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Welfare effects of small-scale farmers' participation in apple and mango value chains in Ethiopia

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ABSTRACT
This study examines the effects of participation in the fruit value chain on small-scale farmers' economic welfare in Ethiopia's Upper-Blue Nile Basin, focusing on apple and mango crops. This household economic welfare is measured by the consumption expenditure approach. Primary data were collected from a random sample of 384 households, 211 of which are fruit value chain participants and the rest are non-participants. The endogenous switching regression model was used to control for selection bias and unobserved heterogeneity. The study finds that the more apple and mango farmers join the value chain, the higher their consumption expenditure becomes. On average, the apple and mango value chain participation increased household consumption expenditure by about 17% and 18.5%, respectively. Overall, the results indicate a positive economic welfare effect of small-scale farmer participation. Hence, supporting small-scale farmers is imperative and a reasonable policy approach to improve their economic welfare in rural Ethiopia.

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KEYWORDS
Household welfare; consumption expenditure; endogenous switching regression; fruit value chain; Ethiopia

1. Introduction

The demand for high-value agricultural products such as fruits and vegetables is growing worldwide (Quisumbing et al. 2015; Barrett et al. 2020). From the year 2000–2017, these products' demand has increased by 21% and 15% in both international and local markets, respectively (Gheri et al. 2020). Within the developing countries, significant shifts in food baskets towards high-value agricultural products are evident, leading to diversification of agricultural production (Reardon et al. 2019). The increase in demand, particularly in developing nations, was triggered by rapid population growth, increasing urbanisation, rising incomes, access to new information communication technologies, and dietary changes (Wiggins 2014; Reardon 2015). Moreover, the growing transformation of agri-food systems in developing countries promises new business opportunities to overcome the problem of integrating smallholders into international and local markets (Tschirley et al. 2015; Devaux et al. 2018). Of particular interest are value chains that link producers with traders and consumers of agricultural products (Lie 2017).

Modernising agri-food systems is a relatively recent trend in Sub-Saharan Africa (SSA) (Barrett et al. 2020; Gómez, Meemken, and Chiu 2020). In SSA, the issue of economic welfare gains to farm households from participation in agri-food value chains has acquired much significance in recent times (Joosten et al. 2011; Barrett et al. 2019). According to Barrett et al. (2019), farm households have a high potential to derive livelihoods from value chain-oriented agriculture. The

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participation of small-scale farmers in agricultural value chains is seen as an essential way of improving their household welfare (Martey et al. 2017; Herrmann, Nkonya, and Faße 2018) and thus promoting rural development and poverty reduction (Mitchell, Keane, and Coles 2009). In many SSA countries, where about 70% of the population relies on agriculture for their livelihoods, poor small-scale farmers can transform their surplus into earnings if only they get the capacity to engage in agri-food value chains (Kissoly, Faße, and Grote 2017; Herrmann, Nkonya, and Faße 2018). There is a demand for high-value agricultural products in SSA, and especially in Ethiopia where farmers still seem averse to engaging in high-value crops. This was observed in the fruits sub-sector (Worako 2015).

Most of the reviewed empirical studies revealed that agri-food value chains increased farm household income and food security. These effects have been attributed to: improved access to value chains (e.g., Kissoly, Faße, and Grote 2017; Herrmann, Nkonya, and Faße 2018), stimulating innovation via facilitating the flow of information exchange (e.g., Fischer and Qaim 2012), and increasing household income and food security (e.g., Muriithi and Matz 2015; Mulatu et al. 2017; Amare et al. 2019; Krause, Faße, and Grote 2019). However, investigation of value chain participation effect on each household's economic welfare is not yet adequately studied. Even the one recently studied by Herrmann, Nkonya, and Faße (2018) assessed the effects of value chain participation on farm households' welfare used a propensity score matching (PSM) approach. However, the PSM technique is known for its limitation to account for unobserved heterogeneity, resulting in bias estimates. The endogenous switching regression (ESR) model is a robust empirical approach that predicts the counterfactual effect of choice regimes when selectivity bias arises (Alene and Manyong 2007). The ESR model used to estimate counterfactual outcomes based on conditional expectation assumptions while controlling observed and unobserved heterogeneity. The model also controls the potential systematic differences between treatment and control groups regarding welfare functions (Deb and Trivedi 2006). This study seeks to bridge this gap and handle the problem of endogeneity using recent cross-sectional data.

Moreover, most of the locally existing empirical studies (e.g., Honja 2014; Getahun et al. 2018; Mengesha et al. 2019; Gebre, Rik, and Kijne 2020; Tarekegn et al. 2020) concentrate mostly on southern and central parts of Ethiopia. They thus may have limited contextual relevance to north-western Ethiopia. That means, results from these studies vary depending on the product being considered, the number and organisation of available channels, and the institutional, technical, social, and economic environments the farmers operate in. Despite their significant contributions to the livelihood of millions of people in the Upper-Blue Nile Basin of Ethiopia, apple and mango fruits have not been given research attention. Therefore, this study examines the effects of participation in the fruit value chain on small-scale farmers' economic welfare in Ethiopia's Upper Blue Nile Basin, focusing on mango and apple crops.

Overall, this paper aims to contribute to the existing literature on the effect of fruit value chain participation. First, our study is primarily agro-ecological based and covers highland, midland, and lowland areas. It also covered a largest basin of the country with a representative sample size. This has allowed us to include several policy-relevant variables that were not included in previous studies. Second, to the best of our knowledge, this is the first rigorous paper on the relationship between household welfare and fruit value chain participation in North-western Ethiopia. Third, many studies have used household income as an indicator of household welfare. However, given the limitations of this indicator (Dercon et al. 2009), this study used consumption expenditure approach, which is rarely carried out in the same study. This research utilised the ESR model to control for selection bias and unobservable farmers' heterogeneity since self-motivation and other individual skills of farmers are likely to impact their decision to participate.

Ethiopia has nearly 38 fruit species grown by small-scale farmers within various agro-ecologies, mainly for income generation and home consumption (Worako 2015). Avocado (*Persea americana*), mango (*Mangifera indica*), pineapple (*Ananas comosus*), apple (*Malus domestica*), banana (*Musa paradisca*), papaya (*Carica papaya*), and orange (*Citrus sinensis*) are naturalised to the Ethiopian agro-ecologies. Most of these fruit crops are grown in farmers' home gardens (Institute of Biodiversity Conservation (IBC) 2012). The majority of Ethiopia's fruits are produced by small-scale farmers on small plots of land, accounting for 94% of total fruit production (Gebre-Selassie and Bekele 2012; Alemayehu et al. 2015). There is great potential for the fruit industry to improve living conditions for the poor in Ethiopia (Wiersinga and de Jager 2009). A total of 114,421.81 hectares of land was covered under fruit production, while 7,924,30.692 metric tonnes of fruit have been produced locally in the 2018/19 cropping calendar. Furthermore, 2,400 metric tonnes of fruit have been exported to Djibouti, Sudan, and Somalia (Central Statistical Agency of Ethiopia (CSA) 2019). Figure 1 indicates cultivated area coverage (hectare), volume of production (metric ton), yield (metric ton per hectare), and amount exported (metric ton) for major fruits (such as avocado, banana, mangoes, papaya, pineapples, orange, apples, and strawberries) over the 2008/09–2018/19 cropping period. During this period (2008/09-2018/19), total cultivated area coverage and production volume increased by 138% and 125%, respectively. The observed fluctuations are attributed to erratic weather conditions, disease and insect pests, and poor post-harvest management shortage of water.

Mango is one of the most widely planted fruit crops in Ethiopia. Its production increased from 70,000 metric tons in 2013/14–105,000 metric tons in 2017/18, which has increased by 45% (Global Agricultural Information Network (GAIN) 2018). Kent, Keitt, Tommy Atkins, and Apple mango are among the main cultivars grown in the country (Bekele, Satheesh, and Jemal 2020). In the midland and lowland areas of the Upper Blue Nile Basin, mango-an an evergreen fruit crop is the leading fruit produced by small-scale farmers (Mossie et al. 2020). On the other hand, apple production has been expanded across several highlands of Ethiopia, including Upper-Blue Nile Basin, with the help of government and non-governmental organisations and private producers, including small-scale farmers. In addition to its dietary importance, apple trees in the Ethiopian highlands can

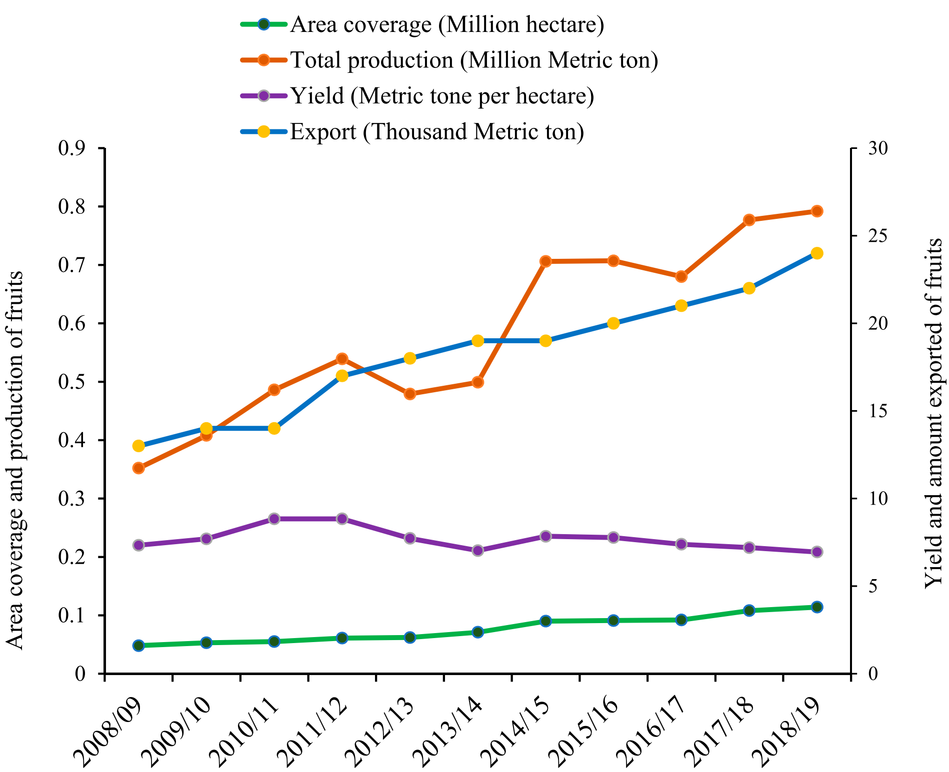

Figure 1. Trends in major fruit crops land area, production, and export in Ethiopia (CSA 2019).

improve soil conservation (Fetena and Lemma 2014). In their home compound in Chencha town, southern Ethiopia, British missionaries first introduced apple seedlings to be planted. In 2017, the production of apple fruit in Chencha was about 154 tons per year (Tamirat and Muluken 2018). There is, however, no actual information on the current national level of apple crop yield in Ethiopia. Both apples and mangoes were selected as the two most important crops to be considered for this study because they are high-value cash-commodities and are mainly produced in the Upper Blue Nile Basin.

2. Methodology

2.1. Study area description

This study was conducted in the Dibatie district from the Metekel Zone, the Fagita Lekoma and Banja districts from the Awi-Zone, and Bahir Dar Zuria district from the West Gojjam Zone, four districts in the Upper-Blue Nile Basin, Ethiopia (Figure 2). The livelihood of the communities in these districts is mainly comprised of a rain-fed mixed subsistence crop production-livestock farming system. Fruit crops such as apple and mango are also the most important contributors to agricultural activity and, hence, a focus for the development in the north-western highlands of Ethiopia. The basin has a high potential for fruit farming and, generally, it is considered among the important fruit growing corridors in the country (Nigussie et al. 2017). Table 1 summarises the study districts' bio-physical characteristics as high, mid, and low elevations as per their elevation order.

2.2. Sampling procedure

A three-stage sampling technique was used. Four districts (Banja and Fagita Lekoma from the apple-producing districts; Dibatie and Bahir Dar Zuria from the mango producing districts) were purposively selected in the first stage. These districts were chosen in such a way that they are capable of capturing the variations between the agro-climate zones, the socio-economic

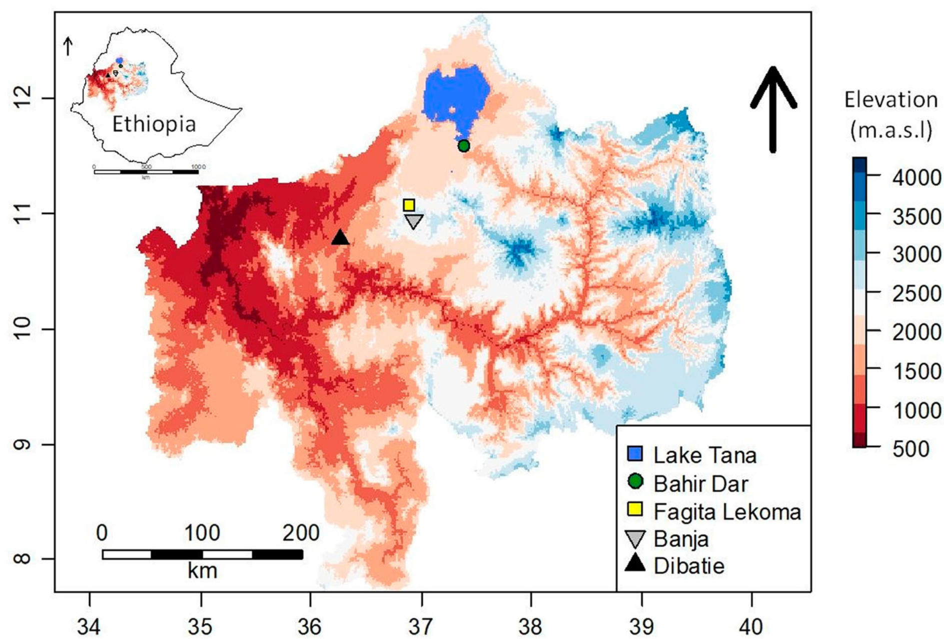

Figure 2. Location map of the study area. Source: Own construction based on Ethiopian Mapping Agency (2019).

conditions, and their fruit production experiences. In the second stage, 10 kebeles (i.e., the smallest administrative unit below the district) were randomly selected (Table 2). A list of rural households was compiled from the respective kebele agricultural offices as a sampling frame with community informants' help and then stratified them into participants and non-participants in the fruit value chain. Fruit value chain participants are defined as those who used to sell a part of her/his apple and mango output in the market during the 2019/20 production year. Non-participant households are defined as farmers who have not used to sell a part of her/his apple and mango output within the same period while they are located in the same kebele.

In the third stage, Using the Mugenda and Mugenda (2003) table, the sample size was determined by considering the confidence level, degree of variability, and precision level. Consequently, n was calculated as follows:

$$n = \frac{Z^2 p(1-p)}{d^2}$$
$$n = \frac{(1.96)^2(0.5)(0.5)}{(0.05)^2} = 384 \quad (1)$$

where n is the required sample size when the population is greater than 10,000; Z is the normal standard deviation (1.96) corresponding to 95% confidence level; p is the predicted target population characteristic assumed by the researcher (is equal to 0.5 where the occurrence level is not known), and d^2 is the desired level precision (0.05).

A sample (n) of 384 fruit-growing households was then set on. Accordingly, among the selected kebeles, 161 apple producers and 223 mango producers were proportionally allocated.

2.3. Sources and methods of data collection

The primary data used in this study were collected through a household survey. The household was the unit of analysis. The survey was conducted from November 2019 to January 2020 by trained enumerators. Survey participants in four districts were interviewed using a structured questionnaire. The instrument was translated into Amharic, the local language, and it was then tested and refined through interviews with fruit-growing farmers before the actual survey. The questionnaire was designed to elicit information on a wide range of items, including household and farm characteristics, access to institutional and infrastructural services, asset ownership (cropland and livestock), and consumer spending components (home-produced, purchased food, and non-food expenses).

Table 1. Biophysical characteristics of the study districts.

Features	Banja	Fagita Lekoma	Bahir Dar Zuria	Dibatie
Altitude (m.a.s.l.)	1850–2925	1800–2900	1922–2250	1479–1709
Temperature (°C)	9–26	9–25	15–28	25–32
Annual rainfall (mm)	1958–3465	1951–3424	895–2037	850–1200
Agro-ecological zone	Moist subtropical	Moist subtropical	Humid subtropical	Tropical hot humid
Soil type	Acrisols, Nitosols	Nitosols, Acrisols	Leptosols, Nitosols	Nitosols, Vertisols
Dominant staple crops	Teff and barley	Barley and teff	Millet, teff, wheat and maize	Maize and millet
Dominant livestock	Cattle, horses and sheep	Cattle, horses and sheep	Cattle, goats, sheep and donkeys	Cattle, goats and donkeys
Dominant cash crops	Potatoes, garlic and apple	Potatoes, garlic and apple	Khat, mango, avocado, papaya and coffee	Mango, coffee and groundnut

Source: Socio-economic profiles of respective districts (2019)

Table 2. Household distribution and sample intensity across the study kebeles

Study district	Selected kebeles	No. of fruit producers in each kebele	Sample size (number)	Percent
Dibatie	Dibatie 01	505	24	6.25
	Gallessa	820	39	10.15
	Dibatie 02	420	20	5.21
Bahir Dar Zuria	Laguna	696	60	15.62
	Wonjeta	928	80	20.83
Fagita Lekoma	Gafera	316	26	6.77
	Endewuha	560	46	11.98
Banja	Bata	263	21	5.46
	Basanguna	188	15	3.91
	Chewusa	665	53	13.80
Total		5361	384	100

Source: Own construction based on data from agricultural offices of the districts (2019)

2.4. Analytical model

As already mentioned, this study is concerned with estimating the effect of farmers' participation in the fruit value chain on their household economic welfare indicators, such as consumption expenditure. This can be specified as:

$$y = \beta X + \delta M_i + \eta \tag{2}$$

where y represents consumption expenditure. X is a vector of explanatory variables for household participation that impacts the outcome variable. The coefficient δ measures the effect of farmers' participation on household economic welfare. M_i is a dummy for household participation. This variable is potentially endogenous, as participation is not assigned randomly, and households may decide whether to participate or not (Lokshin and Sajaia 2004). In other words, farmers who participated may have different characteristics from non-participating farmers, and these variations may vague the real effect of participation on household economic welfare effects (Smale, Diakité, and Keita 2012). Thus, the use of the Ordinary Least Square (OLS) regression technique to estimate the parameters of Equation (2) would result in biased estimates (Lee 1978; Wooldridge 2010).

In the OLS, the coefficients on the control variables would be the same for participants and non-participants. Due to this limitation of OLS, most documented empirical studies applied the PSM model to examine household welfare effects. Although PSM addresses the above problem by preventing functional form assumptions, it assumes that selection is based on observable variables. Still, there is likely to be unobserved heterogeneity because self-motivation and other individual skills of farmers are likely to impact their decision to participate (Lee 1978; Wooldridge 2010). Therefore, PSM generates a bias when there are unobserved heterogeneity factors that affect farmers' participation and the outcome indicators. The ESR model is used to address these issues. In the ESR method, separate outcome equations are specified for each regime, subject to a selection equation. Thus, in our case, we estimate separate household economic welfare indicators for both participants and non-participants, subject to a decision on participation (Lokshin and Sajaia 2004; Alene and Manyong 2007).

In applying the ESR model, the study followed two requisite steps. Step one focuses on the selection equation's definition, whereby farmers' decision to participate in the value chain was determined. In this case, it was assumed that small-scale farmers' participation in the fruits value chain is a binary choice in which the returns from participation are greater than those of non-participants. The difference between the returns from participation in the apple and mango fruits value chain may be denoted as M^*, such that $M^* > 0$, suggesting the returns from participation in the apple and mango value chain exceeds that of non-participation. Even though M^* is not observable, it can be stated as a function of observable element:

$$M_i^* = \alpha Z_i + \eta_i \text{ with } M_i = \begin{cases} 1, & \mathit{if}\ M_i^* > 0 \\ 0, & \mathit{otherwise} \end{cases} \tag{3}$$

where M_i^* = the latent binary variable; M_i = its observable counterpart; Z_i = set of covariates such as the age of the household head, education level, household size, farming experience, frequency of extension contacts, access to price information, plot size, the incidence of disease and insect pests, which determine household's participation; α is a vector of parameters to be estimated; η_i is the disturbance term that captures all unmeasured variables. In this stage, the probit model is used for estimation purposes.

Step two focuses on specifying two main outcome equations based on farmers' participation in the apple and mango value chains. This is done based on the following models as suggested by Di Falco, Veronesi, and Yesuf (2011).

$$\textit{Regime}\ 1\ (\text{Participants}): Y_{1i} = \beta_1 X_{1i} + \varepsilon_{1i}\ \textit{if}\ M_i = 1 \tag{4a}$$

$$\textit{Regime}\ 2\ (\text{Non}-\text{participants}): Y_{2i} = \beta_2 X_{2i} + \varepsilon_{2i}\ \textit{if}\ M_i = 0 \tag{4b}$$

where Y_i is the per capita household consumption expenditure in each regime; X_i represents explanatory variable influencing the outcome variable, and β is a vector of parameters; ε_i are random disturbances. The error terms in equations (3) and (4) assumed to be jointly normally distributed with zero mean vector and covariance matrix are described as:

$$cov(\eta_i, \varepsilon_{1i}, \varepsilon_{2i}) = \begin{bmatrix} \sigma_\eta^2 & \sigma_{\eta\varepsilon1} & \sigma_{\eta\varepsilon2} \\ \sigma_{\varepsilon1\eta} & \sigma_{\varepsilon1}^2 & \sigma_{\varepsilon1\varepsilon2} \\ \sigma_{\varepsilon2\eta} & \sigma_{\varepsilon2\varepsilon1} & \sigma_{\varepsilon2}^2 \end{bmatrix} \tag{5}$$

where σ_η^2 is the variance of the error term (η) in the selection Eq. (3), $\sigma_{\varepsilon1}^2$and $\sigma_{\varepsilon2}^2$ are the variances of the error terms in the consumption functions equation (4a) and (4b). Besides, $\sigma_{\varepsilon1\eta}$ and $\sigma_{\varepsilon2\eta}$ represent the covariances between η_i and ε_{1i}, and between η_i and ε_{2i}, respectively. Therefore, conditional on the sample selection, the expected values of the error terms ε_{1i} and ε_{2i} are given by:

$$E[\varepsilon_{1i}|M_i = 1] = \sigma_{\varepsilon1\eta}\frac{\varphi(\alpha Z_i)}{(\alpha Z_i)} = \sigma_{\varepsilon1\eta}\lambda_{1i} \tag{6a}$$

$$E[\varepsilon_{2i}|M_i = 0] = -\sigma_{\varepsilon2\eta}\frac{\varphi(\alpha Z_i)}{1-(\alpha Z_i)} = \sigma_{\varepsilon2\eta}\lambda_{2i} \tag{6b}$$

where $\varphi(.)$ is the standard normal probability density function, $\Phi(.)$ is the standard normal cumulative density function, $\lambda_{1i} = \frac{\varphi(\alpha Z_i)}{(\alpha Z_i)}$ and $\lambda_{2i} = \frac{\varphi(\alpha Z_i)}{1-(\alpha Z_i)}$. λ_{1i} and λ_{2i} represent the inverse of Mill's ratio (Mills 1926) computed from Eq. (3) and included in (4a) and (4b) to correct for selection bias.

In this study, we enhanced the identification of the ESR model by including the instrumental variables in Z, thus avoiding the potential overlap between Z and X. Referring to empirical procedures from Di Falco, Veronesi, and Yesuf (2011), the instrument variable used in this study is the variable related to the price information source (i.e., access to price information via neighbourhood farmer and government extension workers) in the apple and mango fruits value chain that affects participation decision without influencing the outcome variable (household consumption expenditure). The study established the admissibility of the selection instrument by conducting a simple falsification test based on the equation by Di Falco, Veronesi, and Yesuf (2011). Results show that the identification variable in both apple and mango specifications are jointly significant in explaining participation decision ($\chi^2 = 64.14$, $p = 0.000$, for apple; and $\chi^2 = 72.80$, $p = 0.000$, for mango) but insignificant relationship with the outcome variable (by households that did not participate) ($F = 1.48$, $p = 0.131$, for apple; and $F = 1.49$, $p = 0.124$, for mango).

The Full Information Maximum Likelihood (FIML) technique is efficient for the ESR, simultaneously estimating both the selection (decision to participate) and outcome equations to yield consistent standard errors (Lokshin and Sajaia 2004; Clougherty and Duso 2015). The FIML technique estimates the ESR model parameters using the *movestay* command in STATA software (Lokshin and Sajaia 2004).

A thorough explanation of the FIML's log-likelihood Function for switching regression technique is offered by Lokshin and Sajaia (2004). Following Di Falco, Veronesi, and Yesuf (2011), the ESR model can be employed to compare the expected outcome (i.e., consumption expenditure) of fruit households that participated in the apple and mango value chain (a) with respect to households that did not participate (b), and to investigate the expected outcome (i.e., consumption expenditure) in the counterfactual hypothetical cases (c) that the participated apple and mango households did not participate, and (d) that the non-participant apple and mango households participated (Table 3). This can be described as follows:

$$E(Y_{1i}|M_i = 1) = X_{1i}\beta_1 + \sigma_{\varepsilon 1\eta}\lambda_{1i} \tag{7a}$$

$$E(Y_{2i}|M_i = 0) = X_{2i}\beta_2 + \sigma_{\varepsilon 2\eta}\lambda_{2i} \tag{7b}$$

$$E(Y_{2i}|M_i = 1) = X_{1i}\beta_2 + \sigma_{\varepsilon 2\eta}\lambda_{1i} \tag{7c}$$

$$E(Y_{1i}|M_i = 0) = X_{2i}\beta_1 + \sigma_{\varepsilon 1\eta}\lambda_{2i} \tag{7d}$$

Accordingly, the average treatment effect on the treated (ATT), which represents the economic welfare effect of fruit households' participation in the value chain (based on their households' consumption expenditure), is computed as the difference between (7a) and (7c);

$$\begin{aligned} ATT &= E(Y_{1i}|M_i = 1) - E(Y_{2i}|M_i = 1) \\ &= X_{1i}(\beta_1 - \beta_2) + \lambda_{1i}(\sigma_{\varepsilon 1\eta} - \sigma_{\varepsilon 2\eta}) \end{aligned} \tag{8}$$

Besides, the study computed the expected change in non-participant's economic welfare. Hence, the effect of the treatment on the untreated (ATU) for the fruit households that did not participate in the value chain is hereby expressed as the difference between (7d) and (7b).

$$\begin{aligned} ATU &= E(Y_{1i}|M_i = 0) - E(Y_{2i}|M_i = 0) \\ &= X_{2i}(\beta_1 - \beta_2) + \lambda_{2i}(\sigma_{\varepsilon 1\eta} - \sigma_{\varepsilon 2\eta}) \end{aligned} \tag{9}$$

The selection term (λ) adjusts the problems due to unobserved variables.

Furthermore, using conditional expected outcomes in Eq. (7a) to (7d), we computed heterogeneity effects (HE), because participants may have had higher consumption expenditures than non-participants even if they did not participate in the fruits value chain, due to unobserved factors. Hence, a base HE is described as the difference between Eq. (7a) and (7d) for participants, whereas for non-participants as the difference between Eq. (7c) to (7b). Finally, to examine whether the effect of participating in the fruits value chain is higher or lower for households that participated had they not participated, or for households that did not participate had they participated requires calculations of transitional heterogeneity effects (TH). This is computed from the differences between HE_1 and HE_2 or ATT and ATU. This can be summarised in a table format, according to Di Falco, Veronesi, and Yesuf (2011), as follows.

2.5. Measuring household welfare

In this study, the term "welfare" is defined as the meaning conveyed by the concept of "well-being" widely used in economics and frequently defined by certain economic indicators (Deaton and Zaidi 2002). In developing nations, while household income could be used to measure household welfare, consumption expenditure is sometimes recommended. Consumption expenditure is less prone to measurement errors and seasonal fluctuations and, therefore, more reliable (Dercon et al. 2009). Consumption expenditure data also reflect a household's decision on nutrition and health (Atkinson 1992). Thus, in this study, consumption expenditure adjusted by the number of adult equivalents was used as a measure for the household economic welfare indicator. Household consumption expenditure data for the preceding year were obtained for 12 months. This was collected utilising

Table 3. Conditional Expectations, Treatment, and Heterogeneity Effects

	Decision stage		
Subsamples	Participate (ATT)	Not participate (ATU)	Treatment Effects (ATE)
Participants	$E(Y_{1i}\|M_i = 1)$ (7a)	$E(Y_{2i}\|M_i = 1)$ (7c)	TT
Non-participants	$E(Y_{1i}\|M_i = 0)$ (7d)	$E(Y_{2i}\|M_i = 0)$ (7b)	TU
Heterogeneity effects	HE_1 = (7a-7d)	HE_2 = (7c-7b)	TH

Source: Adapted from Di Falco, Veronesi, and Yesuf (2011)
Notes: *(a) and (b) are the observed expected consumption expenditure outcome; (c) & (d) are counterfactual expected outcomes*
$M_i = 1$ if the respondent participated in the fruits value chain; $M_i = 0$ if the respondents did not participate
Y_{1i} - represents consumption expenditure outcome if participated
Y_{2i} - represents consumption expenditure outcome if they did not participate
TT - represents the effect of the treatment (i.e., participation) on the treated (i.e., participated farmers)
TU - represents the effect of the treatment on the untreated (i.e., farmers didn't participate)
HE_1 - represents heterogeneity effects for participated farmers, and HE_2 – for farmers who did not participate
TH is the difference between TT and TU, i.e., transitional heterogeneity

purchased items, and the amount of money spent each month and aggregated to the annual level. The per capita consumption indicator of household economic welfare is centred on food (home-produced + purchased + gift or aid food) and non-food expenditures. Previous studies that employed consumption expenditure to measure farm household welfare in Ethiopia include Abro, Alemu, and Hanjra (2014), and Ahmed et al. (2017).

3. Results and discussion

3.1. Descriptive results

Table 4 presents the descriptive results of variables used in the regression model, disaggregated by participation status. The respondents' characteristics comprised household characteristics, farm characteristics, institutional support variables, transaction cost variables, and per capita consumption expenditure. Most of these variables have been used elsewhere in evaluating program/treatment effects (e.g., Mmbando, Wale, and Baiyegunhi 2015; Seng 2016; Manda et al. 2017; Bahta, Owusu-Sekyere, and Tlalang 2018; Musara and Musemwa 2020; Warinda et al. 2020). The study reveals that about 48.45% and 59.64% of apple and mango households, respectively, participated in the fruit value chain. This shows that participants and non-participants are systematically different. The treatment group exhibits higher consumption expenditure than the control group by a factor of 4.088 and 5.023 Ethiopian Birr (ETB) for apple and mango households, respectively.

3.1.1. Household characteristics

Regarding the household's age, participants in both apple and mango value chains were about two and one years younger than non-participants, respectively. The result shows that almost equal proportions of male-headed households were in the participants and non-participant categories of apple farmers. Mango value chain participants (39.09%) were headed by males as compared to 32.33% for non-participants. In terms of education level, value chain participants had about three years more education than non-participants for both apple and mango. Regarding household size, non-participants had more household members than participants for both apple and mango. Fruit farming experience between the treatment and control groups was highly significant at a 1% level of significance for both apple and mango. Non-participants, on average, have less experience than the participating households.

3.1.2. Farm characteristics

The study shows that the plot size of both apple and mango value chain participants were significantly larger than that of non-participants in respective crops. The results also revealed that diseases and insect pests were higher in non-participants' apple and mango farms than those of participants.

Table 4. Description and summary statistics of the surveyed respondents.

Variable	Apple producers (N = 161)			Mango producers (N = 223)		
	Participants (78)	Non-participants (83)	*t*-test (χ2 test)	Participants (133)	Non-participants (90)	*t*-test (χ2 test)
Outcome variable						
Consumption expenditure ('000 ETB)	21.727	17.639	−4.088***	27.947	22.924	−5.023***
Explanatory variables						
Household characteristics						
Average age of the head (years)	48.80	50.50	−4.49***	46.00	47.00	−0.89
Sex of the household head; Male (1 = male; 0 = female)	39.80	39.10	0.91	52.00	29.10	7.89***
Average educational level of the head (years of schooling)	4.46	1.25	3.21***	4.18	0.70	−3.48***
Average household size (number)	5.70	5.90	0.66	5.20	5.68	−1.78*
Average income from off-farm activities (ETB)	5951.92	4323.07	−1628.85	6416.70	5674.42	−742.28
Fruit farming experience (years)	9.10	7.10	−4.67***	13.00	6.30	−6.89***
Farm characteristics						
Apple/ mango plot size (ha)	0.11	0.06	−4.69***	0.26	0.14	−5.52***
Incidence of disease and insects; Yes (1 = yes; 0 = no)	9.90	24.20	12.53***	12.60	28.30	53.24***
Perceived wild animals as a serious problem; Yes (1 = yes; 0 = no)	13.70	23.60	5.31***	7.60	34.50	116.58**
Average production (quintals)	2.47	0.84	1.59***	39.11	5.03	−34.08***
Average livestock size (TLU)	4.90	5.98	3.04**	6.20	5.70	−0.72
Institutional support variables						
Average frequency of extension contacts per year (no. of days)	10.90	3.70	−6.64***	6.00	2.50	−4.06***
Access to price information; Yes (1 = yes; 0 = no)	36.00	16.10	29.84***	42.20	7.20	60.09***
Transaction costs variable						
Average distance to the nearest market (minutes of walking)	37.60	41.50	3.99*	33.10	46.20	13.14***
Selection instruments						
Access to price information via neighborhood; Yes (1 = yes; 0 = no)	44.20	26.00	34.86***	45.70	11.20	52.38***
Access to price information via government extension workers; Yes (1 = yes; 0 = no)	29.20	13.00	20.13***	52.50	9.00	97.33***

Note: ***, ** and * represents 1%, 5% and 10% level of significance, respectively. ETB (Ethiopian Birr) is the Ethiopian currency, and during the survey period, 1 $US was about 29.00 ETB.
Source: Own field survey data (2019/20)

Similarly, perceived wild animals as a serious problem were higher in non-participant farms than those of participants. On average, participants in the mango value chain obtained higher production (39.11 quintals) than non-participants (5.03 quintals). Similarly, participants in the apple value chain received higher production (2.47 quintals) than non-participants (0.84 quintals). In terms of livestock assets measured in Tropical Livestock Unit (TLU), non-participants in the apple value chain were better-off than participant households. On the contrary, mango value chain participants had more livestock than non-participants. TLUs are livestock numbers converted to a common unit. Conversion factors are found in Storck et al. (1997).

3.1.3. Institutional support variables

Participants in the apple value chain had a more significant number of average extension contacts (10.90 days/year) than non-participants (3.70 days/year). Likewise, mango value chain participants had a more significant number of extension contacts (6.00 days/year) relative to non-participants (2.50 days/year). The result further depicts that, on average, about 46.15 and 31.73% of apple and mango participants in the value chain had access to price information, compared to 19.39 and 8.00% of the non-participants, respectively.

3.1.4. Transaction costs variable

Regarding market proximity, the study reveals that the average distance of mango growers' residence from the nearest market is less (36.65 min of walking) than apple growers' home (39.55 min of walking on foot). On average, participants are closer to the market than non-participants for the respective crops.

3.1.5. Instrumental variables

About 56.67% of apple participants had access to price information via neighbourhood farmer, whereas 37.44% of apple participants had access to price information via government extension workers. Similarly, about 34.36 and 39.47% of mango participants had access to price information through neighbourhood farmers and government extension workers, respectively.

3.2. Empirical results

Table 5 presents the results of estimations from the two-stage ESR model. In the first-stage of ESR (i.e., selection Eq. of participation), the paper only briefly discussed the results as the aim is to examine the effects of apple and mango value chain participation on the economic welfare of households. Columns 2 and 5 present results for apple and mango fruits value chain participation decision from the selection equation of the ESR model, respectively. Results (column 2) indicate that among 17 covariates, seven of them (i.e., sex of the household head, education level, household size, farming experience, total production, access to price information, and frequency of extension contacts) are significantly associated with apple farmers' value chain participation. Likewise, results (column 5) show that age of the household head, education level, plot size, off-farm income, total production, the incidence of disease and insects, perceived wild animals as a serious problem, and access to price information is significantly associated with mango farmers' value chain participation.

The second-stage estimates (i.e., outcome Eq. of consumption expenditure) of the ESR model results show factors influencing household consumption expenditure for both participants and non-participants. The findings show that a farmer's age has a negative impact on consumption expenditure for mango value chain participants. This implies that as the farmer gets older, their per capita consumption expenditure decreases. This finding is inconsistent with the study by Mmbando, Wale, and Baiyegunhi (2015), who found that age positively impacts consumption expenditure for pigeon pea market participants in Tanzania. The sex of the respondent positively impacts consumption expenditure for both apple and mango value chain participants. This implies that the coefficient of the sex of the household head exhibits that the probability of apple and mango value chain participation increases with being male. Education has a significant positive effect on both specifications (participants and non-participants) in the mango value chain. This might be linked to the fact that the probability of mango farmers participating in the fruits value chain enhances as their level of education increases. This finding is consistent with the study by Bahta, Owusu-Sekyere, and Tlalang (2018), who found that gain in consumption expenditure, is highest for households with educated heads. This may mean that education plays a vital role in adequately adapting households to new production technologies and market requirements.

Farming experience impacts positively on both apple and mango value chain participants' consumption expenditure. This reveals that years of experience increased the probability of consumer spending among the participant farmers. In their study, Martey, Al-Hassan, and Kuwornu (2012) argue that experienced farmers can make better production decisions and have a higher probability

Table 5. Full information maximum likelihood estimates of the switching regression model.

Variables	Apple producers			Mango producers		
		Outcome Eq. of consumption expenditure			Outcome Eq. of consumption expenditure	
	Selection Eq. of participation	Participants	Non-participants	Selection Eq. of participation	Participants	Non-participants
Age	−0.0383 (0.306)	−0.0281 (0.0287)	0.0596 (0.0364)	0.470** (0.161)	−0.0542* (0.0310)	0.0334 (0.0239)
Age squared	1.436 (4.175)	0.389 (0.416)	−0.782 (0.509)	−6.823 (2.340)	0.716 (0.423)	−0.513 (0.338)
Sex (Male)	0.938** (0.435)	0.143*** (0.0454)	−0.0902 (0.0817)	0.219 (0.377)	0.162*** (0.0567)	−0.0354 (0.0536)
Education	0.187** (0.0802)	0.00392 (0.00384)	0.00930 (0.00966)	0.215** (0.0861)	0.0191*** (0.00714)	−0.0238** (0.0120)
Household size	−0.562*** (0.161)	−0.00470 (0.0103)	0.0187 (0.0163)	0.0763 (0.102)	0.000207 (0.0136)	0.00614 (0.0120)
Experience	0.300*** (0.0800)	0.0142*** (0.00636)	−0.0125 (0.00775)	0.0418 (0.0440)	0.00870*** (0.00274)	−0.00168 (0.00309)
Off-farm income	−0.00372 (0.00448)	−0.00596* (0.00354)	0.00579 (0.00628)	−0.0572** (0.0271)	−0.00133 (0.00438)	0.00312 (0.00292)
Plot size	0.490 (3.531)	0.120*** (0.344)	−1.574 (0.538)	4.908** (2.112)	0.312** (0.160)	−0.267 (0.220)
Total production	1.011*** (0.289)	0.0321*** (0.00890)	−0.0327 (0.0285)	0.225*** (0.0615)	0.00614*** (0.00170)	0.00379 (0.00494)
Disease & insects	−0.550 (0.524)	−0.00274 (0.0473)	−0.0567 (0.0588)	−1.516** (0.586)	0.0732 (0.0617)	−0.0498 (0.0453)
Wild animals	−0.228 (0.474)	−0.101*** (0.0379)	−0.00345 (0.0553)	−2.787*** (0.614)	−0.0923 (0.0642)	−0.0466 (0.0501)
Market distance	0.0160 (0.0137)	−0.00245** (0.00120)	0.00200 (0.00208)	0.0161 (0.0114)	−0.0000696 (0.00145)	0.000447 (0.00145)
Livestock holding	−0.121 (0.0971)	−0.00152 (0.0121)	0.00995 (0.0103)	0.00201 (0.0492)	0.00349 (0.00463)	0.00218 (0.00520)
Price information	1.143*** (0.390)	0.104** (0.0540)	0.171*** (0.0640)	1.235*** (0.410)	−0.0494 (0.0518)	−0.181*** (0.0530)
Extension contacts	0.114*** (0.0358)	0.00308 (0.00256)	−0.0151*** (0.00359)	0.0664 (0.0557)	0.0107*** (0.00394)	0.00275 (0.00532)
Neighborhood	1.328*** (0.444)			1.675*** (0.451)		
Extension worker	2.563*** (0.753)			1.601*** (0.462)		
Constant	−12.98 (13.67)	8.392*** (1.478)	12.00*** (1.737)	21.06*** (7.931)	7.630*** (1.420)	12.02*** (1.196)
Sigma (σ_{ei})		0.237 (0.022)	0.157 (0.015)		0.241 (0.0152)	0.175 (0.013)
rho (ρ_j)		−0.456 (0.259)	−0.061 (0.287)		−0.260 (0.274)	0.034 (0.247)
Selection instruments (Wald test)	$\chi^2 = 64.14$***		*F*-stat = 1.48	$\chi^2 = 72.80$***		*F*-stat = 1.49
Observations	161		83	223		90

***, **, * shows significance at 1%, 5% and 10% levels. Robust standard errors in parentheses.
Source: Own field survey data (2019/20)

of value chain participation. The negative coefficient of off-farm income on apple value chain participants implies that income from non-agricultural paid jobs reduces household food consumption expenditure. This finding is in line with Seng's (2016) study, which revealed that farm households engaging on off-farm income are likely to enjoy lower household food security.

Plot size impacts positively on the household consumption expenditure of both apple and mango value chain participants. This implies that households with large plots are more likely to engage in value chains. This result is consistent with Seng's (2016) findings, who reported that landholding has important implications on market participants food security in Cambodia. The total production of apple and mango measured in quintals, positively and significantly impacts participants' consumption expenditure. This could imply that increased participation in the value chain is a due to increased apple and mango productivity. Higher apple and mango production could drive value chain participation, as growers with high productivity have a surplus to sell on the market. This finding is consistent with that of Martey, Al-Hassan, and Kuwornu (2012), and Kyaw, Ahn, and Lee (2018). Perceived wild animals as a serious problem negatively and significantly impact participants' consumption expenditure in the apple value chain. In their finding, Gebru et al. (2019) argue that perceived production risks such as disease and wild animals discouraged households from engaging in the fruit and vegetable business.

The frequency of extension contacts positively and significantly impacts the consumption expenditure of mango participants; suggesting that extension contact is among the important prerequisites for value chain participation (Fischer et al. 2020). Likewise, access to price information positively influences the consumption expenditure of both specifications (participants and non-participants) in the apple value chain. The positive outcome of price information suggests that households with access to price information are likely to market their products. This finding is consistent with the study by Bahta, Owusu-Sekyere, and Tlalang (2018).

Table 6 exhibits the predicted treatment effects under actual and counterfactual conditions of the participation of small-scale farmers. The real causal effects are given by row-wise differences between actual and counterfactual outcomes. The estimated results indicate that participation in the apple and mango value chain increased household consumption expenditure by 17% and 18.5%, respectively. For non-participant households, the mean consumption expenditure would have been raised by 15% if they participated in the apple value chain and 8% had they been participated in the mango value chain. The transitional heterogeneity effect of both apple and mango consumption expenditure is positive, implying that the effect is greater for the participating farm household than the one that did not participate.

Overall, the ATT results indicate that the apple and mango value chain's participation have a positive and significant effect on the economic welfare of farm households. This may be driven by the fact that growers belonging to the value chain have earned relatively higher prices for their products. The finding is consistent with Kissoly, Faße, and Grote (2017), who studied participation in the agri-food value chains in eastern Africa and identified high-value value chain participation to be linked to increased economic welfare and food security. In their analysis in Tanzania Mmbando, Wale, and Baiyegunhi (2015) showed that participation in maize and pigeon pea marketing increased the proportion of consumption spending by 19.8% and 28.9%, respectively. Likewise, Asfaw et al. (2012), in their study, showed that maize and pigeon pea market participation increases the proportion of consumption expenditure by 25% and 32% on average, respectively. This demonstrates the role of participation in the agri-food value chain in increasing the economic welfare of households.

4. Conclusion and recommendations

This study aimed to establish the potential welfare effects of apple and mango value chain participation in north-western Ethiopia using recent data from a cross-section of small-scale households. Comparisons of average consumption expenditure between participants and non-participants in the apple and mango value chain have revealed some significant differences. However, knowledge

Table 6. Treatment effects of small-scale farmers' participation

Subsamples	Decision stage		
	Participate (ATT)	Not Participate (ATU)	Treatment Effect (ATE)
(*i*) Apple producers			
Participants	(a) 10.043	(c) 9.866	TT=0.177 ***
Non-Participants	(d) 9.873	(b) 9.722	TU = 0.151***
Heterogeneity Effects	HE1 = 0.170	$HE_2 = 0.144$	TH = 0.026
(*ii*) Mango producers			
Participants	(a) 10.179	(c) 9.992	TT=0.187***
Non-Participants	(d) 10.104	(b) 10.020	TU=0.084 ***
Heterogeneity Effects	$HE_1 = 0.132$	$HE_2 = -0.028$	TH = 0.160

Note: *** represents $p < 0.001$
Source: Own field survey data (2019/20)

of the average differences is not sufficient to understand the decision to participate across a sample of farmers, as they do not account for the effects of other characteristics that affect participation. Participation is thus modelled as a selection process, where the expected benefits of the fruit value chain drive farmers' decisions. Given that farm households self-select themselves into participants and non-participants, the ESR model is used to control for selectivity bias and capture the differential effect of participation in the fruit value chain of participants and non-participants. The results from this study confirm the more apple and mango households have participated in the fruit value chain, the better their consumption expenditure and economic welfare become. The central point drawn from the findings would be that value chain participation plays an important role in improving economic welfare among apple and mango farmers.

Given the significant contributions of farmers' participation in the fruit value chain to household economic welfare, policymakers in Ethiopia should encourage more households to participate in the fruit value chain. For example, awareness creation to other non-participant farmers can be considered as one of the best options for improving households to participate in the fruits value chain. Policies aimed at providing education to farmers, improving access to price information, and contact with extension officers could enhance the ability of households to participate in the value chain and thus improve their economic welfare. Likewise, policies and programs that support the capacity of small-scale farmers to produce surplus production are also vital. In addition, appropriate policy interventions that encourage institutional support from different stakeholders, such as research institutions, could strengthen the participation of small-scale farmers in the fruit value chain. Further research using different value chain actors (e.g., fruit traders' participation along the value chain) should get attention. Future research on the welfare effects of market channel choice should also be considered.

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