SMALLHOLDER AGRICULTURAL COMMERCIALIZATION AND POVERTY: EMPRICAL EVIDENCE OF PANEL DATA FROM KENYA

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 that showed negative impacts have been criticized for methodological flaws and where real negative evidence existed, then it 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. The results show that household head education and membership to agricultural production networks are negatively correlated with poverty among commercialized and non-commercialized households. Also, reducing transaction costs is important in tackling poverty among commercialized households who depend on markets to earn incomes. Impact analysis showed that commercialized households stand to lose significant amounts of their total per capital annual expenditure if they were not commercialized while on the other hand, non-commercialized households will benefit significantly in terms of increased per capita annual expenditure if they were commercialized. Therefore, this study demonstrates that agricultural commercialization can significantly address poverty among rural smallholder farming households.

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

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 and Chen, 2004; Christiaensen and 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 and Matz 2015), Zimbabwe (Govereh and 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 and 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 determine 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 and Rosegrant 1995; Pingali 1997). Lastly, Gebremedhin and 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 and 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 and 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 if any. In fact, most of the past empirical studies in Kenya on the impact 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 and Matz 2015). Also, most of these past studies used cross sectional data and even those that used panel data like Muriithi and 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). Therefore, the current study aims at analyzing 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 methods used in assessing the impact of agricultural commercialization on household poverty. Results are presented and discussed in section 3. First, results based on descriptive statistics are presented and then followed by the econometric results. Actual and counterfactual treatment effects result as estimated from

the ESR model follows the econometric results. Section 4 is devoted to the summary and conclusions while policy implications are outlined in section 5.

2. Methods and data

Evaluating the impact of a treatment using non-experimental data is very challenging because of the difficulty involved in establishing a counterfactual against which impact can be assessed i.e. 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 the observed and unobserved characteristics of each sample (treated and untreated samples).

Econometric approaches that have been adopted in empirical studies to deal with this problem 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 impact can be represented as a simple parallel shift with respect to the outcome variable (Kassie *et al.,* 2014). However, on the contrary, 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. These switching regressions also relax IV assumptions by estimating two separate treatment outcome equations alongside the selection model. There is substantial empirical application of these switching regression models in labour economics (Oaxaca, 1973; Lokshin and Sajaia, 2004; Lokshin and Glinskaya 2009) and agricultural technology adoption studies (Asfaw and Shiferaw, 2010; Di Falco *et al.,* 2011; Kassie et al., 2014) with limited application if any in agricultural commercialization studies.

2.1 Theoretical model

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 on the basis of expected utility (Bellemare and Barrett 2006; Boughton *et al.*, 2007; Alene *et al.*, 2008). The expected utility of commercialization for household *i* at time *t* is determined by two sets of variables i.e. those that are observable to the researcher (X_{it}) and those that are unobservable (D_{it}). 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 (Eqn. 1):-

$$G_{it}^{*} = \alpha_{it} X_{it} + \eta_{it}; \quad \text{With } G_{it} = \begin{cases} 1 \text{ if } G_{it}^{*} > 0 \\ 0 \text{ Otherwise} \end{cases} \tag{1}$$

Where:

G_{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

This study specifies a two-step endogenous switching regression (ESR) model to assess the impact of agricultural commercialization on household poverty following Lokshin and Sajaia (2004). The first step involves estimation of the binary selection model of commercialization decision based on Eqn. 1. The second step of this ESR model involves estimation of two OLS regressions describing the outcome variable of each group of households in the two treatment regimes. The two household poverty outcome functions conditional on commercialization decision are written in an endogenous switching regression regime model as follows:-

$$\text{Regime 1: } Y_{1it} = \beta_1 X_{1it} + \varepsilon_{1it}: \quad \text{If } G_{it} = 1 \tag{2a}$$

$$\text{Regime 2: } Y_{0it} = \beta_0 X_{0it} + \varepsilon_{0it}: \quad \text{If } G_{it} = 0 \tag{2b}$$

Where:

Where:

Y_{1it} = Outcome indicator variables of agricultural commercialization for commercialized household *i* at time *t* (per capita annual household expenditure on food and non-

food items including own produced and consumed food)

Y_{0it} = Outcome indicator variables of agricultural commercialization for non-commercialized household *i* at time *t* (per capita annual household expenditure on food and non- food items including own produced and consumed food)

X_{1it} = Observed vectors of covariates determining agricultural commercialization outcome (poverty) for commercialized household *i* at time *t*

X_{0it} = Observed vectors of covariates determining agricultural commercialization Outcome (poverty) 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 is normally distributed with zero mean and constant variance

For ESR model to be identified, it is important for the variables in the selection model 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 (commercialization) but not the outcome variables (household poverty). In this study, all the transaction costs outlined in Eqn. 3 were candidates for instrument variables though subject to verification to ascertain their suitability as valid instruments. It was hypothesized that transaction costs affect agricultural commercialization decision more directly and only affects household poverty outcome indirectly through agricultural commercialization.

Following the wage decomposition literature pioneered by Oaxaca (1973), this ESR analytical framework is also used to decompose the household poverty outcome gap between commercialized and non-commercialized households into the portion that is caused by differences in the amount of resources held by the two groups of households (quantity or level effect) and that component due to differences in the resource use efficiency between the two groups of the households (efficiency or return effect). The actual expected poverty outcomes for commercialized and non-commercialized households are computed using Eqn. 3a and Eqn. 3b, respectively. On the other hand, the counterfactual expected poverty outcome are estimated using Eqn. 4a and Eqn. 4b for commercialized and non-commercialized households, respectively.

Actual scenarios (observed from the sample data):

Commercialized: $E(Y_{1it} \backslash G = 1; X) = \beta_1 X_{1it} + \gamma_{1\varepsilon}\lambda_{1it}$ $(3a)$

Non-commercialized: $E(Y_{0it} \backslash G = 0; X) = \beta_0 X_{0it} + \gamma_{0\varepsilon}\lambda_{0it}$ $(3b)$

Counterfactual scenarios:

Commercialized if they didn't commercialize: $E(Y_{1it} \backslash G = 0; X) = \beta_1 X_{0it} + \gamma_{1\varepsilon}\lambda_{0it}$ $(4a)$

Non-commercialized if they commercialized: $E(Y_{0it} \backslash G = 1; X) = \beta_0 X_{1it} + \gamma_{0\varepsilon}\lambda_{0it}$ $(4b)$

Applying these conditional expectations and using commercialization as the treatment variable, the decomposition of the observed poverty gap between commercialized and non-commercialized households (Eqn. 3a less Eqn. 3b) following Oaxaca (1973) is computed as shown in Table 1. The difference in poverty outcome of commercialized households emanating from their differences in efficiency of use of their currently held resources compared to the efficiency of non-commercialized households is obtained by subtracting Eqn. 49a from Eqn. 3a. Similarly, the difference in poverty outcome of non-commercialized households emanating from their differences in efficiency of use of their currently held resources compared to the efficiency of commercialized households is obtained by subtracting Eqn. 3b from Eqn. 4a (Table 1). On the other hand, the difference in poverty outcome of commercialized households as a result of their differences in the amount of resources held compared to the amount of resources held by non-commercialized households, holding efficiency constant, is obtained by subtracting Eqn. 3b from Eqn. 4a. Finally, the difference in poverty outcome of non-commercialized households originating from their differences in the amount of resources held by commercialized household, holding their resource use efficiency constant, is obtained by subtracting Eqn. 94 from Eqn. 3a (Table 1).

Table 1 about here

Variable definition and measurement

In the first-step of the two-step ESR, the treatment equation (determinants of agricultural commercialization) based on Eqn. 3 is estimated using the probit model. On the other hand, the second step of the ESR is based on the OLS estimation of welfare outcome equations of agricultural commercialization (per capita annual household expenditure) for commercialized and non-commercialized households (Table 2). As already mentioned, explanatory variables relating to transaction costs were assessed for their suitability as instrument variables using a simple

falsification test following Di Falco *et al.,* (2011) and Kassie *et al.,* (2014). Those transaction cost variables that passed the suitability test were used accordingly i.e. they were excluded in the second step estimation of ESR (determinants of household annual per capita expenditure). The summary definition and measurement of independent variables used in the first step selection model and second step outcome models, respectively, are shown in Table 2. The independent (explanatory) variables are broadly categorized into demographic characteristics, physical and financial assets, social capital and transaction costs. The measurement scales of the variables used in the model are as indicated in column 2 of Table 2.

Table 2 about here

2.3 Estimation strategy for the endogenous switching regression (ESR)

This study applies a hybrid of random effects (RE) and fixed effects (FE) panel data method called correlated random effects (CRE). The CRE framework produces FE estimates while at the same time it allows the inclusion of time invariant variables as explanatory variables in the same way RE estimates are generated (Wooldridge, 2010; Cameron and Trivedi, 2009). The time varying explanatory variables were averaged across the two panel periods to form the *Mundlak-Chamberlain* device (Wooldridge, 2010). The detailed definition and measurement of these variables were as indicated in Table 2.

The efficient method to estimate ESR models is by full information maximum likelihood (FIML) estimation (Lokshin and Sajaia, 2004). An alternative estimation method is fitting one equation at a time by either 2SLS or maximum likelihood estimation. However, as note by Lokshin and Sajaia (2004), these later methods are less efficient than FIML because they require some potentially cumbersome adjustments to derive consistent standard errors and they also show poor performance in case of high multicollinearity between the covariates of the selection model (Maddala, 1983). On the other hand, the *movestay* command in STATA implements the full information maximum likelihood (FIML) to simultaneously fit the selection (binary) model and the outcome (continuous or binary) parts of the model to yield consistent standard errors. This approach according to Lokshin and Sajaia, (2004) relies on joint normality of the error terms in the selection and outcome equations.

2.4 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. Data collection was conducted by International Maize and Wheat Improvement Center (CIMMYT) in collaboration with its national partners in Kenya with financial support from the Australian Center for International Agricultural Research (ACIAR). The surveyed households were randomly selected from villages in Bungoma and Siaya districts in western Kenya and Embu, Imenti South and Meru South districts 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.

3 Results and discussions

3.1 Descriptive statistics

The descriptive statistics of the 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. For commercialized households, the average commercialization intensity i.e. the 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. On the other hand, the average per capita annual household expenditure of commercialized households was about KSh. 33,423 while that of non-commercialized was about KSh. 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%). 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). Overall, the average formal education level of household heads was about 7.7 years. Again, household heads for 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). The average dependency ratio among the surveyed households was about 0.94. Commercialized households had lower dependency ratio compared to non-commercialized households (Table 3).

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 of about 0.25 ha compared to non-commercialized ones who owned about 0.18 ha. Commercialized households had on average significantly more fertile plots than non-commercialized households (Table 3). The average livestock ownership among the surveyed households was about 1.6 TLU while the average annual household income from non-farm activities was about KSh. 98,000. 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%).

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). Similarly, while the average number of dependable relatives living in the same village with the sampled households was about 6.0, commercialized households had a significantly higher number of dependable relatives staying in the same village (6.3) compared to the non-commercialized households (4.9). 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 the main market using the most commonly used means of transport was about KSh. 50 per person for one way trip (Table 3). Lastly, about 58% of the surveyed households were from eastern Kenya. However, a higher proportion of the commercialized households were from eastern (59%) compared to western region (Table 3).

3.2 Econometric results

The econometric results of ESR model used to assess the impact of agricultural commercialization on household poverty are as presented in Table 4. Households with bigger farm sizes, more fertile soils and accessed agricultural input credit were likely to be commercialized compared to otherwise. In terms of social capital, households that belonged to agricultural production groups (networks) were likely to commercialize compared to their counterparts who were not members. Lastly, for transaction cost variables, smallholder farmers who owned mobile phones were likely to be commercialized while those households that were in more remote areas (had higher transport costs to nearest main market) were unlikely to commercialize (Table 4).

Education level of the household head had a positive and significant "between-household" effect on average annual per capita household expenditure among commercialized and non-commercialized households (Table 4). A commercialized household whose head had one additional year of education was likely to have about KSh. 667 more of per capita annual household expenditure compared to a similar household whose household head had one year less of education. Similarly, a non-commercialized household whose household head had one more year of education was likely to have KSh. 541 more per capita annual household expenditure compared to a similar household whose household head had one year less of education (Table 4).

Household size and dependence ratio had a negative "within-household" effect on the average per capita annual household expenditure (Table 4). However, these two variables were only significant among non-commercialized households i.e. they were likely to increase poverty in this group of households. A unit increase in household size of non-commercialized household was likely to reduce its average annual household expenditure by about KSh. 2,062 while on the other hand, a unit increase in dependency ratio was likely to reduce annual per capita household expenditure by about KSh. 10,839Dependency ratio also had a significant though unexpectedly positive "between-household" effect on the average annual household per capita expenditure of non-commercialized households (Table 4). A non-commercialized household with one more unit of dependency ratio was likely to have about KSh. 12,128 more of average per capita annual expenditure compared to a similar household with one unit less of dependence ratio.

Livestock asset base (TLU) had a positive and significant "between-household" effect on average annual per capita household expenditure of commercialized households. Commercialized households with 100% more of TLU was likely to have about KSh. 264 more of average annual household per capita expenditure compared to a similar household that had 100% less of TLU (Table 4). Per capita own farm size had a positive and significant "within-household" effect on average annual household per capita expenditure among non-commercialized households (Table 4). Also, access to agricultural credit had a positive and significant "within-household" effect on average annual household per capita expenditure of commercialized households. However, this same variable had a negative and significant "between-household" effect on average annual household per capita expenditure of commercialized households. The positive and significant "within-household" effect showed that a commercialized household that had accessed credit to buy agricultural inputs was likely to have a higher per capita annual household expenditure of about KSh. 8,983 compared to a similar commercialized household that did not access this agricultural credit (Table 4). A commercialized household that receives agricultural credit over time is likely to reduce its per capita annual expenditure by almost KSh. 7,656 annually.

Table 4 about here

A commercialized household that belonged to an APN was likely to have a higher per capita annual household expenditure of up to about KSh. 8,346 compared to a similar commercialized household that was not a member of an APN. Similarly, a non-commercialized household that belonged to an APN was likely to have a higher per capita household annual expenditure of up to almost KSh. 7,796 compared to a similar non-commercialized household that was not a member of APN. Also, a commercialized household that had one more dependable relative living in the same village was likely to have a higher per capita annual household expenditure of almost KSh. 258 compared to a similar household that had one less dependable relative living in the same village (Table 4). Household ownership of mobile phone had a positive and significant "within-household" effect on per capita household annual expenditure among commercialized (Table 4).

3.3 Treatment effects of agricultural commercialization on household poverty

This section presents and discusses the 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 (observed) per capita annual household expenditure for commercialized and non-commercialized households, respectively. Therefore, the 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 perfectly in agreement 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 and Winship 1987, Lokshin and Sajaia 2004, Lokshin and 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.

Table 5 about here

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 and amount due to differences in resource use efficiency between the two groups of households. The poverty gap arising from differences in amounts of resources held is normally referred to as the level effect while that emanating from resource use efficiency differences is called the 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. 7,047 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. 5,176 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. 5,176 or 44 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. 6,631 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. 4,760 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. 6,631 or 56 percentage points.

4. Summary, conclusions and recommendations

There exists inconclusive theoretical and empirical literature 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 sector transformation process.Using a more innovative analytical model applied mostly in labour economics and agricultural technology adoption studies, the current study fits 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 than commercialized households. On the other hand, transaction costs variables are more important in determining poverty outcome among commercialized households than non-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 benefit significantly by increased per capita annual household expenditure if they were to commercialize. Decomposition of the current poverty gap between commercialized and non-commercialized households shows that by 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 44 percentage points. The other 56 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 completely if both efficiency and resource amount issues among non-commercialize4d 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	(8a) $E(Y_{Pi}/H=1)$	(9a) $E(Y_{Ni}/H=1)$	(8a) – (9a)
Non-commercialized households	(9b) $E(Y_{Pi}/H=0)$	(8b) $E(Y_{Ni}/H=0)$	(9b) – (8b)
Level effect (difference caused by differences in resource quantities)	LE_N = (8a) – 9b)	LE_P = (9a) – (8b)	(8a) – (8b)

Table 2. Definition and measurement of variables

Variable	Variable measurement	Expected sign	
		Selection model	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		Poverty outcome			
			Commercialized households		Non-commercialized households	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
Demographic characteristics:						
Household head sex	-0.0903	0.1546	1,610.09	2,132.17	1,968.45	1,912.95
Household head age	0.0089	0.0144	230.47	189.75	-49.91	173.74
Household head education	0.0342**	0.0167	666.71***	211.20	541.40***	203.66
Household size	0.0265	0.0627	-1,567.85	1,085.21	-2,061.63**	893.77
Dependency ratio	-0.0539	0.1280	-3,740.54	3,783.63	-10,838.77***	3,861.54
Household size/dependence ration interaction	na	na	-237.18	722.54	1,707.58***	601.09
Physical and financial capital:						
Owned livestock size	0.0147*	0.0080	-26.88	108.25	9.57	95.84
Per capita owned land	3.8204**	1.6995	18,521.26	22,020.81	45,073.29*	25,599.92
Per capita owned land squared	-1.7225**	0.8657	-6,576.31	14,008.38	-20,016.79*	11,940.53
Soil fertility score	-0.1511	0.1283	1,816.39	1,744.63	218.82	1,563.11
Annual non-farm income	-0.0093*	0.0049	33.42	58.14	-58.82	64.08
Got agricultural input credit	0.0569	0.2492	8,982.69***	2,739.17	-3,116.24	3,845.29
Contacts with extension	0.2137	0.1554	1,352.23	1,969.15	-352.32	2,036.03
Social capital:						
Membership to APNs	0.5515***	0.1153	8,345.60***	1,561.23	7,796.03***	1,548.10
Dependable relatives in village	0.0010	0.0051	257.90***	64.12	4.69	62.76
Trust grain traders	0.1804	0.1203	-1,667.13	1,574.00	559.78	1,488.80
Transaction costs:						
Own mobile phone	0.8913***	0.2171	7,600.09**	3,399.05	3,239.94	2,486.59
Transport to nearest main market	-0.0156**	0.0078	na	na	na	na
Own transport means	0.1327	0.1125	2,832.62*	1,525.52	149.30	1,415.56
Regional dummy	0.9400***	0.1405	-2,971.68*	1,711.38	3,624.68*	2,021.69
Mundlak-Chamberlain device:						
Household head age	-0.0116	0.0151	-280.53	199.14	36.83	183.56

Household size	-0.0342	0.0692	-1,337.13	1,229.16	923.74	1,049.18
Dependency ratio	0.1346	0.1500	-3,701.46	4,730.75	12,127.64**	4,948.33
Household size/dependence ration interaction	na	na	702.69	869.60	-2,100.51**	832.32
Owned livestock size	-0.0063	0.0107	264.39*	147.66	-52.74	128.06
Per capita owned land	-1.6208	1.7661	-9,240.01	21,611.01	-37,936.59	27,232.64
Per capita owned land squared	0.3784	0.9639	4,588.53	12,779.83	16,764.26	15,276.34
Soil fertility score	0.4152**	0.1753	252.53	2,239.83	-1,275.81	2,320.62
Annual non-farm income	0.0078	0.0064	75.50	75.75	161.21*	88.02
Got agricultural input credit	0.7084**	0.3317	-7,655.74***	3,833.21	-1,827.38	4,588.79
Contacts with extension	-0.1432	0.2137	2,224.00	2,734.12	2,728.66	2,728.77
Own mobile phone	-0.2894	0.2895	-2,643.33	4,008.93	-469.69	3,501.43
Constants	-1.7167***	0.4261	31,372.88***	6,611.70	19,051.30***	5,181.93

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

Model description

Selection model (Probit)	**Outcome model (OLS)**	
	Commercialized hholds	**Non-commercialized hholds**
Number of obs = 914	Number of obs = 681	Number of obs = 233
LR chi2(30) = 244.88	F(31, 649) = 9.23	F(31, 201) = 3.42
Prob > chi2 = 0.0000	Prob > F = 0.0000	Prob > F = 0.0000
Pseudo R2 = 0.2360	R-squared = 0.3060	R-squared = 0.3453
Log likelihood = -396.4215	Adj R-squared = 0.2729	Adj R-squared = 0.2443
	Root MSE = 17219	Root MSE = 9290

Table 5. Average Expected household poverty outcome

Type of household	Household poverty outcomes (Per capita annual household expenditure – KSh/adult equivalent)		
	Commercialized characteristics	Non-commercialized characteristics	Returns effects
Commercialized (N=681)	34,423 (a)	27,376 (d)	7,047***
Non-commercialized (N=233)	27,792 (c)	22,617 (b)	5,176***
Level effects	6,631***	4,760***	**11,807**

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