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The Effect of Rural Road Transport on Crop Commercialization: Evidence from the Ethiopian Living Standard Measurement Survey

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Abstract

Ethiopia has adopted commercialization of smallholder agriculture as a policy tool for agricultural development and rural transformation thereby to improve rural welfare. Towards this end, the government has given policy focus to rual road infrastracture. The objective of the study is, therefore, to estimate the effect of acess to rual road on commercialization of smallholder farmers in the country. The study used the Ethiopian Socio- Economic Survey, a nationally representative panel data prepared by Central Statistics Agency of Ethiopia and the World Bank. Descriptive statistics as well as Econometric techniques are used to analyze the effect of rural accessibility and mobility on agricultural market participation and commercialization. The descriptive statistics reveals that the commercialization index for households in villages with access to all weather roads is 19 percent against the corresponding figure of 16 percent for their counterparts. The econometrics estimation also tallied with this finding. More interestingly, mode of transport used for agricultural purposes is found to have a positive and significant effect on commercialization. The result indicates that commercialization level for farmers using modern mode of transport is 17 percentage points higher than those who did not use any. In the same manner, the result indicates that commercialization level of farmers using traditional mode of transport is 12 percentage points higher than those who did not use any. Thus, integrating remote areas with urban centers through rural transport infrastructure development that addresses both access and mobility demand of rural communities should be given priority.

Keywords: commercialization, market participation, rural road access, mobility
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Introduction

Economic growth and development in general and transformation of the rural economy in particular require, among others, rapid commercialization of smallholders in agriculture-dependent developing countries (World Bank, 2009). Above all, agricultural commercialization can foster the transition from food insecurity to food security thereby helping to reduce poverty (von Braun and Kennedy, 1994 as cited in Hailua *et al*., 2015). Studies conducted in other developing countries indicate that commercialization improves household income as a result of increased labor and land productivity as well as increased employment opportunities for hired labor (von Braun and Kennedy 1994 as cited in Hailua *et al*., 2015). Studies also indicate that increasing the extent of commercialization among Sub-Sahara Africa's generally semi-subsistence, low-input, and low-productivity smallholder famers plays a crucial role in addressing poverty reduction (Olwande *et al*., 2015 as cited in Abafita, Atkinson and Kim, 2016).

Being cognizant of the role it plays, Ethiopia has adopted commercialization of smallholder agriculture as a policy tool for agricultural development and rural transformation in order to improve rural welfare. In fact, whether farmers commercialize is the result of many factors. A recent literature reviewed by Hagos and Geta (2016) reveal that the major factors explaining smallholder farmers' level of commercialization can be simply categorized and explained from eight key dimensions. These include population growth and demographic change, technologies, institutions, risks, markets and their integration, transaction costs, asset holdings of the households and policy aspects.

Rural households' decision to participate in agricultural markets can be influenced by different socio-economic factors. The decision of rural farmers to participate in local markets can be affected by different socio-economic mileus that can be classfied as micro and macro level factors (Gebremedhin and Jaleta, 2010; Gebreselassie and Ludi, 2008 as cited in Osmani and Hossain, 2015). While micro-level factors, for example, include land size, gender, livestock assets, education and location from urban centers, macroeconomic factors include trade policies, market reform, rural infrastructure improvement and the development of legal and contractual environments (Okezie *et al*., 2012; Martey *et al*., 2012; Agwu *et al*., Von Braun *et al*., 1994; Gebreselassie and Ludi, 2008 as cited in Osmani and Hossain, 2015).

From the perspective of rural makret development and poverty reduction, the role of rual infrastracture in fosterring rual economic development and market integration cannot be over emphsizied. However, reports indicate that rural economic infrastructure in general and rural road transport in particular has still remained low in many parts of the world. For example, there are almost 1 billion people in rural areas worldwide without adequate access to all-weather roads

(International Bank for Reconstruction and Development, 2014). In fact, rural people are poor mainly due to their isolation from socio-economic activities and opportunities (Carney, 1999). Studies also indicate that in a predominantly agrarian economy such as that of Ethiopia, lack of adequate access to rural road transport is one of the prominent factors explaining poverty and low agricultural growth (Faiz, 2012). This suggests that rural roads essentially can play a significant role in poverty reduction by helping create economic opportunities, sustaining agricultural growth, reducing transportation and transaction costs, improving access to social services and economic activities thereby enhancing food security (Fan, Hazell and Thorat, 2000 and Leinbach, 1983).

In Ethiopia, the role of rural road transport can be considered as the backbone of the socio-economic activities. This is evident, as road transport is the dominant form of transport accounting for 90 to 95 percent of motorized inter-urban freight and passenger movements (ERA, 2013). More interestingly, while the average Road Access Index (RAI) for the country is around 50 percent, the proportion of rural population within 2km access is only 28 per cent, which is very small compared to the size of 90 million people in rural areas of the country (ERA, 2013). Furthermore, reports indicate that there is low level utilization of intermediate mode of transport in the country (ERA, 2011). Besides, agricultural markets are not playing their expected role as there is lack of integration into the broader market systems, which increases transaction costs and reduces farmers' incentive to produce for the market (Mitiku, 2014).

However, little information is available on the existing level of agricultural commercialization in Ethiopia and how rural transport affects both market participation and commercialization of smallholder farmers. Moreover, most of the literature on Ethiopia has been largely crop-specific (focusing on a single crop in most cases) and lack national representativeness that does not allow generalization for policy. The other important gap in the existing literature is lack of analysis on the effect of mode of transport or mobility on crop commercialization. This study, therefore, is based on a broader geographical converge and a focus on the contribution of rural transport (both access and mobility) to commercialization level of smallholder farmers.

The Data

The empirical data was drawn from two consecutive panel surveys of the Ethiopian Rural Socioeconomic Survey (ESS) –Living Standard Measurement Survey (LSMS). This data was prepared by the Central Statistics Agency (CSA) and the World Bank. The first round survey was conducted in 2011 and the second was after two years (in 2013). In agriculture and rural transport, medium and small-towns were excluded from the sample. The panel data was created using three criteria: (1) Households must be from rural areas; (2) households should cultivate some plot of land and with positive value of production; and 3) households with zero or missing values of cultivated plot of land, production and expenditure were excluded. Based on these criteria, a balanced panel of 2177 households consisting of 4354 observations over two rounds was created.

The data cleaning process required explanation for some of the variables used in the analysis. Farmers reported their cultivated land by using different local units of measurements, which were then converted into hectare using the CSA's conversion factor. Finally, the plot level information was aggregated into household level data. Aggregation of real consumption per capita involved four steps. First, total food and non-food expenditure was calculated. Second, the food and non-food expenditure was converted into real expenditure using CSA's consumer price index. Third, the data was aggregated at household level in order to get total real value of expenditure at household level. Finally, the real expenditure was divided by family size in adult equivalent to get real consumption per capita. Household size in adult equivalent was converted using the Nutrition (calorie) equivalence scales prepared by FAO.

Since quantity of output produced was already measured by standard units (kg and gm), there was no need to convert. However, quantities reported in grams were converted into kilograms. The quantity of production (crop and root crops or fruits) was converted into value in ETB using the following procedure. First, unit price of each crop was calculated by dividing the value of output sold by the quantity of output sold in the market (this is possible because we have crop level information about the quantity and value sold). This would give the unit price of each crop and once the unit price is obtained we can simply multiply it by the amount of output produced (by each crop) to get the total value of each crop produced. However, for households who did not report any crop sell in the market the mean village level price of each crop was used to convert quantity of production into value of production. Finally, the nominal value of production was converted into real values using CSA production price data and 2011 was used as a base year. Livestock ownership in tropical livestock units (TLUs) was calculated using Janke‘s (1982) approach.

Another important issue is the measure of the quality of road access and mobility. In the survey, the road quality of the sampled villages was compiled through a structured community level questionnaire. Community leaders were asked to identify the type of community/village roads in their respective villages. Following Dercon *et al*. (2008) and Wondemu and Weiss (2012), the road quality of the villages is categorized into two groups. The first one is 'good road access' that indicates access to all-weather roads. The second one is 'poor road access' which represents roads that do not allow reasonable access throughout the year. Therefore, while estimating the empirical model, a value of 1 is given for villages that have good road access and 0 for villages with poor road access. The other transport indictor variable is mobility or the mode of transport used for agricultural related activities. The means with which people choose to move themselves or their goods around (or simply mobility) refers to the mode of transport used for economic activities by a particular household (Maunder *et al.*, 2000). This definition has been used by other empirical studies (Kassali *et al.*, 2011). Thus, in this study mobility refers to the type of mode of transport used by farmers to transport agricultural inputs and outputs. In this regard, foot, traditional mode of transport (pack animals, animal drawn carts, locally made cart etc) and modern mode of transport (Bajaj, motor cycle, bicycle, mini-bus etc) were identified as major mode of transport used for agricultural purposes.

Method

Measurement of Commercialization

The concept of commercialization in this paper is used to assess farmers' participation mainly in output market. According to Strasberg *et al.* (1999 as cited in Abera, 2009), commercialization index or household Crop Commercialization Index (CCI) can be stated as the ratio of gross value of all crop sales over gross value of all crops produced multiplied by hundred. Accordingly, the commercialization index of smallholder famers can be constructed using the following simple formula for data with panel structure:

$$\text{HCI}it = \frac{\text{Gross value of crop sales hh i year T}}{\text{Gross value of all crop production hh i year T}} \times 100$$

(1)

In order to identify variables influencing market participation and level of commercialization, double hurdle model is employed. The double hurdle model is selected because it helps to identify factors influencing market participation and level of commercialization (amount sold) at the same time. The justification for the application of the double hurdle model can be seen from two sides; first, the fact that the specification of the double hurdle model allows for a two-stage analysis where both determinants of participation and level of participation would be estimated and second, the double-hurdle model helps to deal with survey data which has many zero observations in a continuous dependent variable. (Guajarati, 1995).

Thus, the decision to participate in marketing of agricultural produce and the decision of how much to sell are independently made but not simultaneously. As such, following Gujarati (1995), Tamir *et al.* (2015), and Xu (2008), this study adopted the same econometric approach to model the two decisions.

Model Specification of Commercialization

The Craggit double hurdle model is used to analyze the effect of rural accessibility and mobility on agricultural market participation and commercialization. The Craggit model uses a pooled estimator that clusters observations at household level. The Craggit double hurdle model is selected over the normal double hurdle model because the estimation using the normal double hurdle model could not achieve convergence. The major reason for estimating the Craggit model is to estimate how rural transport related covariates are related to the decision to participate in agricultural markets. In this sub-section, issues addressed while estimating the Craggit double hurdle model are presented.

Controlling for Unobserved Heterogeneity

Given the dependent variables (participation decision and level of commercialization) which are non-linear in nature, we cannot use the traditional standard methods like fixed effects (to control for potential endogeneity problem) (Wooldridge, 2010). Thus, the decision of households who produce agricultural output but did not sell anything is considered as rational economic decision. Thus, zero is assigned to those who produce but did not sell. In this regard, the Craggit double hurdle model could be applied to panel data using a pooled estimator and clustering at the household level in order to control for possible autocorrelation of the error term within households (Burke, 2009). Here, we can assume independence of errors because the zeros are real values rather than unobserved (Burke, 2009). That is, farmers who chose not to sell any output are considered to be rational economic agents in their decision and zero observations are included in the second hurdle (as commercialization is considered to be output sold divided by output produced, those households who produced but did not sell anything have zero commercialization index).

In order to estimate a consistent result in panel data setting, the explanatory variables must not be correlated with the time-constant unobserved term *(ci*) that is, we have to control for unobserved heterogeneity (Wooldridge, 2010). This can be solved using a fixed effects panel estimator, but when using a pooled estimator the easiest way to control for it is to include a correlated random effects (CRE) developed by Mundlak-Chamberlain (Gilbert, Jayne and Chirwa, 2011). The CRE consists of a vector of variables containing the means of all time varying covariates for each household (Burke and Jayne, 2014). These additional control covariates have the same value for each household during the period under study but vary across households (Burke and Jayne, 2014). Their coefficients account for the differences between households over the entire period (due to unobservable timeconstants), while the coefficients of the time varying covariates explain the within household effects or simply the effect of a deviation from the household average over time (Burke and Jayne, 2014). Following Gilbert *et al.* (2011), we model heterogeneity as follows:

$c_i = \varphi + \overline{X_\iota} + a_i, a_i | x_i \sim$ normal $(0, \delta_a^2)$

(2)

where; $\overline{X_\iota}$ represents household means of the independent variables.

Modeling the heterogeneity in this way is known as the correlated random effects (CRE) or the Mundlak-Chamberlain approach. In estimation, variables that are the same for each household are excluded from xi. In the first stage, the model is estimated using CRE probit by controlling for those unobserved effects. The second stage of the model is executed with a CRE truncated regression. A truncated regression is a linear estimation of parameters with a dependent variable that is limited at some value. Our truncated regression is estimated on only the households with greater than zero market participation indexes. Finally, following the work of Gilbert *et al.* (2011), the two stage Craggit model that considers the CRE Probit and truncated Tobit models is presented in the following equation (the difference between equation 2-5 and equation 7-8 is that in equation 2-5 we did not include CRE model to control for unobserved heterogeneity.)

$P(Mpp_{it} = 1|X_t) = \alpha_1 x_i + \gamma_1 \bar{x}_i + \varepsilon_i$ = tier one representing market participation (3)

$CIP_i = \rho + \alpha_2 x_i + \gamma_2 \overline{x_\iota} + \epsilon_i$ = tier two representing commercialization index (4)

Where Mpp ; is the decision to participation in market, equal to 1 if the household chose to participate in the market and equal to 0 otherwise, and,
CIP is the commercialization index that takes values between 0 and 100.

x_i is the set of all explanatory variables common to both stages;
ρ is the constant intercept estimated in stage 2;
α_1 is the set of coefficients estimated on x_i in stage 1;
α_2 is the set of coefficients estimate on *xi* in stage 2;
γ_1 is the set of coefficients estimated on mean values in stage 1;
γ_2 is the set of coefficients estimated on mean values Xbari .

The estimable form of the Craggit first hurdle model (market participation) satisfying the correlated random effects (CRM) model condition is given as:

$$P(Mp_{it} = 1|X_t) = \alpha_0 famiiyszie + \alpha_1 output_i + \alpha_2 offfarm_i + \alpha_3 age_i + \alpha_4 sex_i + \alpha_5 edu_i + \alpha_6 area_i + \alpha_7 notlu_i + \alpha_8 accext_i + \alpha_9 accredit_i + \alpha_{10} irr_i + \alpha_{11} accraod_i + \alpha_{12} trransp_i + \alpha_{13} dist_i + \alpha_{14} \overline{mean}\ otput_i + \alpha_{15} mean\ famil_i + \alpha_{16} \overline{mean}\ age_i + \alpha_{17} \overline{mean}_i\ edu_i + \alpha_{18} \overline{mean}\ area_i + \alpha_{19} \overline{mean}\ dis_i + \alpha_{20}\ meanfamilysize_i + \varepsilon_i \quad (5)$$

On the other hand, estimable form of the Craggit second tier (commercialization index) satisfying the correlated random effects (CRM) model condition is given as:

$$CPI_i = \rho + \alpha_{20} output_i + \alpha_{21} offarm_i + \alpha_{22} age_i + \alpha_{23} sex_i + \alpha_{24} edu_i + \alpha_{25} area_i + \alpha_{26} notlu_i + \alpha_{27} accext_i + \alpha_{28} accredit_i + \alpha_{29} irr_i + \alpha_{30} accraod_i + \alpha_{31} trransp_i + \alpha_3 dist_i + \gamma_{32} meanoutput_i + \gamma_{33} meanfamil_i + \alpha_{34} meanage_i + \alpha_{35} meanedu_i + \alpha_{36} meanara_i + \alpha_{37} meandis_i + \epsilon_i \quad (6)$$

Table 1: Definition of variables used in the commercialization equation

Variables	Definitions of the variables	Expected sign
$output_i$	value of total output produced by the i^{th} household	+
$offarm_i$	off farm income of the i^{th} household	+
age_{it}	age of the i^{th} household	+/-
sex_{it}	sex of the i^{th} household	-
edu_i	level of education of the head	+
$area_i$	farm size (area) of the i^{th} household	+
$notlu_i$	number of livestock owned in TLU for household *i*	+
$accext_i$	access to extension service	+
$accredit_i$	credit access availability for the i^{th} household	+
irr_i	availability of irrigation access for the i^{th} household	+
$accraod_i$	availability of all weather road access	+
Transpmi	mode of transport by the i^{th} household at time *t*	+
$dist_i$	the natural logarithm of rainfall 12 months before the survey	-

Source: Compiled from various empirical literature

Endogeneity Test for Craggit Double Hurdle Model

According to Woodridge (2010), the above model should be strictly exogenous. In order to make the result more robust and consistent, we had to also test endogeneity. Otherwise, the estimates will still be inconsistent if the independent variables are correlated with unobservable time-varying shocks. In this study, following Woldeyohannes *et al*. (2015); Gilbert *et al.* (2011) and Woodridge (2010), endogeneity would occur if unobserved factors affecting commercial market participation affect the level of commercialization (output sold divided by output produced). The study applied the control function approach (CFA) to test and control for potential endogeneity problem in the Craggit estimation. As Woldeyohannes *et al.*, (2015) indicated, there could be potential simultaneity of off-farm income (which is one of the explanatory variables of market surplus or level commercialization) with crop output market participation decision and the level of market surplus and hence level of commercialization. For example, while smallholder market surplus or level of commercialization could be affected by off-farm earnings, increased income as a result of higher market surplus or high level of commercialization could also help farmers to overcome financial constraints and engage in own off-farm business that would probably increase off-farm income. In this case, off-farm income is likely to be endogenous and correlated with unobserved time varying shocks (Woldeyohannes *et al.,* 2015).

To test for endogeneity of off-farm income, one needs to estimate the reduced-form model from which the residuals can be extracted. The reduced-form model for off-farm income is estimated using Tobit model. The CFA requires an instrumental variable (IV) to be used in a reduced-form model but excluded from the structural model of crop output market participation and commercialization. The instrumental variable (IV) should be correlated with the potentially endogenous variable (off-farm income) but should not be correlated with unobserved time varying shocks in the structural model. For this purpose household labor supply (family size is used as proxy variable) in adult equivalent unit was used as an instrumental variable (IV) in the reduced form model. Household labor supply measures the amount of labor available to participate in off-farm work and determines earnings from off-farm source. The strength of this instrument variable is checked using the partial correlation in the reduced form model.

The estimation result shows there is strong partial correlation between family size (labor supply) and potentially endogenous off-farm income which is statistically significant at 1% level. Now we can test the endogeneity of off-farm income using the control function approach. In order to do so, the residuals from the reduced model were included as covariates in hurdle one which is market participation decision and in hurdle two which is the level of commercialization.

According to the test results, the p-value for both hurdles indicates that the residual term is not significant. In the CFA, the test of endogeneity is the statistical significance of the coefficient of the residual in both decision models (Woldeyohannes *et al.*, 2015). Hence, there is no evidence in the data to reject the null hypothesis of no correlation between off-farm income and the error terms in the structural models. Thus, the CRE Craggit double hurdle model can now be estimated without including the residual term as additional covariate. The final result from CRE and CFA double hurdle model of factors influencing households' decision of output market participation and commercialization is presented in section four.

Results

Descriptive Results

The summary of key variables is presented in Table 2, 3 and 4 below. While Table 2 presents the overall mean values of the variables at household level, Table 3 and 4 present mean comparison test results for selected variables at household level by the type of accessibility and survey periods, respectively. Accordingly, Table 2 reveals that the mean value of output was 5509.5 ETB. The value of output was later transformed into its logarithmic form in order to keep the assumption of normality. The result in Table 2 also depicts that the proportion of households engaged in market participation is found to be 64 percent.

Table 2 further shows that 80 percent of the respondents in the sample are men, the remainig 20 percent are female respondents. The mean age is 45.5 and that of family size (converted to adult equivalent) is 4.7. Table 2 further presents a summary of farm characteristics of the sample households. The mean values of land size, fertilizer and total labor used for the pooled data was found to be 2.4 ha, 60 kg and 388 respectively. Table 2 gives summary about access to social and agricultural services like extension, credit, irrigation and road access. According to the result, households with access to extension, credit, irrigation, and all weather road accesses are 40 percent and 20 percent 10 and 30, respectively. The mean value of farm asset indicators (number of ploughing oxen, number of farm capital and total livestock units) are 1.5, 4.9 and 6.7.

Table 2: Descriptive statistics for variables used in the Craggit model

Variable	Observations[3]	Mean	Std. Dev.	Min	Max
Age of the household head	4354	44.5	12.83	17	97
Proportion households engaged in off farm activity		0.26 (26%)		0	1
Gender of the respondents (1 =Male)	4354	0.812 (81%)	-	0	1
Proportion of households engaged in market participation (Yes =1)	4354	0.64 (64 %)	0.47	0	1
Years of schooling of the head	4354	1.9	2.67943	0	17
Land size (Ha)	4353	2.4	1.85812	0.0012	9.97
Fertilizer (Kg)	4352	60.4	90.5362	1	769.425
Access to extension (yes=1)	4354	0.4		0	1
Access to credit (yes=1)	4354	0.2		0	1
Access to irrigation (yes=1)	4353	0.1		0	1
Access to all weather road (yes=1)	4354	0.3	-	0	1
Total value of output	4354	5509.5	8956.98	2.5	138815
Number of ploughing oxen	4354	1.5	0.95564	1	14
Farm capital (number)	4354	4.9	3.34533	1	31
Family size in Adult equivalent	4354	4.7	1.90766	0.74	12.95 1353.25

[3] Some of the variables have missing values and we left it as it is as it does not change the result.

Total labour used in mandays	4354	408	329.537	0	5
Total number of livestock owned	4354	6.720	6.42	0	69

Source: Own estimation from the Ethiopian Socio-economic survey data

The mean value comparison for key variables by the type of rural road accessibility is presented in Table 3. The result shows that there is statistically significant difference in irrigation use, real value of output produced, years of schooling, land size, family size, and number of farm capital between households in villages with access to all weather roads and those with no access to all weather roads. For example, as evident in Table 3, while 16 percent of households in villages with good road access have used irrigation, the corresponding figure is 12 for their counterparts ($p<0.05$).

Table 3: Mean comparison of the variables used in the Craggit model by type of access

Variables	Observations	Good access	Poor access	Difference	P-Value
Age of the head	4354	46.2521	45.2288	1.023	0.0246 **
Years of schooling	4354	2.0788	1.7983	0.281	0.0019 ***
Land size owned (Ha)	4353	2.5044	2.2992	0.205	0.0010 ***
Amount of fertilizer used	4352	63.6673	59.1495	4.518	0.1383
Total labor used in mandays	4354	404.8127	410.047	-5.234	0.637
Access to credit	4354	0.2421	0.2197	0.022	0.1113
Access to irrigation	4353	0.1617	0.1256	0.036	0.0017 ***
Number of oxen owned	4354	1.4988	1.4784	0.02	0.526
Total value of output	4354	5927.90	5344.58	583.3	0.0530 *
No. of farm capital owned	4354	5.3412	4.6599	0.681	0.0000 ***
Family size adult equivalent	4354	4.7825	4.6742	0.108	0.0917 *
Livestock owned in TLU	4354	6.7385	6.714	0.108	0.9103

*p<0.1; ** p<0.05; *** p<0.01

Source: Own estimation from the Ethiopian Socio-economic survey data

The mean comparison test and values of the variables when compared by survey periods are presented in Table 4. Real value of crop production over the two survey periods has grown from 4803.977 ETB in 2011 to 6215.02 ETB in 2013 ($p<0.01$). The mean value of fertilizer used per household increased from 53.46 Kilogram in 2011 to 67.38 Kilogram in 2013 ($p<0.01$). Similarly, access to extension which was 33.9 percent in 2011 increased to 44.9 percent in 2013. The area cultivated has slightly increased from 2.1 hectares to 2.5 hectares at household level ($p<0.01$). On the other hand, farm asset indicators such as number of ploughing oxen, number of farm capital and total livestock owned in tropical livestock unit (TLU) increased from 1.4 to 1.5, from 4.5 to 5.1 and from 6 to 7, respectively. However, years of schooling has relatively remained unchanged during the two production periods with a mean value of 1.8. The proportion of households with access to credit has decreased from 26 percent in 2011 to 18 percent in 2013 ($p<0.01$).

Table 4: Mean comparison of the variables used in the Craggit model by survey period

Variables	Observation	2013	2011	Difference	P-value
Age of the head	4351	46.355	44.7381	1.617	0.0003***
Years of schooling	4354	1.8911	1.864	0.027	0.7386
Land size owned (Ha)	4353	2.542	2.1724	0.37	0.00 ***
Amount of fertilizer used	4352	67.381	53.464	13.917	0.00***
Total labor used in mandays	4354	428.106	389.02	39.079	0.0001***
Access to credit	4354	0.1856	0.2664	-0.081	0.00***
Access to extension	4354	0.4492	0.3397	0.109	0.00***
Access to irrigation	4353	0.1406	0.131	0.01	0.356
Number of oxen owned	4354	1.5425	1.4258	0.117	0.0001***
Total value of output	4354	6215.02	4803.977	1411.048	0.00***

No. of farm capital owned	4354	5.1915	4.5136	0.678	0.00***
Family size in Adult equivalent	4354	4.8723	4.5374	0.335	0.00***
Livestock owned in TLU	4354	7.1515	6.2903	0.861	0.00***

*p<0.1; ** p<005; *** p<0.01

Source: Own estimation from the Ethiopian Socio-Economic Survey Data

As evident in Figure 1, the proportion of households in villages with access to all weather roads (good access) increased from 658 (30.24 percent) in 2011 to 671 (30.89 percent) in 2013. Although this is a small change, the increase in access to all weather roads might be attributed to the ongoing universal road rural access program (URRAP), which aimed at connecting all Kebeles to the nearby all-weather roads, the construction of 11,212 kilometers of new rural roads and the construction of 71,523 kilometers of Woreda roads until 2015 (ERA, 2013).

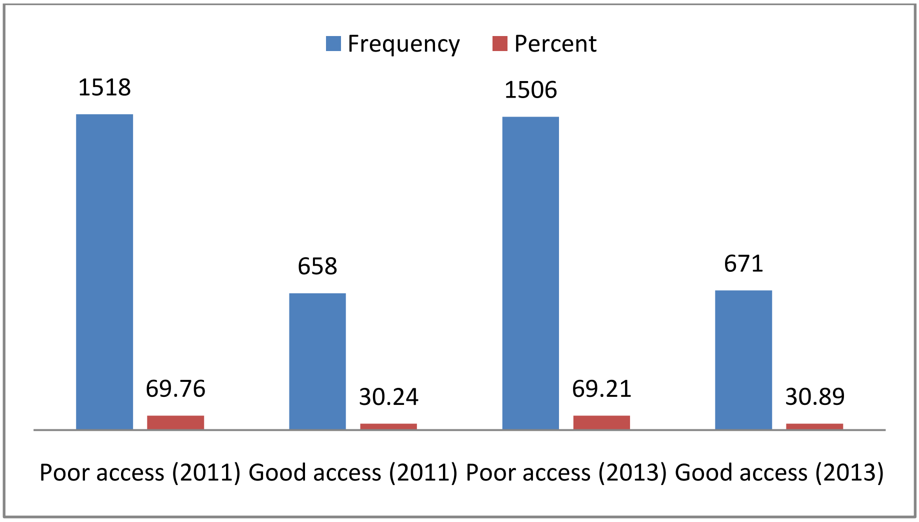

Figure 1: Rural road accessibility condition
Source: Own depiction from the Ethiopian Socio-Economic Survey Data

The overall distribution of the major mode of transport used for agricultural purposes is presented in Figure 2. The pooled distribution of mode of transport in

Figure 2 shows that while 3410 (78%) used foot and 701 (16%) traditional mode of transport, only 241 (5.4%) used modern mode of transport.

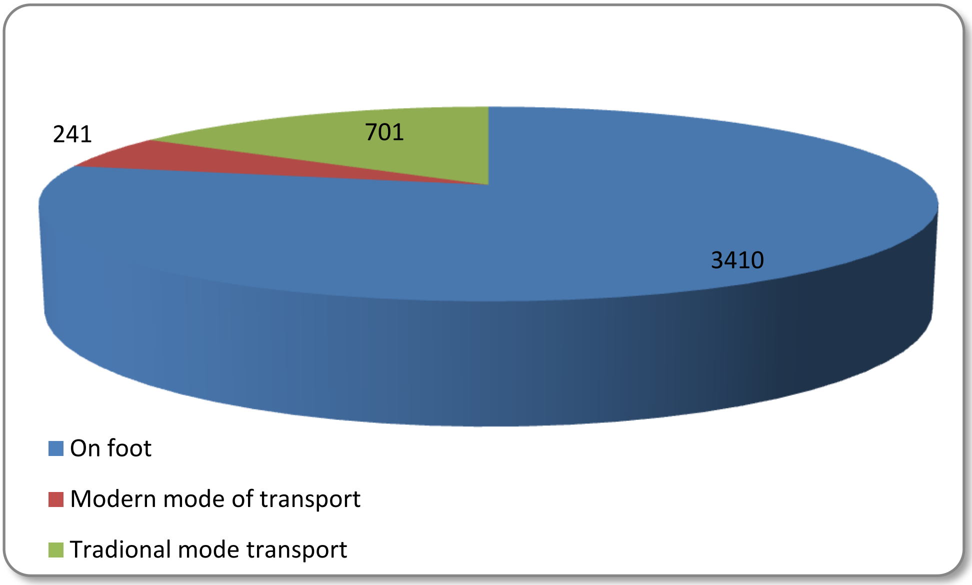

Figure 2: Major mode of transport used for agricultural related activities
Source: Own depiction from the Ethiopian Socio-Economic Survey Data

The comparison of mode of transport used between households in villages with good access to roads and households in villages with poor access is presented in Table 5. As evident from the Table, irrespective of level of access to roads, around majority of households used foot as major mode of transportation followed by traditional mode of transport. Similarly, disaggregated data based on survey period also shows the same pattern suggesting that access to roads is not the only factor determining the type of transportation modality households use.

Table 5: Comparison of households based on mode of transport, survey period and type of road

Mode of transport used	***Based on access level***		***Based on year***	
	Good access (pooled)	***Poor access (pooled)***	***2011 (for both access levels)***	***2013 (for both access levels)***
On foot	1033 (77.79)	2377 (78.6)	1841 (84.6%)	1569 (72.1%)
Modern mode of transport	78 (5.87)	163 (5.39)	99 (4.55%)	142 (6.53%)
Traditional mode of transport	217(16.34)	484(16.01)	236 (10.58%)	465 (21.37%)
Total	1328	3024	2176	2176

Source: Own depiction estimation from the Ethiopian Socio-Economic Survey Data

As presented in Table 6, the mean value of output produced 4803 ETB and 6215 ETB 2011 and 2013, respectively. Table 6 also shows that the mean value of output sold was 914.190 ETB and 1285.29 ETB in 2011 and 2013, respectively.

Table 6: Mean value of crop produced, value of crop sold and level of commercialization

Variable	**Survey period**	**Mean**	**Std. Dev**	**Min**	**Max**	**Observation**
Value of output produced	2011	4803.97	9886.6	4.708	109571	2177
Value of output produced	2013	6215.02	7858.0	5.617	138815	2177
Value of output produced	Pooled	5509.50	8956.9	8.708	138815	4354
Value of output sold	2011	914.190	3263.5	0	58200	2177
Value of output sold	2013	1285.29	2975.5	0	35512	2177
Value of output sold	Pooled	1099.74	3128.06	0	58200	4354

Source: Own estimation from the Ethiopian Socio-Economic Survey Data

The value of output produced and value of output sold was also compared by type of road used during the survey period. According to the result in Table 7, the mean value of output for households in villages with good access was 5927, while that of households in villages with poor access was 5344.5 (p<0.1). The same Table also shows that there is a significant variation in the mean value of output produced and sold in 2013 and 2011, respectively

Table 7: Mean comparison value of output and value sold by accessibility

Variable	Survey period	Obs	Good access (=1)	Poor access(=0)	Diff (1)-(0)	P-Value
Value of output produced	Pooled	4354	5927.90	5344.5	583.327	0.053*
Value of output produced	2011	2177	4945.26	4750.8	194.429	0.6827
Value of output produced	2013	2177	6847.19	5954.1	893.081	0.0159**
Value of output sold	Pooled	4354	1370.66	992.9	377.715	0.0003***
Value of output sold	2011	2177	1299.78	769.1	530.626	0.0007***
Value of output sold	2013	2177	1436.9	1222.6	214.281	0.1266

*p<0.1; ** p<005; *** p<0.01

Source: Own estimation from the Ethiopian Socio-Economic Survey Data

The growth in value of output sold is presented in Figure 3. The result shows that even though households in villages with good road access have relatively higher level of value of production, the gap in value of production seems decreasing.

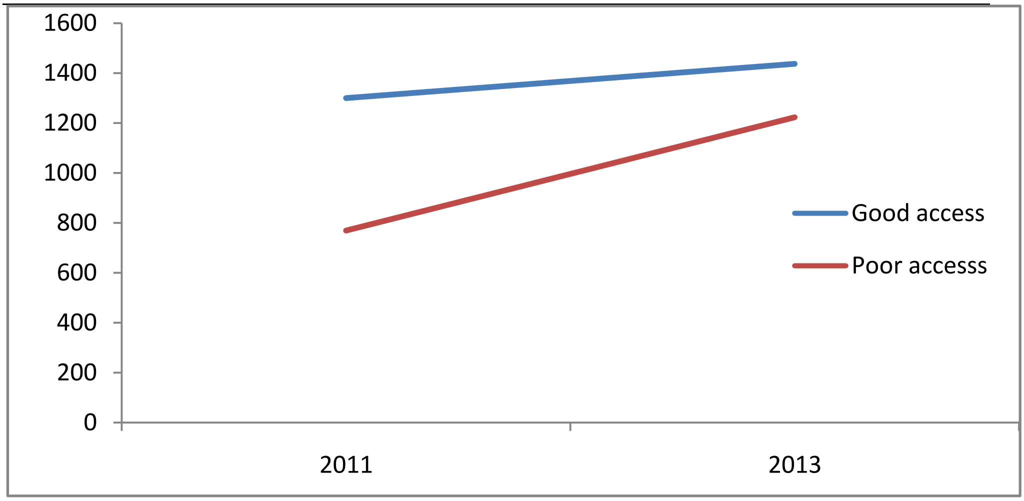

Figure 3: Mean value of output sold
Source: Own depiction from the Ethiopian Socio-economic survey data

The result in Table 8 revealed that there is variation in the level of commercialization index and market participation when compared by the type of rural road access. The result shows that the commercialization index is 19% for households in villages with good access to all weather roads and 16% for households in villages with poor access ($p<0.00$). The level of market participation for the pooled data is 67 percent for households in villages with access to all weather roads and 63.9 % for households in villages with poor access to all weather roads ($p<0.05$).

Table 8: Mean comparison test for commercialization index and market participation

Variable	Survey period	Obs	Good access	Poor access	(1)-(0)	P-Value
commercialization index	Pooled	4354	0.1942	0.1633	0.031	0.0001***
commercialization index	2011	2177	0.2128	0.1576	0.055	0.000***
commercialization index	2013	2177	0.1768	0.1692	0.008	0.4562
market participation	Pooled	4354	0.6767	0.6391	0.038	0.0193**
market participation	2011	2177	0.5429	0.5095	0.033	0.165
market participation	2013	2177	0.8019	0.7722	0.03	0.1283

P<0.1; ** p<005; *** p<0.01

Source: Own estimation from the Ethiopian Socio-Economic Survey Data

Econometrics Results

The study investigated the partial effects of rural road accessibility, mobility and other covariates on the levels of smallholder commercialization. In the Craggit model presented in Table 9, the first column (Hurdle 1) shows the marginal effect of the determinants of farmers' participation in the agricultural market, and the second column (Hurdle 2) shows the influence of the covariates on the level of commercialization conditional on participation (the first hurdle).

The Wald chi-square value of 588.37 models is statistically significant at 1 percent (see table 9). Thus, the explanatory variables in both models jointly explain the probability of participating in markets and level of commercialization. The result in Table 9 shows that with respect to participation, it was found that output has a positive and statistically significant effect ($p<0.01$), though the effect is small. In this regard, many other empirical studies have also found similar results on the effect of output on market participation (Samuel and Sharp, 2007; Pender and Alemu, 2007).

The three rural transport indictors are road quantity (access to all weather roads), mode of transport used and distance to market, which were found to have a statistically significant effect in explaining rural farmers' decision to participate in agricultural markets. According to the result, the probability of participating in agricultural market increases by 2 percentage points for households in villages with good road access as compared to households in villages with poor access and the result is also statistically significant ($p<0.01$). For example, access to markets, access to good quality roads, and ownership of transport modes reduce marketing and other transaction costs that can further encourage market orientation and market participation (Gebremedhin and Jaleta, 2010). However, it should be noted here that Gebremedhin and Jaleta has only adressed crop specific questions and did not also inlcude the effect of mode of transport. In this regrad, this paper has adressed both issues.

The result for mode of transport used (in Table 9) shows that the coefficient of modern mode of transport is found to have a negative effect on the probability of participating in agricultural markets ($p<0.01$). Thus, for modern mode of transport users the probability of market participation decreases by 24 percentage points as compared to those who are using walk as means of transport ($p< 0.01$). One of the possible explanations from the descriptive statistics is the existence of low utilization of modern transport for agricultural transportation. The descriptive result shows that only 6 percent of the farmers used modern mode of transport for agricultural related purposes. The other possible explanations are the cost associated with the use of modern means of transport for agricultural purposes as well as the extent of reliability and availability of the transportation services which this study has not addressed. Other empirical studies showed that there is high transport cost involved as far as the use of modern mode of transport for agricultural purposes is concerned. The other interesting result is that for households using traditional mode of transport, market participation increases by 9 percent as compared to those who are not using any mode of transport.

Household characteristics were also included in the analysis of market participation and level of commercialization. The coefficient of gender was found to be one of the significant factors in explaining market participation in rural Ethiopia. The result indicates that probability of output market participation is higher by 3 percentage points if the household is male-headed ($p<0.1$). Similar result was also found in Woldeyohannes *et al* (2015). Another household demographic characteristic, years of schooling of the head, was also found to be positive and significant ($p<0.1$). The result confirmed that a one year increase in schooling of the head increases the probability of market participation by 0.5 percent.

Farm size which can be considered as households' wealth indictor, with respect to participation, was found to be positive and statistically significant ($p<0.05$). For each additional hectare of land cultivated the probability of market participation increases by 1.4 percent. The number of livestock owned by a household (which is another indicator of asset stock of rural farmers) has a negative and statistically significant effect on the probability of participation in agricultural markets ($p<0.01$). The implication is that as the livestock size increases by one unit, the probability of participating in rural agricultural markets decreases by 0.4 percent. However, this result is not consistent with prior expectations and it can be explained by what empirical studies refer to as the "livestock complex myth". According to this myth, peasant farmers would keep livestock merely for prestige and wealth rather than for their economic values (Ranela, Alemu & Groenewald, 2008). In this regard, wealth is defined as the accumulation of assets, which confer, among other things, prestige, emotional satisfaction and status (Doran *et al.*, 1979 in Ranela, Alemu & Groenewald, 2008).

Access to credit was found to be negative and statistically significant in explaining market participation decision ($p<0.01$). Accordingly, the result indicates that probability of output market participation for households with credit access is lower by 7 percentage points as compared to households having no access to credit. This is probably due to the consumption effect of credit. Thus, at times of inter temporal consumption gap, households might use some of the credit for the purpose of consumption than investing in anther productive economic activities. The result for access to irrigation shows that the probability of market participation for households using irrigation is grater by 11 percentage points compared to households who are not using irrigation.

According to Isinika, Ashimogo, and Mlangwa, (2003), smallholder farmers in developing countries can be affected by transportation costs, as rural roads are underdeveloped. According to de Janvry *et al.,* (1991), a household's decision to be a seller in a given market is determined by a price band which depends also on transportation costs to and from the market. Furthermore, the study by Jagwe (2011) indicates that long distances to markets and high cost of improved means of transport facilities are among the causes of high proportional transaction costs and low market participation. Their findings also show that farmers living far away from markets incur more transportation costs than those living nearby markets.

The second hurdle shows the result for covariates influencing the level of commercialization of smallholder farmers. The level of output was found to have a negative and statistically significant effect on Agricultural commercialization ($p<0.01$). Thus, more production does not necessarily mean more agricultural commercialization. For example, even if farmers might produce more quantity of output, the level of commercialization will not increase unless there is increase in marketable surplus. Among the demographic factors, the coefficient of age and gender were found to be important factors in explaining level of commercialization. The result indicates that as age of the household head increases, the level of commercialization increases by 0.5 percent ($p<0.05$). The empirical literature in this regard has a mixed result. For example, Gebremedhin and Jaleta (2010) found that age has a positive effect on the degree of market participation due to the fact that as age increases farmers will be more experienced in crop production and hence can have a positive effect on commercialization. On the other hand, experience can be expected to be negatively associated with commercialization, as older household heads tend to be more dependent on subsistence production activities (Ehui *et al.,* 2009).

The amount of off-farm income has a small but positive and significant effect on the level of commercialization ($p<0.05$). As the result in the descriptive section indicated, only 26 percent of famers were engaged in off-farm activities. However, we cannot be sure whether income from off-farm activities is enough to stimulate farm investment. Nevertheless, some empirical and theoretical studies suggest that off-farm income could have both positive and negative effects on smallholder commercialization. For example, according to Woldehanna (2000), off-farm income can enhance smallholder commercialization if used as a liquidity source for farm investments that will further increase productivity and production of marketable surplus. This in turn may increase the proportion of crops sold by smallholder farmers. However, this is more likely if households are engaged in higher earning wage or self-employment activities and saving rate is higher (Woldehanna, 2000).

Table 9: Marginal effect estimation from the Craggit model

	dy/dx	Delta – method Std. Err.	Z	P>z	dy/dx	Delta- method Std. Err.	Z	P>z
Total value of output	0.000104	2.00E-05	5.21	0.000	-0.0000273	9.97E-07	-2.74	0.006
Age of the head	0.002109	0.0019926	1.06	0.290	0.0051635	0.0023883	2.16	0.031
Gender (male=1)	0.037874	0.0196675	1.93	0.054	-0.005415	0.0200077	-0.27	0.787
Years of schooling	0.005846	0.0036319	1.61	0.108	0.0080459	0.0040611	1.98	0.048
Land size	0.014262	0.0060192	2.37	0.018	0.0058971	0.0076895	0.77	0.443
No of livestock in TLU	-0.00483	0.0011924	-4.05	0.000	0.0061008	0.0014927	-4.09	0.00
Extension access(yes=1)	0.0045	0.0149427	-0.3	0.763	-0.0895144	0.0162888	-5.5	0.00
Credit access(yes=1)	-0.07007	0.0162623	-4.31	0.000	-0.0704047	0.0200825	-3.51	0.00
Access to irrigation (yes=1)	0.116201	0.0211432	5.5	0.000	0.076299	0.0174654	4.37	0.00
Access to all weather roads	0.026424	0.0151936	1.74	0.082	0.0358998	0.0142931	2.51	0.012
Modern mode of transport	-0.24619	0.0327659	-7.51	0.000	0.1733915	0.0310301	5.59	0.00
Traditional mode	0.098258	0.0202355	4.86	0.000	0.1267527	0.0169095	7.5	0.00
distance to market	0.001655	0.0014559	1.14	0.256	-0.0074082	0.0060766	-1.22	0.223
Year	-0.21979	0.0119914	-18.3	0.000	0.1368482	0.013569	10.09	0.000
Off farm income	-2.83E-06	5.50E-06	-0.52	0.606	7.70E-06	4.14E-06	1.86	0.063
Wald=588.37; prob>chi2 0.0000								

Unlike market participation (hurdle one), number of livestock owned measured in tropical livestock units has a positive and significant effect on the level of commercialization ($p<0.01$). This probably has to do with the wealth effect of livestock ownership, households who own livestock are relatively rich and rich farmers are likely to sell more rather than self consumption. Heierli and Gass (2001) argued that acquisition and ownership of productive assets (e.g. cattle) can pave the way for a household to be engaged in commercialization activities. Here it should be clear that the negative effect of livestock size on market participation is ambiguous. According to Gebremedhin and Jaleta (2012), the effect of livestock size on market orientation and market participation is not clear for two reasons. These are; 1) It could be that ownership of livestock is negatively associated with crop output market orientation and market participation by offering alternative cash income sources and 2) cash income obtained from livestock can be used to acquire crop production resources.

On the other hand, unexpected results were found for policy variables like access to credit and extension services which were found to be negative and significant ($p<0.01$). The result indicates that the level of commercialization is lower by 8 percent and 7 percent for households with access to extension and credit service respectively as compared to those who do not have access to these services. This indicates that participation in credit and extension services has not brought the desired goal when compared with those who are not participating in extension and credit services. This could be due to the consumption effect of credit. Thus, farmers receiving credit could use it directly for consumption purposes rather than buying agricultural inputs that might help them to increase crop production and productivity.

Another interesting result is that the level of market participation for households using modern mode of transport was found to be 27 percentage point lower compared to those who do not use modern mode of transport. Well, this is probably due to the fact that there is low level adoption of modern mode of transport. For example, the descriptive analysis shows that only 5 percent of the households have used modern mode of transport for the purpose of agricultural activities.

In the same token, market participation for households using traditional mode of transport have increased by 9 percent as compared to those who do not have traditional mode of transport ($p<0.05$).

Thus, the commercialization index for farmers with access to all weather roads is 3 percentage points above the commercialization index of famers who have no adequate access to all weather roads. The result by Gebremedhin and Jaleta (2010) shows a similar result in Ethiopia, but they did not incorporate the effect of mode of transport in their analysis. The main reason for the positive and significant effect of rural road quality (access to all weather roads) on crop commercialization is probably due to the argument proximity to all-weather road encourages market orientation due to their effect of reducing marketing costs (transaction costs), thus improving profitability (Gebremedhin and Jaleta, 2010). However, Gebremedhin and Jaleta, (2010) only used a single Woreda which has less policy implications and they did not also incorporate the effect of mode of transport used which is important to explain the whole effect of rural transport (road access and mode transport). More interestingly, mode of transport used for agricultural purposes was found to have positive and significant effect on commercialization. The result indicates commercialization level of farmers using modern mode of transport is 17 percentage points above those who did not use modern mode of transport ($p<0.01$). This is probably due to the effect of modern mode of transport in reducing agricultural production loss. That is, adoption of modern mode of transport can reduce the loss due to poor infrastructure and poor transport system including lack of improved transport facilities. In the same manner, the result indicates that commercialization level of farmers using traditional mode of transport is 12 percentage points above those who did not use any transport ($p<0.01$). Generally, the effect of mode transport seems to have an opposite direction or effect on commercialization (positive) and on participation (negative). Thus, at this point we can conclude that the contribution of mode of transport used is more important while farmers actually supply to market (possibly through reducing loss due to poor transport system) than their initial decision to particulate in the market.

Conclusions and Policy Implications

The result from the descriptive statistics shows that heterogeneity in rural road transport explains differences in the level of output, commercialization and market participation of smallholders. The result shows that commercialization index is 19 percent and 16 percent for households in villages with good access to all weather roads and for households in villages with poor access, respectively ($p<0.00$). The level of market participation for the pooled data was found to be 67 percent for households in villages with access to all weather road against the corresponding figure of 63.9 percent for households in villages with poor access to all weather roads ($p<0.00$). For the pooled data, it was found that there is significant difference in mean value of output sold between household in villages with access to all weather roads and households in villages with poor access to all weather roads ($p<0.1$). The result also shows that there is a statistically significant difference in the mean value of output sold between households in villages with good access to all weather roads and those in villages with poor access to all weather roads in 2011 ($p<0.1$).

The main reason for estimating the econometric model of smallholder commercialization is to see the interaction of rural road quality and mode of transport with the level of market participation and commercialization of smallholder farmers. In this regard, the coefficient of road quality is found to be positive and significant. Thus, the commercialization index for farmers in villages with good access to all weather roads is 3 percentage points above the commercialization index of famers who do not have access to all weather roads. More interestingly, mode of transport used for agricultural purposes was found to have positive and significant effect on commercialization. The result indicates that commercialization level of farmers using modern mode of transport is 17 percentage points above those who did not use modern mode of transport. This is probably due to the effect of modern mode of transport in reducing agricultural production loss. That is adoption of modern of mode transport can reduce the loss due to poor infrastructure and poor transport system including lack of improved transport facilities. In the same manner, the result indicates commercialization level of farmers using traditional mode of transport is 12 percentage points above those who did not use any transport.

Over all, the analysis indicates that the level of commercialization and market participation in accessible communities is found to be higher than that of inaccessible communities. In addition, the provision of rural road can increase the level of smallholder's market participation and commercialization significantly as it facilitates market integration and reduce the transport cost burden. The type of mode of transport used also affects market participation and the level of commercialization. The main implication here is that, both access to all weather roads and the mode of transport used is key in enhancing rural market participation. Thus, the provision of access to all weather roads and the adoption of agricultural transport facilities can improve agricultural market participation and the level of commercialization in rural Ethiopia.

Generally, the study indicated that households located in villages with poor access to all weather roads were found to be less likely to participate in agricultural markets and have lower level of commercialization as compared to households in villages with good access or better access to all weather roads (where farmers still prefer to use traditional mode of transport and foot (low level adoption of modern mode of transport). The finding that good access to all weather roads promotes commercialization and households still prefer to use traditional mode of transport imply that rural transport policies should focus on the provision of low cost and easily accessible mode of transport.

Thus, policies geared towards integrating remote areas with urban areas through integrated rural transport infrastructure development and addressing both access and mobility demand of rural communities should be given priority.

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