 2014). Therefore, logically, these coefficients can be interpreted as the effect of a deviation within a household. On the other hand, λ and γ are estimated parameters that are interpreted as "between-household" or "between-cluster" effects (Burke & Jayne 2014). These variables are constant for each household across the panel period and therefore they only represent "between-household" effect. This means that the time varying covariates (X_{it}) can be decomposed into "within" and "between" cluster or household effects. Detailed derivation and interpretation of "within" and "between" estimates are given in Schunck (2013) and Burke & Jayne (2014).

3 Results and discussions

3.1 Descriptive statistics

The descriptive statistics of variables used in ESR model are presented in Table 3. About 75% of the surveyed households were commercialized i.e. sold at least some of the crop output they had produced on their farms. The average commercialization intensity (proportion of total value of all crops produced on the farm that was sold) was 37%. The average per capita annual household expenditure on food and non-food items including own produced and consumed food among the surveyed households was about Ksh. 31,414. Commercialized households had a significantly high annual per capita expenditure (33,423) compared to their non-commercialized counterparts (22,617).

Majority of the surveyed households were male headed (84%) though commercialized households had the highest proportion of male household heads (86%) compared to non-commercialized households (79%). This might indicate that female headed households either face barriers to participate in markets as sellers or they give priority to feeding their household members before selling. The average age of the household heads among the surveyed farmers was about 51 years. Those households that were commercialized had relatively young household heads (50 years) compared to non-commercialized ones (52 years). Younger household heads could be more risk takers compared to their older counterparts and thus can easily venture into markets. Overall, the average formal education level of household heads was about 7.7 years. Again, household heads of commercialized households had on average more years of formal education (8.0) compared to those heading non-commercialized households (6.7). On the other hand, the average household size among sampled households in terms of adult equivalents was about 5.1. Non-commercialized households had bigger household sizes (5.5) compared to their commercialized counterparts (4.9). This finding could be pointing to the possibility that non-commercialized households mainly focus on food crop production and they hardly produce surplus for sell.

Further summary statistics showed that the average per capita own farm size among the surveyed households was about 0.24 ha. Commercialized households had bigger average farm size (0.25 ha) compared to non-commercialized ones (0.18 ha). Commercialized households had on average significantly more fertile plots than non-commercialized households (Table 3). These summary statistics on farm size and soil fertility could be pointing to the importance of productivity in stimulating market participation (commercialization). The proportion of households that had contacts with extension was about 50% while those who had accessed agricultural input credit were about 14%. A significantly higher proportion of commercialized households accessed this agricultural input credit (17%) compared to non-commercialized households (5%) – again showing how important credit access is in commercializing smallholder agriculture.

[Table 3 about here]

About 51% of the surveyed households belonged to some agricultural production groups/networks (APNs). A higher proportion of commercialized households belonged to these groups than non-commercialized households (Table 3). The descriptive statistics showed statistically significant differences in all transaction costs variables between commercialized and non-commercialized households (Table 3). While about 83% of the surveyed households owned mobile phones, about 89% and 68% of commercialized and non-commercialized households, respectively, owned a phone. The average cost of transport to main markets was about KSh. 50 per person for one way trip (Table 3).

3.2 Econometric results

The econometric results used to derive conditional expectations to assess the impact of agricultural commercialization on household poverty are presented in Table 4. We briefly discuss these results since the objective of this paper was to estimate the impact of agricultural commercialization on poverty and not the determinants of agricultural commercialization or determinants of poverty among sampled households. We interpret these econometric results very cautiously as simple correlations and no causality is claimed with certainty due to possibility of endogeneity between the dependent variables and some of the explanatory variables.

From the selection model, we find positive and significant "between-household" effects/associations between agricultural commercialization and education level of the household head, livestock ownership, owned land, membership to agricultural production networks and cell phone ownership. Household heads with better education achievements are more likely to access better information that is likely to enable them participate in markets. This is particularly important in many developing countries like Kenya where market failures and information asymmetry are pervasive. Similarly, membership to APNs is likely to enable households access information, increase their market bargaining power and access lucrative markets that they could not have been able to access if they were not members (Shiferaw, et al., 2008). On the other hand, we find significant negative "between-household" effects/associations of agricultural commercialization and non-farm income and transport costs to nearest main market (Table 4). This finding on transport costs highlights the importance of transactions costs and remoteness in curtailing rural farming households from commercializing their agricultural activities. While soil fertility and access to agricultural credit have no "between-household" effect, they have positive "within-household" effects on agricultural commercialization.

[Table 4 about here]

The econometric results on the determinants of poverty shows that education of the household head has a positive “between-household” effect on per capita expenditure of both commercialized and non-commercialized households (Table 4). However, this effect is only significant among commercialized households implying that education is more important in alleviating poverty among commercialized than non-commercialized households. Access to credit and social capital variables like membership to APNs and number of dependable people in the village have also a positive and significant “between-household” effect on per capita expenditure of commercialized households. It is also important to note that given their commercial orientation, transaction costs variables (ownership of cell phone and transportation equipment) have positive and significant “between-household” effects on per capita expenditure of commercialized households (Table 4). These are assets that lower market transactions costs and thus increasing net income of commercialized households. Livestock ownership and access to agricultural input have significant positive and negative “within-household” effects, respectively, on per capita expenditure of commercialized households.

3.3 Treatment effects of agricultural commercialization on household poverty

This section presents and discusses results of the impact of agricultural commercialization on household poverty (per capita annual household expenditure on food and non-food items including the value of own produced and consumed food). The per capita annual household expenditure is compared under actual and counterfactual scenarios for commercialized and non-commercialized households (Table 5).

The statistics reported in cell (a) and cells (b) of Table 5 were generated from Eqn. 8a and Eqn. 8b, respectively, representing actual per capita annual household expenditure for commercialized and non-commercialized households, respectively. Therefore, average per capita household annual expenditure among commercialized households was about KSh. 34,423 while that of non-commercialized households was KSh. 22,617. These figures are consistent with those generated using descriptive statistics as presented in Table 3. A quick comparison of these two figures reveals that commercialized households have about KSh. 11,807 advantage of per capita annual household expenditure over their non-commercialized counterparts. Theoretical and empirical literature of ESR (Mare & Winship 1987, Lokshin & Sajaia 2004, Lokshin & Sajaia 2011, Kassie *et al.*, 2014) shows that this quick and direct comparison might not tell so much without isolating (decomposing) the causes of this poverty gap between the two groups of households.

The average treatment effect on the treated (impact of commercialization on poverty of the commercialized households) is about KSh. 8,094. This means that had the commercialized households not commercialized, then their annual per capita expenditure could have reduced significantly by KSh. 8,094. On the other hand, the average treatment effect on the untreated is about KSh. 5,590 – implying that had the non-commercialized household commercialized, then their average annual per capita expenditure could have increased significantly by this much. These results show that commercialization has a significant positive impact on per capita household expenditure. However, it is important to note that though commercialization process is beneficial to both groups of farmers, commercialized households have unobserved characteristics that makes have significantly higher annual per capita expenditure than their non-commercialized counterparts. For example, even if they had not commercialized, commercialized households would still have had a significantly higher per capita expenditure of about KSh. 3,713 compared to non-c0mmercialized household in their current state of not commercialized. Similarly, even if non-commercialized households were to commercialize, their annual per capita expenditure could have been significantly lower than that of commercialized household in their current state of being commercialized by about KSh. 6,216 (Table 5).

Table 5 about here

Apart from the average treatment effects on the treated and untreated interpretations in the preceding paragraph, we attempt to interpret these same results by decomposing the annual per capita expenditure difference we observed from the two groups of households. Following Oaxaca (1973) decomposition framework, the per capita annual household expenditure difference (poverty gap) of KSh. 11,807 can be decomposed into the amount due to differences in amounts of resources that commercialized and non-commercialized households hold (level effect) and amount due to differences in resource use efficiency between the two groups of households (returns effect).

Therefore, starting with returns effect, the results presented in Table 5 shows that if commercialized households had their current level of resources, and hypothetically adopted the resource use efficiency level of the non-commercialized households, then the former's per capita annual household expenditure could reduce significantly by about KSh. 8,094 i.e. cell (a) less cell (b) in Table 5. On the other hand, if non-commercialized households were to have hypothetically the same efficiency level like that of commercialized households while holding the former group's resource amounts constant, then their per capita annual household expenditure could increase significantly by about KSh. 5,590 i.e. cell (c) minus cell (b) in Table 5. Therefore, improving resource use efficiency levels of non-commercialized households will not be able to close the poverty gap between commercialized and non-commercialized households because that will only reduce the poverty gap by about KSh. 5,590 or 47 percentage points.

The analysis of level or resource amount effect shows that if non-commercialized households were to have same amount of resources like the ones held by commercialized households while keeping their resource use efficiency levels constant, then non-commercialized households' per capita annual household expenditure could increase significantly by about KSh. 6,216 i.e. cell (a) less cell (c) in Table 5. Similarly, if commercialized households were to have the same amount of resources like what non-commercialized households have while keeping their resource use efficiency level constant, then the former's per capita annual household expenditure could significantly decrease by almost KSh. 3,713 i.e. cell (d) less cell (b) in Table 5. The implication of this finding, like in the previous returns effect, is that boosting the amount of resources held by non-commercialized households alone will not close the observed poverty gap between commercialized and non-commercialized households. Instead, such approach will only manage to reduce the poverty gap by about KSh. 6,216 or 53 percentage points.

4. Summary, conclusions and recommendations

There exists inconclusive evidence on the impact of agricultural commercialization on smallholder welfare. Despite this research gap, many developing countries with majority of their population engaged in smallholder agriculture continue to pursue this agricultural transformation process. Using analytical model applied mostly in labour economics and agricultural technology adoption studies, we fit an endogenous switching regression (ESR) model on household level panel data collected from rural smallholder farming households in Kenya to analyze the impact of agricultural commercialization on household poverty. The results show that demographic characteristics are more important in explaining household poverty outcome among non-commercialized households while transaction costs variables are more important in determining poverty outcome among commercialized households.

Impact analysis of agricultural commercialization on household poverty level showed that agricultural commercialization significantly reduces poverty among rural smallholder farming households. Commercialized households stand to lose a significant amount of their total household per capital annual household expenditure if they were not to commercialize while on the other hand, non-commercialized households will significantly increase their per capita annual household expenditure if they were to commercialize. Decomposition of current poverty gap between commercialized and non-commercialized households shows that improving resource use efficiency level of non-commercialized households will not be able to close this gap as this will only reduce the gap by about 43 percentage points. The other 57 percentage points can be covered if the amount of resources currently held by non-commercialized households can be improved. This means that the current poverty gap between commercialized and non-commercialized (in favour of commercialized households) can only be closed if both efficiency and resource amount issues among non-commercialized households can be improved to the level of commercialized households.

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Tables

Table 1. Conditional expectations, treatment effects and heterogeneity effects

Household type	Market participating households' response to characteristics	Non-market participating households' response to characteristics	Returns effects (difference caused by difference in resource use efficiency)
Commercialized households	(4a) E(Y_{1i}/T=1)	(5a) E(Y_{0i}/T=1)	(4a) – (5a)
Non-commercialized households	(5b) E(Y_{1i}/T=0)	(4b) E(Y_{0i}/T=0)	(5b) – (4b)
Level effect (difference caused by differences in resource quantities)	LE_0 = (4a) – 5b)	LE_1 = (5a) – (4b)	(4a) – (4b)

Table 2. Definition and measurement of variables

Variable	Variable measurement	Expected sign: Selection model	Expected sign: Outcome model: Household poverty
Dependent variables:			
Output market participation (H_{it}) – the treatment	Binary (1=Participating; 0=Otherwise)	√	na
Household poverty (Y_{it})	Continuous	na	√
Demographic characteristics:			
Household head sex	Binary (1=Male; 0=Otherwise)	+	+
Household head age (years)	Continuous	+	-
Household head education (years)	Continuous	+	+
Household size (adult equivalent)	Continuous	+/-	-
Dependency ratio	Continuous	+/-	-
Household size/dependence ratio	Continuous	na	-
Physical & financial assets:			
Livestock owned (TLU)	Continuous	+	+
Per capita own farm size (ha/adult equivalent)	Continuous	+	+
Weighted mean soil fertility score of cultivated plots	Count (1=poor; 2=average; 3=good)	+	+

Total annual non-farm income (KSh)	Continuous	+/-	+/-
Access to agricultural input credit	Binary (1=Yes; 0=Otherwise)	+	+
Contacts with agricultural extension staff	Binary (1=Yes; 0=Otherwise)	+	+
Ox-plough ownership	Binary (1=Yes; 0=Otherwise)	na	+
Social capital:			
Membership to agricultural production networks/groups (APN)	Binary (1=Yes; 0=Otherwise)	+	+
Number of dependable relatives in village	Continuous	+	+
Trust grain traders	Binary (1=Yes; 0=Otherwise)	+	+
Transaction costs:			
Mobile phone ownership	Binary (1=Yes; 0=Otherwise)	+	+
Average transport cost to main market (KSh/person/trip)	Continuous	-	na
Own any local transport means (bicycle, carts, wheelbarrow, motorbike)	Binary (1=Yes; 0=Otherwise)	+	+
Regional dummy	Binary (1=Eastern; 0=Western	+/-	+/-

Table 3. Descriptive statistics of the Endogenous Switching Regression Model

Variable label	Commercialized (N=681)		Non-commercialized (N=233)		Total (N=914)		Difference
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	
Per capita annual expenditure (1,000 KSh)	34.4233	20.1934	22.6166	10.6868	31.4135	18.9535	11.8067***
Proportion of commercialized households	1.0000	0.0000	0.0000	0.0000	0.7451	0.4361	1.0000
Proportion of value of crop produced sold	0.3690	0.2461	0.0000	0.0000	0.2749	0.2664	0.3690***
Demographic characteristics:							
Household head sex	0.8561	0.3513	0.7897	0.4084	0.8392	0.3676	0.0664**
Household head age	50.4787	13.2821	51.5236	14.9854	50.7451	13.7355	-1.0449
Household head education	7.9716	3.7410	6.8670	3.8757	7.6900	3.8043	1.1047***
Household size	4.9024	2.1937	5.5433	2.4678	5.0658	2.2825	-0.6409***
Dependency ratio	0.9108	0.7747	1.0166	0.9093	0.9377	0.8119	-0.1059*
Physical and financial assets:							
Tropical livestock units (TLU)	1.6877	1.9248	1.5260	1.6682	1.6465	1.8632	0.1617
Per capita owned farm size	0.2527	0.2248	0.1844	0.2238	0.2353	0.2264	0.0683***
Per capita owned farm size squared	0.1143	0.2399	0.0839	0.3760	0.1066	0.2810	0.0305
Average soil fertility score	2.1456	0.5540	1.9644	0.7464	2.0994	0.6135	0.1812***
Total annual non-farm income (1000 KSh)	97.0434	212.4168	99.6298	227.8099	97.7027	216.3209	-2.5864
Had contacts with extension staff	0.4963	0.5004	0.4936	0.5010	0.4956	0.5003	0.0028
Household got agricultural credit	0.1689	0.3749	0.0515	0.2215	0.1389	0.3461	0.1174***
Social capital:							
Membership to APNs	0.5653	0.4961	0.3562	0.4799	0.5120	0.5001	0.2091***
Number of dependable relatives in village	6.3612	10.6046	4.8798	10.6954	5.9836	10.6416	1.4814*
Trust in grain traders	0.7401	0.4389	0.7296	0.4451	0.7374	0.4403	0.0105
Transaction costs:							
Owns mobile phone	0.8869	0.3169	0.6824	0.4665	0.8348	0.3716	0.2045***
Transport cost to main market	48.1278	34.6282	54.7082	35.4104	49.8053	34.9279	6.5804**
Own local transport means	0.6711	0.4702	0.6052	0.4899	0.6543	0.4759	0.0659*
Regional dummy	0.5844	0.4932	0.2318	0.4229	0.4945	0.5002	0.3527***

Significance: *** at 1%; ** at 5%; * at 10%

Table 4. Endogenous Switching Regression: Impact of agricultural commercialization on household poverty outcome

Variable label	Selection model		Determinants of poverty					
			Commercialized households		Non-commercialized households		Pooled	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Demographic characteristics:								
Household head sex	-0.090	0.155	1,499.169	2,139.558	2,448.805	1,945.716	1,190.134	1,626.200
Household head age	0.009	0.014	249.505	191.966	-109.409	179.473	197.347	149.915
Household head education	0.034**	0.017	718.772***	225.239	338.942	256.805	792.254***	179.411
Household size	0.027	0.063	-1,551.781	1,085.941	-2,231.199**	901.918	-1,936.708**	805.112
Dependency ratio	-0.054	0.128	-3,766.952	3,785.458	-10,431.570***	3,868.054	-7,191.919**	2,988.140
Household size*dependency ration	na	na	-238.962	722.858	1,695.676***	600.170	602.228	533.937
Physical & financial capital:								
Livestock owned	0.015*	0.008	-1.481	114.799	-71.843	114.604	-8.135	89.450
Per capita owned land	3.820**	1.699	23,212.560	23,125.510	19,779.800	32,206.520	31,007.740*	17,321.680
Per capita owned land squared	-1.723**	0.866	-8,907.956	14,443.690	-8,413.203	14,931.040	-13,433.600	9,295.829
Soil fertility score	-0.151	0.128	1,610.506	1,772.458	1,081.799	1,697.744	715.104	1,361.774
Annual non-farm income	-0.009*	0.005	22.237	60.532	-5.974	75.954	-0.695	49.765
Got agricultural input credit	0.057	0.249	8,953.119***	2,740.703	-2,944.868	3,841.235	7,075.518***	2,329.398
Contacts with extension	0.214	0.155	1,730.622	2,050.029	-1,881.409	2,352.738	1,311.347	1,659.927
Social capital:								
Membership to APNs	0.551***	0.115	9,234.818***	2,053.399	4,621.752	2,904.762	9,186.350***	1,613.758
Dependable relatives in village	0.001	0.005	260.116***	64.229	1.459	62.707	201.582***	51.099
Trust grain traders	0.180	0.120	-1,388.684	1,629.055	-467.672	1,686.104	-945.662	1,290.709
Transaction costs:								
Own cellphone	0.891***	0.217	9,468.960**	4,405.942	-1,855.445	4,663.588	8,083.200***	3,137.178
Transport to nearest main market	-0.016**	0.008	na	na	na	na		
Own transport means	0.133	0.112	2,932.307*	1,533.467	-741.922	1,572.906	2,689.657*	1,194.829
Regional dummy	0.940***	0.140	-1,384.824	2,930.901	-1,766.871	4,639.465	549.719	2,243.433
Mundlak-Chamberlain device:								
Household head age	-0.012	0.015	-301.444	201.675	112.531	192.415	-227.439	157.552

Household size	-0.034	0.069	-1,363.794	1,230.332	1,131.315	1,059.717	-710.281	929.736
Dependency ratio	0.135	0.150	-3,639.697	4,733.677	11,350.270**	4,976.736	1,548.568	3,802.875
Household size*dependency ration	na	na	719.191	870.320	-2,104.401**	830.952	-165.682	685.071
Livestock owned	-0.006	0.011	253.292*	148.656	-16.655	130.870	173.080	115.351
Per capita owned land	-1.621	1.766	-10,559.670	21,710.570	-26,458.870	28,605.160	-16,995.180	17,387.770
Per capita owned land squared	0.378	0.964	4,904.244	12,794.050	13,327.480	15,481.830	6,863.115	10,007.900
Soil fertility score	0.415**	0.175	959.559	2,478.812	-3,782.715	3,023.301	1,098.184	2,010.087
Annual non-farm income	0.008	0.006	84.192	76.897	111.735	95.872	97.305	63.406
Got agricultural input credit	0.708**	0.332	-6,780.243*	4,053.224	-5,541.082	5,409.897	-4,797.588	3,350.393
Contacts with extension	-0.143	0.214	1,854.211	2,790.900	3,892.365	2,869.595	1,712.635	2,236.781
Own cellphone	-0.289	0.290	-3,136.376	4,078.185	749.244	3,620.983	-2,344.652	3,111.361
Inverse Mills Ration (IMR)	na	na	4,598.161	6,893.035	-10,088.960	7,817.026	2,112.824	4,669.788
Constant	-1.717***	0.426	24,836.290**	11,822.450	38,476.510**	15,915.140	21,593.070**	9,109.437

Statistical significance: *** at 1%; ** at 5%; * at 10%

Model description

Selection model (Probit)		Outcome models (OLS)					
		Commercialized households		Non-commercialized households		Pooled	
Number of obs=	914	Number of obs=	681	Number of obs=	233	Number of obs=	914
LR chi2(30)=	244.880	F(32, 648)=	8.950	F(32, 200)=	3.380	F(32, 881)=	12.840
Prob > chi2=	0.000	Prob > F=	0.000	Prob > F=	0.000	Prob > F=	0.000
Pseudo R2=	0.236	R-squared=	0.307	R-squared=	0.351	R-squared=	0.318
		Adj R-squared=	0.272	Adj R-squared=	0.247	Adj R-squared=	0.293
		Root MSE=	17227.000	Root MSE=	9274.600	Root MSE=	15934.000

Table 5. Average Expected household poverty outcome

Household type	Household poverty outcomes (Per capita annual household expenditure – KSh/adult equivalent)		
	Commercialized characteristics	Non-commercialized characteristics	*Treatment (returns) effect*
Commercialized (N=681)	34,423 (a)	26,329 (d)	*8,094****
Non-commercialized (N=233)	28,207 (c)	22,617 (b)	*5,590****
Heterogeneity (level) effect	*6,216****	*3,713****	*11,807*

Statistical significance: *** at 1%; ** at 5%; * at 10%