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Agricultural Economics Research, Policy and Practice in Southern Africa

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/ragr20

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To cite this article: Josiah M. Ateka, Perez Ayieko Onono-Okelo & Martin Etyang (2021) Selling at the farmgate? Role of liquidity constraints and implications for agricultural productivity, Agrekon, 60:4, 388-407, DOI: 10.1080/03031853.2021.1980409

To link to this article: https://doi.org/10.1080/03031853.2021.1980409

Published online: 19 Oct 2021.

AGREKON
2021, VOL. 60, NO. 4, 388–407
https://doi.org/10.1080/03031853.2021.1980409

Selling at the farmgate? Role of liquidity constraints and implications for agricultural productivity

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ABSTRACT
Market trends in many developing countries indicate that selling agricultural produce to itinerant traders at the farmgate has been rising, despite criticism that the practice preys on and exploits farmers. Using a cross-sectional data set of 525 households, we investigate the factors influencing participation in farmgate trading and its effects on agricultural productivity in western Kenya. We specifically consider the role of liquidity–related variables within a context of the perennial export crops, a contribution that has received less attention in literature. Our analysis reveals that variables related to demand for liquidity at the household level are strongly correlated with the selling of tea at the farmgate by smallholder tea farmers in the study area. The results also show that the household context (farmer's age, education and residence), farm characteristics (volume of output and age of tea plantation) and institutional variables (group membership and extension) are key determinants of household selling decisions. In addition, we find evidence that farmgate selling has a positive influence on crop productivity. We recommend strengthening of mechanisms that enable farmers to engage better with the existing market channels and encourage greater competition, in place of policies seeking to curtail the operations of farmgate traders.

ARTICLE HISTORY
Received 7 May 2020
Accepted 6 September 2021

KEYWORDS
Market participation; farmgate; liquidity constraints; endogeneity; tea productivity

1. Introduction

Participation in agricultural markets is essential for agricultural transformation in developing countries (Ouma et al. 2010; Arias et al. 2013; Poole 2017). Since the pioneering work by De Janvry, Fafchamps, and Sadoulet (1991), many authors have held that addressing the barriers of market access can lift smallholder farmers out of high-risk subsistence farming to more commercial high value agriculture (Barrett 2008; Abu, Haruna, and Nkegbe 2016). De Janvry and a number of other subsequent works show that market failures and their associated transaction costs can strongly influence the decisions of smallholder farmers to participate in markets (Goetz 1992; Key, Sadoulet, and Janvry 2000; Fafchamps and Hill 2005; Bellemare and Barrett 2006; Zanello et al., 2014; Fafchamps and Minten 2012; Mmbando, Wale, and Baiyegunhi 2015; Aker and Fafchamps 2015).

Literature on market participation in developing countries can generally be grouped into two strands. The first strand comprises studies addressing constraints that restrict farmers from taking advantage of market opportunities and hence the preference to remain at autarky or subsistence level (examples include, Goetz 1992; Key, Sadoulet, and Janvry 2000; Holloway, Barrett, and Ehui 2005; Bellemare and Barrett 2006; Burke, Myers, and Jayne 2015). These studies tend to focus on

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mechanisms for promoting access to markets by smallholder farmers. The second strand includes studies that focus on the choice of market channels (examples include, Fafchamps and Hill (2005), Zanello et al. (2014) and Courtois and Subervie (2015)). This strand has started to grow (Zanello et al. 2014; Courtois and Subervie 2015; Mmbando, Edilegnaw, and Baiyegunhi 2017; Negi et al. 2018; Melkani et al. 2019), in response to the need for new understanding on the alternative institutional arrangements that have emerged to serve farmers over the last two or so decades–as a result of market reforms.

One of the key institutional changes associated with market reforms is the advent of farmgate (FG) trading – a practice that involves itinerant traders moving across rural villages to buy produce from farmers (Fafchamps and Hill 2005). The practice is part of the pluralistic marketing arrangements introduced in a number of countries in Sub-Saharan Africa (SSA) to enhance competition and efficiency, in response to widespread concerns about the poor performance of agriculture in the region (Mbeche and Dorward 2014). Market trends across many countries in the region indicate that participation in FG trading has been rising, despite criticism that the practice preys on and exploits farmers (Sitko and Jayne 2014; Courtois and Subervie 2015). This raises important empirical questions about the factors explaining the seeming paradox – defined by a rising trend in FG participation among farmers, amidst complaints of uncompetitive market behaviour. Compared to mainstream market systems, FG transactions are normally characterised by lower producer prices, some degree of flexibility on quality standards and shorter (prompt) payment cycles (Sitko and Jayne 2014; Negi et al. 2018). While the shorter payment cycles point to a possible role played by the FG channels in addressing household liquidity constraints, empirical evidence on this dimension is limited in SSA to date. The limited studies analysing the choice of market channels in the region have mainly focused on transaction costs and information asymmetries (Fafchamps and Hill 2005; Zanello et al. 2014; Abi et al. 2016; Mmbando, Edilegnaw, and Baiyegunhi 2017), with limited attention to the possible role of liquidity-related constraints. In addition, the studies appear to concentrate on staples such as maize (Zanello et al. 2014; Abi et al. 2016; Mmbando, Edilegnaw, and Baiyegunhi 2017; Melkani et al. 2019), while giving limited attention to perennial export crops (such as tea and coffee). This bias overlooks the fact that the factors driving farmers' selling decisions are highly contextual and likely to be influenced by household characteristics, institutional setting and types of crops (Barrett 2008). Despite the potential of these perennial export crops to improve the livelihoods of farming households, they are currently faced with many marketing flaws that undermine their performance (Republic of Kenya 2007; Mbeche 2012; Republic of Kenya 2014). This paper focusses on choice of market arrangements in tea – which is the second most important crop in Kenya in terms of foreign exchange earnings after horticulture (Tea Directorate of Kenya 2019).

The lack of empirical evidence on the implications of FG participation on agricultural productivity is also a key gap in the literature. The majority of existing studies on market channels have focused on the factors influencing the choices farmers make (Fafchamps and Hill 2005; Zanello et al. 2014; Abi et al. 2016; Melkani et al. 2019) with limited attention on the impacts the choices have on expected outcomes. The few exceptions include Mmbando, Edilegnaw, and Baiyegunhi (2017) who show differences in welfare (consumption expenditure per capita) across households based on the choice of market channels for maize and pigeon pea in Tanzania. Courtois and Subervie (2015) have also shown that access to market information can enhance farm profits through bargaining interactions between farmers and traders within the FG markets. Evidence linking the choice of tea marketing channel and farm productivity is important for policy questions about which marketing arrangements can work "best" for smallholders. In addition, understanding the implications of FG trading on tea productivity is important in light of conflicting accounts about the effects of agricultural market reforms. While some studies (Nyairo, Kola, and Sumelius 2010; Babu, Shailendra, and Gajanan 2014) show positive impacts, there are contestations that some of the reforms have worsened the plight of poor farmers (Thomas 2006; Mbeche and Dorward 2014).

Our study attempts to bridge the gaps in the literature by assessing the following research questions: (i) what factors influence smallholder farmers' participation in FG selling; (ii) what is the role of liquidity constraints in influencing the farmers' FG selling decisions; and (iii) what is the association between FG participation and agricultural productivity among smallholder farmers? We explore these gaps using the case of the Kenyan smallholder tea sub– sector. This is against a backdrop of declining productivity in the sector and rising apprehensions among farmers and other actors that the tea market reforms (implemented in the sector over the last two decades) have not significantly improved the livelihood of the farmers (Poole 2017; Mbeche and Dorward 2014). A key contestation among stakeholders relates to the effects of the alternative systems that have emerged to serve farmers in the era of post–market reforms.

2. Methodological framework

2.1 Data

Data were obtained through a combination of methods which included: a household survey of tea farming households, review of documents, key informant interviews (KIIs) with key industry actors and focus group discussions (FGDs) with tea growers. The household survey was implemented through a three-step procedure. In the first stage, two leading tea producing counties in Western Kenya, Bomet and Nyamira, were selected (Figure 1).

The counties were purposively selected because they both have pluralistic tea marketing arrangements that are a subject of interest in this study. The counties are also characterised by relative diversity in farm sizes, demographic characteristics and tea production practices – which are important aspects in the analysis of productivity. At the second stage, we randomly

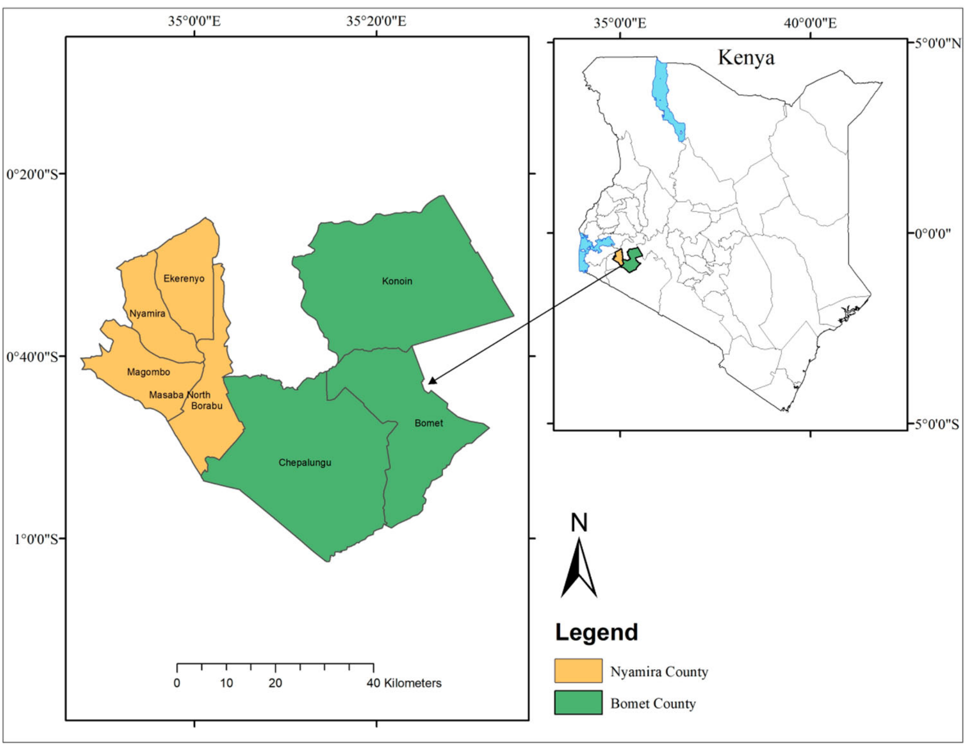

Figure 1. Study sites.

sampled two tea growing sub-counties in each county, while in the final stage, 525 tea farming households (194 in Bomet and 331 in Nyamira) were randomly sampled. The sample size in each of the two counties was proportionate to the population of tea farming households in the respective area. The field work for data collection was conducted from November 2015 to March 2016. The questionnaire we used contained sections on tea production indicators (including level of input use, self-reported indicators of soil quality and yields), and marketing and liquidity–related variables for two seasons (2013/2014 and 2014/2015). This approach enabled us to link the liquidity–related variables with the market participation under the assumption that a household's liquidity position in one season (2013/2014) would influence its selling decisions at the beginning of the next season (2014/2015) (Burke et al. 2019; Melkani et al. 2019). The survey also captured demographic characteristics over the 12 months prior to the survey. In addition to the field interviews, the authors also utilised industry statistics on plot sizes and tea yields to validate the self-reported information on productivity.[1]

The quantitative data from the survey was complemented with qualitative information from KIIs and FGDs. A total of 15 KIIs were conducted prior to the survey and targeted farmers' representatives and officers from the County Government, FG tea traders, tea factories in the study area, Kenya Tea Development Agency (KTDA), the Ministry of Agriculture and the Kenya Tea Directorate. The interviews were used to develop understanding of the operations of the smallholder tea markets in the study area. Additionally, we implemented six (6) farmer FGDs (three in each of the selected sub-counties), each having 8–12 participants selected based on gender and differences in demographic characteristics. The FGDs helped in understanding market choices and the extent to which emerging market arrangements have constrained or supported growth of the tea enterprise.

2.2 Conceptual framework

In this article, we follow a framework that allows exploration of the household decisions on market channels and the association the choices have with agricultural productivity. In the framework, we consider a dichotomous market setting where a farmer can either sell at the farmgate (FG) or through a designated market centre (MC). Following previous literature, (Fafchamps and Hill 2005; Babu, Shailendra, and Gajanan 2014), the household's decision to choose FG or MC is assumed to depend on the differences in net price received at the two markets, which in turn depends on the respective transaction costs (TC) necessary to conclude a sale in either of the markets. Consequently, a farmer will choose FG if the net price received at the farm gate is at least greater than the net return at the alternative market, MC, as shown in Equation (1);

$$(P^{FG} - TC^{FG}) \geq (P^{MC} - TC^{MC}) \tag{1}$$

where (P^{FG} and TC^{FG}) and (P^{MC} and TC^{MC}) are the prices and transaction costs at the FG and MC markets respectively. Equation (1) assumes that transaction costs are applicable in both markets, which is realistic in our context where both the FG and MC markets operate within close spatial proximity. If we let the difference between the net price from selling at FG and MC be represented by π as shown in Equation (2), then a household will sell at FG if $\pi > 0$ and vice versa.

$$(P^{FG} - TC^{FG}) - (P^{MC} - TC^{MC}) = \pi \tag{2}$$

Equation (2) implies that factors that raise π will raise sales in the FG market as opposed to MC and vice versa. The empirical modelling of a farmer's choice of FG can be represented by a binary variable (D) such that:

$$D = \begin{cases} 1 & \text{if } \pi^* = \pi + \varepsilon = (P^{FG} - TC^{FG}) - (P^{MC} - TC^{MC}) \geq 0 \\ 0 & \text{otherwise} \end{cases} \tag{3}$$

where π is a latent variable that is explained by the difference in payoffs from selling at FG or MC and ε is the standard error term. Equation (3) can be estimated once the explanatory variables for transaction costs (e.g., distance to market as applied in many studies) have been identified.

The formulation in Equation (3), assumes that the wedge between the FG and MC prices can be explained fully by the relative differences in transaction costs in the two market regimes. This could be an overly strong expectation or assumption in the context of our survey sites where both the FG and MC were operating within the same spatial proximity (see Table 1). The specification also ignores the fact that the two market regimes are characterised by different payment arrangements, leading to differences between the time famers supply their crop and when they actually receive payment. Unlike the FG system where payment is made on delivery, farmers selling through the MC have to wait for some time before they access proceeds. This implies a possibility that a farmer facing liquidity constraints can opt to sell through the FG even when $\pi < 0$. In order to incorporate liquidity constraints, Equation (3) can be modified as follows:

$$D^* = f((\pi),\ (LC)) + \beta Z + \varepsilon \tag{4}$$

where Z_i represents farm and household characteristics that can influence household choice of market location and LC_i is a set of indicators, representing liquidity constraints. Based on Equation (4), the following scenarios are simulated:

$$D_i^* = \left\{ \begin{array}{ll} 1\ (\text{FG}) & if\ \ \pi_i \geq 0,\ \ LC_i = 1 \\ 0(\text{MC}) & if\ \ \pi_i < 0,\ \ LC_i = 0 \\ \text{Either 1 or 0} & if\ \ \pi_i \leq 0,\ LC_i = 1 \end{array} \right\} \tag{5}$$

The specification in Equation (5) depicts the following three scenarios:

(1) Scenario one: Household will sell at the FG if the net price received at FG is at least greater than the net price at the MC and the household faces binding liquidity constraints. A better net price at the FG is reinforced by binding liquidity constraints.
(2) Scenario two: Household will sell at the MC if the net price received at MC is at least greater than the net price at the FG and the household does not face liquidity constraints. A better net price at the MC is reinforced by absence of liquidity constraints.
(3) Scenario three: Household will either sell at the MC or FG depending on the relative magnitude of the differences in net price in the two markets and the level of liquidity constraints.

In our analysis, we assume that the household's decision has implications on productivity as shown in Figure 2. The figure shows that the decision of the household to sell at a particular location (either FG or MC), depends on the relative differences in transaction costs, presence of liquidity constraints and other farm and household characteristics. A key pathway linking market decisions with farm performance draws from the assumption that the market choices can influence the household`s capacity to optimally employ good agricultural practices. A feedback loop is included to capture the reciprocal influence of farm performance on market decisions.

Similar to other literature on market participation, this study is underpinned by the random utility model, given the assumption that a household faced with two or more alternatives will select the option that will lead to attainment of the highest utility (McFadden 2000). In our context, we assume that a household faced with two alternatives, FG and MC, will choose to sell through the FG if the indirect utility V(FG) associated with the choice is at least greater than the maximum utility V(MC) of selling through a designated market centre (McFadden 2000). This comparison could be depicted as:

$$\text{V}^{\text{FG}} f(\pi_i, LC_i, Z_i) \geq \text{V}^{\text{MC}} f(\pi_i, LC_i, Z_i) \tag{6}$$

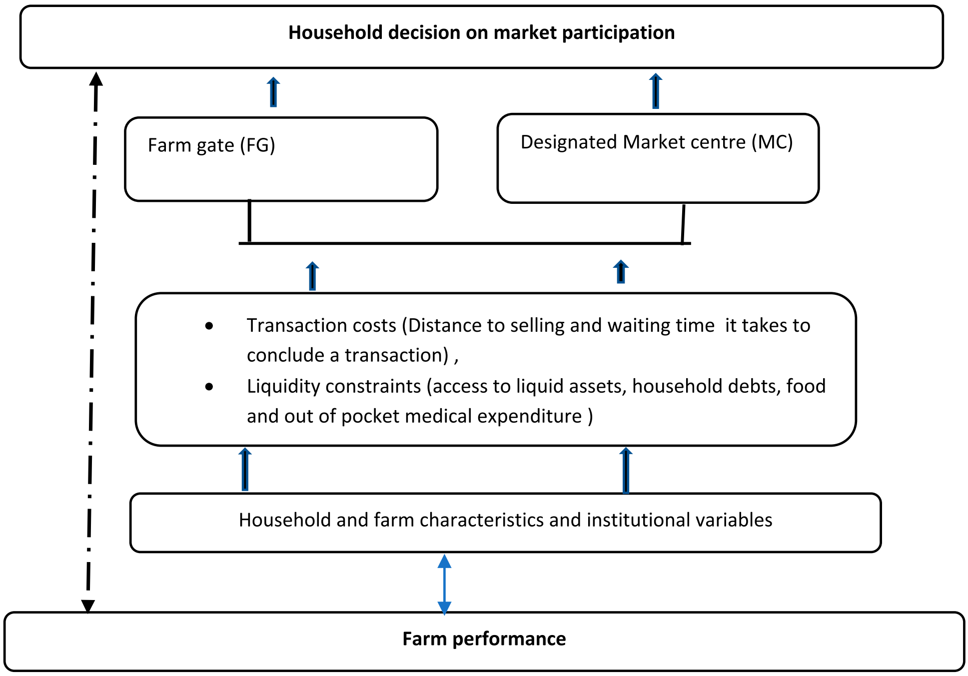

Figure 2. Linkage between market participation and farm performance.

In this article, we account for liquidity constraint (LC_i) using a set of liquidity–related variables – given the difficulties of finding direct measures of liquidity constraints at the household level (Gerards and Welters 2020). The variables used include, the value of liquid assets owned by the household, household debt and sourcing arrangements for food staples. The assets applied in the case of the first indicator were chicken, small ruminants (sheep and goats), stored grain and share deposits held with table banking groups, Saving and Credit Cooperative Societies (SACCOs), and rural microfinance groups. FGDs with farmers in the study area revealed that the selected assets could easily be converted into cash within a short period of time. Following Sun et al. (2013), household debt was included to indicate whether a household had a loan with a bank, microfinance institution or a credit and savings group that required to be paid off in the last 12 months preceding July 2014. The assumption is that households already having debts would be denied further credit or require more cash to pay off the existing debts – and therefore face a higher likelihood of experiencing liquidity restrictions. In the analysis, we also include two complementary indicators: sourcing arrangements for food staples (own production verses market purchases) and occurrence of illness affecting a household member. This selection is based on FGD information showing that food expenditure and out-of-pocket medical expenses were key expenditure items accounting for over 70 percent of the total household expenses.

The measurement of transaction costs is based on proxies such as distance to the nearest market, all-weather road and tea selling point. As observed in the wider literature, transaction costs are in most cases not observable in surveys and are therefore represented by proxies based on observable factors that determine them (Key, Sadoulet, and Janvry 2000; Burke, Myers, and Jayne 2015; Poole 2017).

2.3 Estimation strategy

Our estimation strategy is implemented in two steps. First, we assess the determinants of FG participation and then proceed to examine the association between the choice of a market option and tea productivity.

2.3.1 Determinants of farm gate participation

To assess the determinants of market choice, we consider that a tea producing household can sell its output (green leaf) at the FG or an alternative (MC). Following Equation (4), we estimate the empirical model specified in Equation (7).

$$D_i^* = \alpha Z_i + \beta LC_i + \varepsilon_i \quad \text{with } D_i = \begin{Bmatrix} 1 & \text{if } D_i^* > 0 \\ 0 & \text{otherwise} \end{Bmatrix} \tag{7}$$

where Z_i is vector representing household and farm characteristics, transaction costs and other institutional variables hypothesised to affect FG participation. The indicators for liquidity constraints are represented by LC_i and include the proxies described in section 2.2 while α is a vector of parameters to be estimated. The variable (D_i^*) is dummy that is equal to one (1) if the household sold tea through the FG and zero otherwise and ε_i is the error term. The specification in Equation (7) was estimated as a probit under the assumption that our error term was normally distributed.

Equation (7) is used to explore the associations between FG participation and the liquidity–related variables (described in Section 2.2). In the estimation, we acknowledge the potential endogeneity between FG participation and some of the LC variables (described in Section 2.2) due to unobservable heterogeneities (e.g., attributes such as human capital and competence in farm management can potentially influence both the household's decision on market participation and its liquidity status). Equally, FG participation may also influence the household's liquidity status, leading to reverse causation. Despite this understanding, we were not able to find suitable instrumental variables (IVs) that could have been used to address the possible biases given the nature of our data. Due to the difficulty of finding suitable and robust IVs, we therefore report the results from Equation (7) as associations between the LC variables and the choice of a tea market channel. However, our results provide an indication of how and under what circumstances household liquidity constraints may influence a household's market participation decisions.

2.3.2 Estimating the effect of market choice on productivity

We measure productivity using technical efficiency (TE) which is considered a robust measure of total factor productivity (Greene 2003; Helfand and Levine 2004). A number of previous studies have used other productivity measures such as yield per unit area, which gives more attention to land at expense of the other factors of production. Accounting for the other inputs such as labour and fertiliser is important since tea production is a perennial crop and its management is highly labour intensive (Tea Research Foundation of Kenya 2002; Ateka, Onono, and Etyang 2018). The estimation of TE is based on the Data Envelopment Analysis (DEA) model following Charnes, Cooper, and Rhodes (1978). DEA is used because it has less parametric restrictions on the underlying technology – and is therefore less likely to suffer from inaccurate specification (Färe, Grosskopf, and Lovell 1994). The empirical specification of the estimated DEA is shown in Annex 1 (Equation (A1)). The model assesses the extent to which smallholder tea producers are able to maximise their output from the outlay of owned or purchased production inputs. The strategy for assessing the effect of FG participation on productivity is undertaken in two steps. The first approach is based on the ordinary least squares (OLS) and the fractional response model (FRM), followed by the endogenous switching regression (ESR) in the second stage.

2.3.2.1 Ordinary least squares (OLS) and fractional regression model (FRM). Examining the effect of market choice on productivity would be done by introducing a dummy variable representing FG participation in a productivity Equation (8). We estimate the Equation (8) using the OLS and FRM approach, following Papke and Wooldridge (1996). FRM is used to model dependent variables that fall within the unit interval [0, 1]

$$Y = \beta D_i + \alpha X_i + \varepsilon_i \tag{8}$$

where Y_i represents TE of tea farming household, D_i is dummy representing FG participation, while β and α are parameters to be estimated and ε is a random error term. The vector X contains control variables hypothesised to influence productivity (TE), and would include household characteristics and farm and institutional variables such as access to extension and collective action. However, the results from the model (Equation (8)) are prone to biases, since the decision of the household on FG participation is voluntary and non-random (which could lead to self-selection biases). Consequently, the variable D is potentially endogenous in productivity, which justifies use of ESR to correct or break the biases (Lokshin and Sajaia 2004; Shiferaw et al. 2014; Khonje et al. 2015).

2.3.2.2 Endogenous switching regression. Our ESR model is made up of two outcome regimes, depending on the FG participation status (Equation (9)).

$$Y_P = X\beta + \mu_{1i} \quad if\ D_i^* = 1 \tag{9a}$$

$$Y_{NP} = X\alpha + \mu_{0i} \quad if\ D_i^* = 0 \tag{9b}$$

where Y_P and Y_{NP} repesent the TE of the FG participants and non-participants respectively, X is a vector of variables considered to influence tea productivity, β and α are the parameters we estimate and μ_{1i} and μ_{0i} are the error terms. The error terms ε_i (Equation (7)) μ_{1i} and μ_{0i} (Equation (9)) are assumed to have a tri-variate normal distribution with mean zero and covariance matrix shown in Equation (10) (Shiferaw et al. 2014; Khonje et al. 2015).

$$Cov\ (\varepsilon_i, \mu_{1i}, \mu_{0i}) = \begin{pmatrix} \sigma_\varepsilon^2 & \sigma_{\varepsilon\mu 1i} & \sigma_{\varepsilon\mu 0i} \\ \sigma_{\varepsilon\mu 1i} & \sigma_{\mu 1i}^2 & . \\ \sigma_{\varepsilon\mu 0i} & . & \sigma_{\mu 0i}^2 \end{pmatrix} \tag{10}$$

where σ_ε^2 represents the variance in participation Equation (7) and is assumed to be equal to one (1), since the coefficients of α are estimable up to scaler factor (Di Falco, Veronesi, and Yesuf 2011). The variances of μ_{1i} and μ_{0i} are denoted by $\sigma_{\mu 1i}^2$ and $\sigma_{\mu 0i}^2$ respectively, while the covariance of ε_i, μ_{1i} and μ_{0i} are denoted by $\sigma_{\varepsilon\mu 1i}$ and $\sigma_{\varepsilon\mu 0i}$. Since Y_P and Y_{np} cannot be observable at the same time, the covariance of μ_{1i} and μ_{0i} is not defined and is therefore shown using dots in the covariance matrix (Maddala 1986). This error structure has implications that the expected values of μ_{1i} and μ_{0i} have non-zero expected values conditional on FG participation (see Equations (11) and (12)).

$$E(\mu_i|D = 1) = \sigma_{\varepsilon,\mu}\left(\frac{\varphi(Z_i\alpha)}{1 - \Phi(Z_i\alpha)}\right) \neq 0 \tag{11}$$

$$E(\mu_i|D = 0) = \sigma_{\varepsilon,\mu}\left(\frac{\varphi(Z_i\alpha)}{1 - \Phi(Z_i\alpha)}\right) \neq 0 \tag{12}$$

where $\sigma_{\varepsilon,\mu}$ is the covariance between the error term of FG participation and TE equations, $\varnothing$ (.) is the standard normal probability density function while Φ (.) represents the standard cumulative density function. Following Maddala (1983), correction of endogeneity is achieved using the inverse mills ratio (IMR) that is calculated from the binary model (Equation (7)) as illustrated in Equations (13) and (14).

$$E(\mu_{1i}|D_i = 1) = \sigma_{\varepsilon\mu 1i}\frac{\varnothing(Z_i\alpha)}{1 - (Z_i\alpha)} = \sigma_{\varepsilon\mu 1i}\gamma_{i1} \tag{13}$$

$$E(\mu_{0i}|D_i = 0) = \sigma_{\varepsilon\mu 0i}\frac{\varnothing(Z_i\alpha)}{1 - (Z_i\alpha)} = \sigma_{\varepsilon\mu 0i}\gamma_{i0} \tag{14}$$

where $\varnothing$ (.) and Φ (.) are the standard normal probability density and the standard cumulative density function respectively, while γ_{i1} and γ_{i0} denote the IMRs which indicates the probability that an observation belongs to the selected sample. The IMR accounts for the unobserved variables and therefore breaks potential endogeneities in the model (Khonje et al. 2015).

$$Y_P = X\beta + \sigma_{\varepsilon\mu 1i}\gamma_{i1} + \mu_1 \text{ if } D_i^* = 1 \tag{15}$$

$$Y_{NP} = X\alpha + \sigma_{\varepsilon\mu 0i}\gamma_{i0} + \mu_0 \text{ if } D_i^* = 0 \tag{16}$$

Following literature (Di Falco, Veronesi, and Yesuf 2011; Shiferaw et al. 2014), we apply the concept of exclusion restriction to ensure that the model is properly identified. This approach requires that the ESR model contains at least one valid instrument – variables that directly affect market participation (the selection variable) but not the outcome (TE). The selected variables were group membership, distance to the market and the sourcing arrangement for common staples such as maize, following other literature (Ng'ombe, Kalinda, and Tembo 2017). The main mechanisms through which group action and distance to markets can deliver improved productivity is through improved access to high quality inputs and reduced transaction costs of sourcing the inputs (Ouma et al. 2010; Poole 2017). While this could be the case for many agricultural crops, coordination arrangements that have evolved over time in Kenya's tea value chain mean that most farmers can efficiently access purchased production inputs irrespective of their group or market participation status.[2] The implication is that these variables would not have any significant influence on tea productivity. As reported in the FGDs, fertiliser (which is the only purchased input in tea production) is normally delivered at locations nearest to the farmer's home by the tea collection trucks, which makes access to and transportation of fertiliser less of a challenge. Sourcing arrangements for the key food staples (in our case, maize) was excluded based on our view that no systematic association could be captured between the variable and tea productivity. The results of a falsification test used to check the validity of the excluded variables (Table A1 in Appendix 2) shows that the selected instruments are in the admissible set – since the variables jointly influence FG participation, but not tea productivity (probit selection model, $\chi^2 = 27.61$; $P = 0.000$; against FRM, F-statistic = 3.89; $P = 0.0.566$).

The effect of FG participation on tea productivity (Y) is calculated as the difference in the conditional mean of Y based on the two FG participation regimes (as shown in Equation (17)). The differences reflect the average treatment effects of the treated (ATET). ATET reflects the change in productivity due to FG participation, based on the assumption (conditional independence) that given a set of explanatory variables (X), the potential non–treatment (participation) effects are not dependent on the participation status (Verbeek 2012).

$$\text{ATET} = E(Y_P|D = 1; X) - E(Y_{NP}|D = 1; X) \tag{17}$$

where Y_P and Y_{NP} repesent the TE of the FG participants and non-participants respectively, X represents variables assumed to be arguments in the tea productivity equation, while D is dummy representing FG participation.

3. Results and discussions

3.1 Descriptive statistics

The results of the descriptive analysis compares the means of key variables between the FG participants and non-participants (Table 1). The results show that the proportion of households selling their tea through the FG channels was about 36 percent with an estimated market share of about 40 percent based on industry statistics (Republic of Kenya 2015; Tea Directorate of Kenya 2019). The results indicate that FG trading, which initially lacked official recognition, has gained significant growth in recent years.

The results (see Table 1), also show that households selling through the FG had higher productivity based on mean yields and TE than their non–participating counterparts, suggesting that the choice of a market has implications on farm performance. However, causal interpretation

Table 1. Descriptive summaries.

Variable	Full sample (*N* = 525)	SD	FG participants (*N* = 191)	Non participants (*N* = 334)	*p* value
Outcome variables					
yield per acre	2745.9	2067.6	3154.7	2512.2	0.001
TE score	0.46	0.240	0.504	0.433	0.000
Liquidity constraints					
Value of liquid assets (KES)	36009.2	1435.3	30692.6	39104.9	0.0046
Household debt (% Yes = 1)	69.1		82.2	61.7	0.000
Sourcing of staples (# Weeks)	40.9	0.81	40.8	41.0	0.894
Sickness or injury (% Yes = 1)	39.5		35.1	42.0	0.117
Farm and institutional					
Scale (volume harvests Kgs)	3208.3	3019.8	4138.6	2676.3	0.000
farm size (acres)	1.34	1.11	1.47	1.26	0.043
Fertiliser (50 kg bags/acre)	4.54	3.8	4.12	4.78	0.083
Labour (man-days/acre)	197.3	138.5	185.9	203.8	0.392
Share of family labour (%)	58.2	45.5	61.1	56.4	0.256
Age of farm (Years)	27.0	15.2	26.8	27.2	0.783
Distance to market (Kms)	2.90	2.73	2.89	2.90	0.974
Distance to selling point (KMS)	0.76	0.75	0.74	0.76	0.834
Distance to road (KMS)	1.08	1.28	1.04	1.10	0.630
Improved tea variety (% Yes = 1)	60.0		61.3	59.3	0.657
Extension (% Yes = 1)	52.8		49.3	54.8	0.219
Group membership	79.2		87.4	74.5	0.006
Household and demographic					
Age of farmer (Years)	49.20	14.47	47.41	50.23	0.032
Household size (Members)	6.31	2.81	6.28	6.33	0.846
per capita exp (KES/person)	42658.5	32682.0	44498.3	41593.6	0.329
Total household assets (KES)	107245.8	98976.6	102545.3	109982.8	0.418
Location (% Bomet = 1)	36.95		44.5	32.6	0.007
Location (% Nyamira = 1)	63.1		55.5	67.4	0.007
Gender (% male = 1)	84.2		85.9	83.2	0.427
Residence (% on farm = 1)	89.3		95.8	85.6	0.000
Education (1 = primary)	45.3		42.9	46.7	0.404
Education (1 = secondary)	43.1		42.9	38.8	0.334
Education (1 = tertiary)	9.5		11.5	8.3	0.240
Education (1 = university)	4.95		2.6	6.3	0.062

Source: Authors estimation comparison of means based on independent *t* test.

cannot be assigned to the differences, since the FG participation decision is voluntary and therefore potentially endogenous. The level of the liquidity–related variables (based on the value of liquid assets and household debt) was higher among the FG participants than the non-participants. The summary statistics also reveal that there were statistically significant differences across various farm and household characteristics (scale of operation, plot sizes, fertiliser use, age of the farmer and education and residence of the household head). We also note that the differences for variables representing market access (such as the distance to the road and market) were not statistically important ($P > 0.1$). The average distance from the farm to nearest tea selling point was about 0.75 kilometres, suggesting that both the FG and MC were operating in close proximity with each other.

On pricing, the results (see Figure 3) reveal that the differences in tea prices received by farmers across the two systems were considerable. For example in Bomet, the average price in 2013/2014 was KES[3] 44.50 (USD 0.445) in the MC market, while KES 33.00 (USD 0.33) was received by the FG participants. A similar pattern was noted in Nyamira County where the FG price was about 30 percent lower compared to the MC market. Figure 3 also reveals that the two markets are characterised by different payment structures. While payment in both systems is generally structured into two instalments, participants at the FG received a significant share (about 70 percent) of the proceeds immediately after completing a sale transaction. This is in contrast with the MC system, where a much smaller share (less than 35 percent) accounted for the initial payment. Based on information

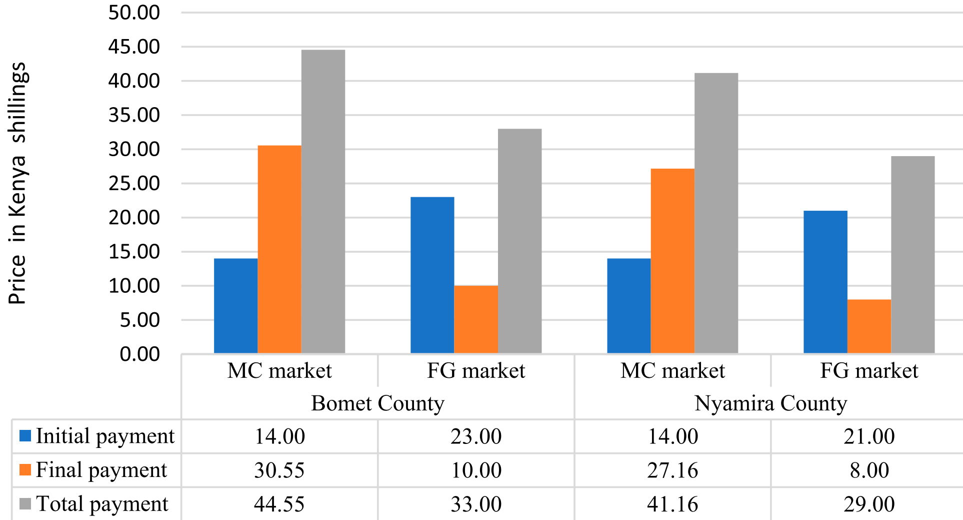

Figure 3. Price differentials between the FG and MC markets in Bomet and Nyamira Counties of Kenya (2013–2014).

from FGDs and KIIs, there was very limited variability in prices among farmers selling through the same channel within the same geographical location or region, which explains why price was not included in our regression models.

3.2 Determinants of farm gate participation in markets

The results of the probit model (Equation (7)) estimated to assess the determinants of FG participation are shown in Table 2.

Table 2. The marginal effects from the probit results on determinants of FG participation.

	Probit	
Variable	Marginal effects (dy/dx)	*P* > z
Indicators of Liquidity constraints		
Ln value of liquid assets (KES)	−0.059**	0.018
Household debt (yes = 1)	0.161***	0.003
Sourcing of staples (# weeks)	0.000	0.723
Transaction costs		
Distance to market (KMS)	0.000	0.965
Distance to selling point (KMS)	−0.002	0.931
Distance to road (KMS)	−0.013	0.676
Household characteristics		
Gender (% male = 1)	0.008	0.910
Household size (# members)	−0.003	0.764
Age of household head (years)	−0.006***	0.008
Residence of head (1 = at farm)	0.165**	0.018
Education (1 = primary)	0.131	0.364
Education (1 = secondary)	0.178	0.212
Education (1 = tertiary)	0.301*	0.058
Farm characteristics		
Location (Bomet = 1)	−0.041	0.473
Scale (volume harvests Kgs)	0.002***	0.000
Share of family labour (%)	0.060	0.295
Age of farm (years)	0.004*	0.072
Institutional variables		
Group membership	0.140**	0.017
Extension (access, yes = 1)	−0.158***	0.001
LR (χ^2)	78.44***	0.000

Source: Authors estimation asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).

One of the empirical questions addressed in this study relates to the association between the liquidity–related variables and the household's selling decisions for tea by smallholder farmers. We focus on liquidity given that the two market regimes under consideration in this study are characterised by considerable differences in prices and payment structure (how and when farmers are paid for their tea deliveries). While the FG transactions are characterised by relative informality, shorter payment cycles (often immediately after the transaction) and lower prices, selling at the MC is more structured with defined procedures for product quality and handling. The MC is also characterised by considerable lag between the time farmers supply their crop and when they actually receive payment.[4] Against this context, the analysis in this section engages with the possibility that tea farming households can sell their crop through the low–but promptly paying FG channels, if they lack the means to address their liquidity constraints.

The results in Table 2 reveal existence of an important relationship between the value of liquid assets owned by a household and its tea selling decisions. The results predict that an increase (of one percent) in the value of liquid assets owned by a household would be associated with a six percent decrease in the probability of the household participating at the FG. The finding is expected considering that tea dominates the income sources of tea farmers in the study area, contributing an estimated 70 percent of household incomes. Ownership of liquid assets for households lacking other livelihood options can lower their liquidity demands and therefore dissuade them from FG participation (Benjamin, Brandt, and Giles 2005). Table 2 further shows that there is a statistically significant relationship between household debt and the household decision to participate in an FG market. As shown in the table, an average tea producing household would have a 16 percent probability of selling through the FG if the household had debts in the preceding season. These results suggest that household debt (one of the key liquidity-related variables) is positively associated with choice of the FG channel. The result is consistent with the observation that the more debts a household needs to pay off, the more the extra cash it will require and therefore the higher the probability that it will face liquidity restrictions (Sun et al. 2013). The reason is that, while the FG transactions are less remunerative, they provide the means of addressing pressing household needs. Our FGD results indicate that while the MC channels offer better prices and provide a mechanism for encouraging farmers to accumulate savings, there are concerns that the delayed payment can be a key source of cash-flow predicament, household indebtedness and transitory penury.

Overall, our findings reveal that there is an important association between liquidity–related variables and the household market participation decisions in the study area. This association is consistent with literature (though based on cereals) showing that liquidity constraints can influence households to sell grain soon after the harvest when prices are lowest – even when they have knowledge of opportunities for inter-temporal arbitrage (Stephens and Barrett 2011; Burke et al. 2019; Melkani et al. 2019). However, our finding are inconsistent with other studies (Shilpi and Umali-Deininger 2008; Courtois and Subervie 2015; Negi et al. 2018) which report that lack of systems for collective action, poor infrastructure and information asymmetries are common factors explaining FG participation. While some of these factors are widely affirmed by many authors, their role does not appear to be very important in the context of smallholder tea markets in the study area. First, findings from the interviews and FGDs indicate that most farmers had good understanding of the market conditions (e.g., differences in transaction costs and prices across the two market regimes) which refutes the commonly held view that asymmetries in information is a key driver of FG sales (Sitko and Jayne 2014). In addition, the two market regimes (FG and MC) were found to be operating fairly within the same geographical proximity (less than one kilometre as shown in Table 2), making explanations based on spatial isolation less plausible. Our findings also did not reveal any relationship between gender and the market participation decisions.

The coefficient for the partial effects for age of the household head was −0.06 suggesting that the probability of being an FG participant was 0.6 percent lower for each additional year lived by the farmer. This finding is consistent with other literature such as Yoshiko (2011) who found that due to averseness to risks of new market dynamics, the relatively aged farmers had a preference to sell their tea to the state–owned tea factories in Vietnam. Other studies (Abu, Haruna, and Nkegbe 2016) have also shown that younger farmers tend to be more open to new thinking which emboldens them to engage with emergent initiatives, including new markets. From the results (Table 2), it can also be noted that the probability of FG participation was higher (16.5%) for households residing within the farm, compared to the non–residents. The difference possibly reflects the disparities in access to off-farm income between households living within the farm, and those residing elsewhere. This affirms our observation that the majority of the heads living outside the farm were working in town with a possibility of having access to additional income – which can reduce liquidity constraints and therefore discourage FG participation.

With regard to the scale of operation, our estimates show that an increase in the scale of operation would be associated with a rising probability of FG participation. The result would be attributed to the differences in procedures for product quality and handling that are applied across the two market regimes. While transactions at the FG are informal and flexible, selling tea at the MC requires compliance to stipulated guidelines on leaf quality and tea harvesting (Mbeche and Dorward 2014). These differences in procedures and quality standards have implications on labour sourcing and intensity of use and therefore the selling decisions of the household. Households operating bigger farms could face more constraints in obtaining sufficient labour needed to meet the stringent plucking standards prescribed by the MC markets. This observation was confirmed during the interviews with a number of farmers indicating that limited access to plucking labour was a key challenge in tea farming. It is also notable that the flexible arrangements that define the operations of FG transactions are attractive in enabling market actors to be more responsive to the needs of smallholder farmers, which are highly heterogeneous and household specific (Poole 2017).

As shown in Table 2, the age of the farm is positively linked with FG participation which could possibly be associated with the farmer's experience in tea farming. Experience is important since it can broaden the farmer's social network and therefore access to market information and establishment of market linkages (Shilpi and Umali-Deininger 2008). The other reason could be associated with the lack of growth vigour in aging tea bushes to produce high quality shoots required by MC markets. On extension, the results show that farmers who had access to extension services were likely to sell their tea through the MC rather than the FG. This finding is inconsistent with Abi et al. (2016) who found that farmers having access to paid extension in Ghana had a higher likelihood of selling at FG than the MC. Finally as shown in Table 2, group membership had a positive effect on the FG participation. This could be explained by the fact that collective action can strengthen farmer's bargaining and lobbying power, which could be the skills needed to engage with the intermediaries in FG channels. This result is consistent with Muamba (2011) who found that farmers belonging to rotating savings and credit associations were selling their produce through FG channels.

3.3 The effects of farm gate participation on productivity

3.3.1 OLS and FRM/naive estimation results

The results of the OLS and FRM used to assess the effect of FG participation on productivity (TE) are presented in Table 3; columns (1) to (4). We begin with a parsimonious model in column (1) with FG participation as the only explanatory variable with no control variables. We then incrementally add control variables beginning with farm characteristics and ending with liquidity constraints in the subsequent estimations (columns two to four). This procedure allowed us to check the robustness of the market participation coefficients.

Table 3, shows that the coefficient for FG participation is positive and significant across all the four regressions, suggesting presence of a strong association between household selling decisions and farm performance. The results also show that farm level factors (farm size, age of tea bushes), location, agency and household demographics (share of family labour applied in tea production, education and extension) have an influence on tea productivity. The tea yields included in the regressions for this section are based on tea harvests for the financial year 2014/2015, which

Table 3. OLS and FRM estimation on effect of FG participation on tea productivity (TE).

Variable	One (1)		Two (2)		Three (3)		Four (4)	
Dependent = TE	OLS dy/dx	FRM dy/dx	OLS dy/dx	FRM dy/dx	OLS dy/dx	FRM dy/dx	OLS dy/dx	FRM dy/dx
Market location (FG = 1)	0.071***	0.071***	0.087***	0.090***	0.070***	0.074***	0.062***	0.065***
	(.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.003)
Farm size (acres)			−0.158***	−0.162***	−0.158***	−0.165***	−0.166***	−0.174***
			(0.000)	(.000)	(.000)	(0.000)	(.000)	(0.000)
Square of Farm size (acres)			0.022***	0.022***	0.021***	0.021***	0.023***	0.024***
			(.000)	(0.000)	(0.000)	(.001)	(0.000)	(.001)
Planted variety			0.034*	0.036*	0.010	0.011	0.007	0.008
			(0.084)	(0.078)	(0.589)	(0.561)	(0.717)	(0.698)
Age of farm (years)			−0.004	−0.004	−0.006**	−0.006**	−0.005**	−0.006*
			(0.110)	(0.127)	(0.023)	(0.026)	(0.047)	(0.054)
Square age of farm (years)			0.000	0.000	0.000	0.000	0.000	0.000
			(0.356)	(0.384)	(0.072)	(0.078)	(0.151)	(0.162)
Location (Bomet = 1)					0.152***	0.157****	0.154***	0.160***
					(0.000)	(0.000)	(0.000)	(0.000)
Gender					−0.015	−0.015	−0.013	−0.014
					(0.565)	(0.585)	(0.610)	(0.622)
Share of family labour (%)					0.044*	0.046*	0.042*	0.045*
					(0.056)	(0.055)	(0.075)	(.071)
Education (1 = primary)					0.076*	0.080**	0.078	0.084**
					(0.099)	(0.022)	(0.129)	(0.021)
Education (1 = secondary)					0.069	0.074**	0.076	0.082**
					(0.122)	(0.030)	(0.131)	(0.021)
Education (1 = tertiary)					0.072	0.077*	0.081	0.087**
					(0.156)	(0.057)	(0.156)	(0.044)
Extension (access, yes = 1)					0.051***	0.053***	0.049**	0.051**
					(0.007)	(0.005)	(0.013)	(0.012)
Distance to market (Kms)					(−0.002)	(−0.002)	(−0.001)	(−0.002)
					0.548	0.598	0.677	0.712
Value of liquid assets (KES)							0.000	0.000
							(0.296)	(0.264)
Household debt (% yes = 1)							−0.005	−0.004
							(0.803)	(0.859)
Sourcing staples (# weeks)							0.000	0.000
							(0.993)	(0.961)

Source: Authors estimation *p* value are in parentheses asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).

began in July 2014 and ended in June 2015. The FG participation decision reflects the decision of the farmers made prior to start of the year (2014/2015). FGDs with farmers revealed that over time (since the early 2000s) tea growers are able to self-select themselves into either of the market options in line with the Kenya Tea Licensing, Registration and Trade Regulations of 2008 (repealed in 2016). The regulations required all tea growers in country to sign an annual Green Leaf Supply Agreements (GSA) with a preferred market service provider (option), which therefore restricted farmers from side–selling between options (switching between options) during the term of the contract. The GSA also stipulates the product quality specifications necessary to meet the buyer's requirements, when and how production activities should be implemented and details on how inputs (fertiliser) will be provided by the buyer.

3.3.2 ESR results

We estimated an ESR model consisting of a binary probit and two tea productivity (TE) equations (one for the FG participants and the other for the non-participants). The results are shown in Table 4 (columns 1–3). The results of the binary equation (column 1) highlight the important influence of liquidity–related variables as well as farm, institutional and household characteristics on FG participation as discussed in section 3.2. Based on the estimates of the productivity equations (columns 2 and 3), ATET was calculated using the simulation in Equation (17) (see Table 5).

Table 4. ESR estimation on effect of FG participation on tea productivity (TE).

Variable	Participation (1/0) Coefficient	TE score (FG = 1) Coefficient	TE score (FG = 0) Coefficient
Ln value of liquid assets (KES)	−0.165**	−0.090**	−0.024
	(0.018)	(0.035)	(0.382)
Household debt (yes = 1)	0.505***	0.173*	−0.149**
	(0.001)	(0.076)	(0.015)
Farm size (acres)	0.110	−0.306***	−0.382***
	(0.196)	(0.000)	(0.000)
Distance to road (KMS)	−0.012	0.057	−0.021
	(.825)	(0.101)	(0.269)
Distance to selling point (KMS)	−0.021	−0.071	−0.003
	(0.802)	(0.164)	(0.915)
Gender (% male = 1)	0.062	−0.249**	−0.036
	(0.728)	(0.021)	(0.608)
Household size (# members)	−0.014	−0.007	−0.016*
	(0.565)	(0.606)	(0.083)
Age of household head (years)	−0.015***	−0.004	0.002
	(0.008)	(0.278)	(0.321)
Residence of head (1 = at farm)	0.394	0.283*	−0.020
	(0.108)	(0.086)	(0.801)
Education (1 = primary)	0.367	−0.038	0.073
	(0.346)	(0.877)	(0.556)
Education (1 = secondary)	0.440	0.191	0.042
	(0.247)	(0.437)	(0.730)
Education (1 = tertiary)	0.715*	0.194	0.099*
	(0.086)	(0.454)	(0.495)
Location (Bomet = 1)	−0.053	0.047	0.192***
	(0.730)	(0.609)	(0.003)
Scale (volume harvests Kgs)	0.001***	0.001***	0.001***
	(0.002)	(0.000)	(0.000)
Share of family labour (%)	0.205	0.119	0.107*
	(0.191)	(0.208)	(0.084)
Age of farm (years)	0.009*	−0.001	−0.004***
	(0.087)	(0.851)	(0.053)
Extension (access, yes = 1)	−0.405***	−0.087	0.077
	(0.001)	(0.273)	(0.160)
Constant	0.038	−0.687	−0.579
	(0.965)	(0.209)	(0.068)
Sourcing of staples (# weeks)	0.002		
	(0.443)		
Distance to market (KMS)	−0.004		
	(0.814)		
Group membership	0.381***		
	0.005		
Rho 0	1.547***		
	0.000		
Rho 1	−0.791**		
	0.012		
Wald Test	128.48***		
	0.000		
LR test of independent equations	14.02***		
	0.002		

Source: Authors estimation *p* value are in parentheses asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).

Table 5 shows that the coefficient of ATET was positive and statistically significant, suggesting that FG participation has a positive impact on tea productivity. The magnitude of the coefficient (0.0758) suggests that FG participation can increase the technical efficiency (TE) of smallholder tea production by about 7.6 percent. The finding is consistent with other literature such as Chirwa and Kydd (2006) who found that farmers who marketed tea through a state–based organisation in Malawi achieved lower yields compared to those who sold their crop through the alternative arrangements. The positive impact of FG participation on tea productivity would be attributed to

Table 5. ESR results on effects of FG participation on tea productivity (TE).

$E(TE_{1i}\|D_i = 1; X)$		$E(TE_{2i}\|D_i = 1; X)$		$E(TE_{1i}\|D_i = 1; X) - E(TE_{2i}\|D_i = 1; X)$	*P* value
Mean TE	Std dev	Mean TE	Std dev	ATET	
0.4841	0.2065	0.4083	0.1555	0.0758***	0.000

Source: Authors estimation asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).

Table 6. PSM results on effects of FG participation on tea productivity (TE).

Estimator	Outcome	Effect	Coefficient	AI Robust SE	Z value	P value
NNM	TE score	ATET	**0.05924***	**0.02505**	**2.36**	**0.018**

Source: Authors estimation asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).

(among other factors) the prompt payment system that characterises the FG transactions. This is because the timing of payment has implications on the ability of the household to undertake timely implementation of recommended agricultural practices. Tea is a perennial enterprise with a unique production calendar with crop harvesting (plucking) happening every seven (7) to 14 days depending on availability of labour and level of management (Ateka, Onono, and Etyang 2018). Consequently liquidity constraints can affect the capacity of the household to optimally implement the required production practices, especially if they have to hire labour. In various FGDs, farmers selling through the MC reported that they were undergoing considerable difficulties in funding their farm operations, particularly tea harvesting, which accounts for over 60 percent of farm expenses.

The second explanation is that delays in tea collection from the buying centres for farmers selling through the MC could also provide explanation for our impact results. Mbeche and Dorward (2014) report that farmers selling tea to KTDA (the leading actor in the MC system) sometimes have to wait at the aggregation or buying centre for up to three days for their tea to be collected. Our interviews with the local extension officers revealed that the delays were mainly caused by vehicle breakdowns and insufficient processing capacity at the factories. It is expected that poor delivery of services can discourage farmers from investing more effort to improve their farms, therefore leading to low productivity. Our findings on the impact of FG participation are inconsistent with Yoshiko (2011) who established that farmers contracted by the state-owned companies (equivalent to MC) in Vietnam had higher TE compared to those who were not contracted.

We test the robustness of our results using the propensity score matching (PSM) approach following Rosenbaum and Rubin (1983). The matching procedure is implemented using the nearest neighbour matching (NNM) algorithm. We then calculate ATET after confirming that the overlap and common support conditions (a necessary condition for the PSM) are satisfied in the data (Asres et al. 2013). The results are reported in Table 6. The PSM results (Table 6) provide a consistent result indicating that FG participation has a positive impact on tea productivity.

Overall our results show that the liquidity–related variables have an important association with the household marketing decisions. We also find evidence that the choice of market has an influence on tea productivity. The implication is that strengthening mechanisms that enable farmers to better articulate and engage with emerging market alternatives might be more beneficial for agricultural growth and household welfare than policies focusing on curtailing their operations.

4 Conclusions and policy implications

The implementation of agricultural market reforms in SSA has led to a number of changes in the way many agricultural commodities are marketed. The growth of farmgate selling is one of the key developments that has emerged following the reforms and is now part of the pluralistic marketing arrangements introduced to spur efficiency and, by extension, agricultural productivity (Republic of Kenya 1999). While FG trading has been chastised by some critics for exploiting farmers (Sitko and Jayne 2014; Courtois and Subervie 2015), market trends across many countries in SSA show that the practice has been rising over the last two or so decades (since the 2000s). This article assessed the determinants of farmgate participation among smallholder tea farmers and their implications on agricultural productivity. The paper focused on the role of liquidity–related variables, a domain that has received limited research attention to date. The paper also contributes to the understanding on the effect of farmgate selling on agricultural productivity in the context of conflicting accounts about the outcomes of agricultural market reforms.

The paper has shown that liquidity constraints have an important association with the farmers' market participation decisions. The paper argues that the need to respond to household obligations (such as buying food and meeting out-of-pocket medical expenses) can motivate households facing liquidity constraints to participate in markets paying lower prices – but having shorter and more flexible payment terms. The study has also shown that farmgate selling has a positive effect on tea productivity, especially in situations where the mainstream market arrangements are characterised by inefficiencies and poor delivery of services. Overall, our findings point to the importance of promoting efficiency of agricultural commodity marketing systems and flexibility in payment arrangements if the reforms have to deliver expected productivity and welfare outcomes. Consequently, policy reforms should focus on deepening and facilitating greater competition as a pre–requisite for agricultural transformation instead of working towards elimination of farmgate trading.

Notes

1. The tea industry players in Kenya (Tea Directorate, tea factories and KTDA) have digitalised data on tea transactions and a few farm characteristics such as plot area.
2. Refers to arrangements across the two market systems that allow farmers to collect inputs – basically fertiliser on credit. The cost is recovered later from the farmers' tea proceeds.
3. Kenya shillings.
4. Under the current structure farmers receive an initial payment of KES 17 per kilogram of green tea delivered at the end of the month, while the remaining portion is paid as final payment at the end of the year.

Disclosure statement

No potential conflict of interest was reported by the author(s).

Funding

This work was supported by Jomo Kenyatta University of Agriculture and Technology [grant number 2017/2018]; National Commission for Science, Technology and Innovation [grant number PhD grant 2016-2017].

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Appendices

Appendix 1. DEA model for estimating TE

Minimize θ

Subject to;

$$
\begin{aligned}
& -Y^q + \lambda Y_i \geq 0 \\
& \theta X^q - \lambda X_i \geq 0 \\
& \theta Z_j^q - \lambda Z_{ij} \geq 0 \\
& \lambda \geq 0 \\
& \sum_{n=1}^{n} \lambda = 1
\end{aligned}
\tag{A1}
$$

The model solves for θ; where θ is the value of the efficiency score for the Qth farm and represents the proportion of the farm's input bundle needed to produce its own output, Y_Q denotes the tea output of the Qth farm and Y_i ($i = 1, 2, \ldots, N$) are the outputs of the other tea farms in the sample. The vector X^Q and Z_j^Q ($j = 1, 2$) denote the inputs used by the Qth farmer (X is fertiliser, Z_1 is labour and Z_2 is land under tea), X_i and Z_{ij} are the inputs (fertiliser, labour and land) used by all the other tea farms in the sample and λ is the weight given to each farm in the construction the frontier.

Appendix 2

Table A1. Test for validity of selection instruments.

	Model 1 (1/0) Selection model (probit)		Model 2 Productivity (TE) by households that did not participate in FG (FRM)	
Variable	Coefficient	$P > z$	Coefficient	$P > z$
Gender	0.054	0.739	0.037	0.856
Household Debt	0.588***	0.000	−0.172	0.358
Distance to market	−0.007	0.736	0.002	0.929
Group membership	0.160*	0.096	−0.207	0.344
Sourcing of staples	0.002	0.864	−0.023	0.196
Constant	−0.947***	0.000	0.519	0.150
Wald test; Chi square (X2)	27.61	0.000	3.89	0.566

Source: Authors estimation asterisks denote significance (*** at 1%, ** at 5% and * at 10 %).