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The Effect of Road Accessibility on Households' Wellbeing in Ethiopia

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Abstract

The main objective of the study is to investigate the effect of road accessibility on households' well-being in rural Ethiopia. This study analyzed two-wave panel data set for two years (2011 and 2015) which was collected by CSA. Data analysis was carried out using descriptive statistics and econometric analysis including Propensity Score Matching (PSM) combined with Difference-in-Differences (DiD) method and finally robustness of DiD was checked using fixed effects of regression. The outcome variables were the commercialization index (commindex), total expenditure (tot_exp) and poverty indicator (poordummy). The DiD result revealed that the commercialization index and total expenditure were statistically significant at 1% for both variables. Moreover, the DiD for the poverty indicator at the end shows that there is statistical difference between 2011 and 2015 HHs at a 10% level of significance which means that road accessibility helped in the reduction of poverty. The results of the fixed effects model showed that, after controlling for the effects of time-invariant unobserved factors, road accessibility has a positive and significant impact on the commercialization index and total expenditure. By way of recommendation, the government and other stakeholders are advised to increase their investment in expanding road accessibility with proper monitoring and evaluation tools in order to avoid delays in projects and to effectively utilize scarce resources.

***Keywords*:** Road accessibility, household well-being, Difference-in-Differences, impact

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Introduction

The development of a community is very much associated with the services available to its people. Access to these services is resolved, to some extent, by how troublesome, tedious, and expensive it is for people to achieve well-being focuses, schools, markets, administrative services, and other sometimes-important organizations (Bucheli *et al*, 2016). Physical infrastructure development like road construction is considered as the engine of economic development and thereby economic growth. As observed in various studies, there is a huge difference in such developments between the developed and developing nations as it demarcates the line between nations that are advanced and who are otherwise.

Better road access would contribute to economic growth by reducing transport costs, travel time, and vehicle operating costs. Roads can improve rural residents' access to agricultural inputs and product markets. It likewise encourages the use of existing socio-economic services, for example, education, and health which improves the human capital accumulation of poor people. In addition, roads assume an imperative part to improve profitability by cultivating innovation and data streams. Also, roads make work open doors for nearby individuals through the facilitation of small businesses and industries in the long run while providing temporary employment openings through road development works (Terefe, 2012).

In Africa, especially in sub-Saharan countries, such developments are found at the infant stage as the road networks fall far behind what is supposed to be. The history of Ethiopia in such developments has no difference from the above countries. Ethiopia is a large, landlocked, and diverse country. It is the 11th poorest country in the world by income per person, and home to Sub-Saharan Africa's second largest population of about 102 million people (World Bank, 2016), the vast number of which are living in provincial zones.

The natural resources base remains the establishment for most employments and is liable to impressive atmosphere dangers. Regardless of past advancement, a notable heritage of underinvestment still bears its check as the greater part of the grown-up populace is unskilled and the nation's infrastructure shortages stay one of the highest in the world. Ethiopia is experiencing

a speedier statistic change than whatever is left of Africa and the quickly rising working-age populace presents opportunities as well as challenges (World Bank, 2016).

So as to culminate infrastructure deficits, various programs were planned, prepared, and executed by the government of Ethiopia and some impressive results have been observed even though there are a lot of work to be done to fulfill the needs of the population in this sector.

Road transport infrastructure is relied upon to assume a crucial part of economic development in the country and to lessen poverty. As a result, Ethiopia has experienced rapid expansion in road infrastructure since 1997 as the result of the Road Sector Development Program. A massive amount of capital has been contributed by the government with the help of universal contributors for the arrangement of every all-weather road that enhances local availability (Terefe, 2012).

This paper is concerned with the evaluation of the effect of road accessibility on households' well-being in Ethiopia by utilizing various econometric methods like difference-in-difference, propensity score matching, and quintile regression techniques. It also gives full attention and due emphasis to the rural parts of Ethiopia. The study used a panel data set of the Ethiopian Rural Socioeconomic Survey (ERSS2011 and ESS 2015) collected by the Central Statistical Agency (CSA) of Ethiopia in collaboration with the World Bank (WB).

Research Methodology

This paper uses the Ethiopian Socio-economic Survey. The Ethiopian Socioeconomic Survey (ESS) is a cooperative venture between the Central Statistics Agency of Ethiopia (CSA) and the World Bank Living Standards Measurement Study-Integrated Surveys of Agriculture (LSMS-ISA) venture. The target of the LSMS-ISA is to gather multi-theme board family unit level information with an extraordinary spotlight on enhancing farming measurements and the connection amongst horticulture and other family wage exercises.

The STATA 14 software was used for the analysis of the data by using different statistical tools such as descriptive and inferential statistics.

The poverty rate based on the international poverty line of 1.9 USD per day per person was predicted to be 27 percent in 2019 and is expected to remain about the same in 2020 and 2021(World Bank, 2021). In another insight, (Bersisa *et al.*, 2016) tried an in-depth analysis of multidimensional poverty in rural and small towns in Ethiopia. As social well-being or poverty is a multidimensional phenomenon, using a multidimensional measure of poverty helps circumvent problems surrounding the conventional measures of poverty and helps show clearly the realities of households. In this line, our analysis used six dimensions with 14 indicators to construct a multidimensional index of poverty using the first rounds of the Ethiopian Rural Households' Socioeconomic Survey data set. The study also employed a factor analysis for determining relative weights in computing a multidimensional index and did an in-depth analysis of the stochastic dominancy of poverty for different segments of society. Besides, a comparison of the extent of poverty using the conventional measure of poverty and the multidimensional approach was also done. The results reveal that the intensity, severity, and depth of poverty vary considerably across the two measures. Moreover, demographic, regional, and household heads' characteristics are major factors in determining poverty.

Model Specification of Wellbeing indicators

This paper used descriptive statistics and inferential statistics (econometrics) for the analysis of data. The Quasi-experimental design Propensity Score Matching model combined with the Difference-in-Differences model was employed to evaluate the effect of road accessibility on households' well-being in Ethiopia. Households who have access to the road have been used as a participant (treatment group) and those who have not as a non-participant (control group) to get the comparison group.

Moreover, with two-period information on treated and non-treated groups before and after the introduction of the program, one can build a quantile difference in differences (QDiD) estimate. In particular, in the QDiD approach, the counterfactual conveyance is figured by first ascertaining the adjustment in Y after some time at the qth quantile of the control group and after that adding this change to the qth quantile of Y (observed before the program) to the treatment group.

Two Periods Panel Data Analysis

The study tried to analyze the simplest kind of panel data because the study had two years of data; namely t =1 and t =2. These years were not adjacent, but t =1 corresponded to the earlier year. The study applied Pooled OLS because it cannot control all factors that affect the dependent variable (McManus, 2011). Thus, the study included the data that is registered in the earlier period. This helps the study to view the unobserved factors affecting the dependent variable as consisting of two types: those that are constant and those that vary over time. Letting i denote the cross-sectional unit and t the time period, the study can write a model with a single observed explanatory variable as

$$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it} + \alpha_i + u_{it} \quad t=1 \text{ and } 2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

In the notation, y_{it} i denote the households, and t denotes the time period. The variable $d2_t$ is a dummy variable that equals zero when t =1 and one when t = 2; it does not change across i, which is why it has no i subscript. Therefore, the intercept for t =1 is β_0, and the intercept for t = 2 is $\beta_o + \delta_o$. Thus, the model of the study is:

$$Households' \ Wellbeing_{it} = \beta_0 + \delta_0 d2015_t + \beta_1 RoadAccessibility_{it} + \alpha_i + u_{it} \quad t=2011 \text{ and } 2015$$

Checking Robustness of DD with Fixed-Effects Regression

As Khandker *et al*., 2009, Fixed-effects regression plays an important role in controlling unnoticed and unchanged characteristics of households that may influence the outcome variable. The Stata "xtreg" command is used to run fixed-effects regression. In particular, with the "fe" option, it fits fixed-effect models. Table 2 depicted a summary of variables used in the models with their respective name in STATA and sign.

Table 2

Summary Statistics of Variables Used in the Models

Name of Variable	Measurement and respective name in STATA	Expected Sign
1. Accessibility	Intervention dummy: 1 if HH has access to the road, 0 if otherwise. Accessibility indicator	
2. Commercialization Index	The continuous variable is measured in percent. Commindex	+
3. Total Expenditure	The continuous variable measured in Birr. tot_exp	+
4. Poverty Indicator	Dummy variable: 1 if HH is poor and 0 if otherwise. Poordummy	-
5. Sex of HH Head	Dummy variable: 1 if HH head is male and 0 if HH head is female	+/-
6. Age of HH Head	Continuous Variable: hh_s1q04a	+/-
7. Educational Level of HH Head	Continuous Variable: hh_s2q05	+/-
8. HH Distance from Nearest Market	Continuous Variable measured in Kilometers. dist_market	-
9. Land Size	Continuous Variable measured in Hectare. land_size	+/-
10. HH access to Extension	Dummy Variable: 1 if HH is incorporated in the extension program, 0 if otherwise. Extension	+/-
11. HH access to Credit	Dummy Variable: 1 if HH has access to credit, 0 if not. Credit	+/-
12. TLU	Continuous Variable measured in Kilogram: 1 TLU= 250 kg. TLU	+/-

Source: Own Estimation

Result and Discussion

This chapter is all about showing the result of the analysis and discussing a related issue that is observed during the process. Demographic and socio-economic characteristics of households are presented using descriptive statistics tools such as mean, standard deviation, percentage, and frequency. The inferential statistics such as t-tests for continuous variables are employed in the mean comparison of participant and non-participant groups using different control (covariate) variables. In addition tables, figures, and graphs are used whenever it deemed necessary. The effect of road accessibility on households' well-being outcomes, is estimated via employing the non-

experimental econometric estimation PSM design and combined with the difference in difference matching techniques, are interpreted and analyzed in detail.

General Description

From Table 3, it can be observed that the total panel household observation is 4,352 of which half of the Households(HHs) are from Wave One and the rest half is from Wave Three and the same HHs are used for the entire analysis. Regarding their sex composition, 81.7% of the sample was represented by male-headed and 18.3% represented by female-headed households. Of the total sample households, 1,325(30.4 %) are in treatment and 3,027(69.6%) are in the control category.

Table 3
Total Sample Observation

Survey Year	Treatment	Control	All
2011	655	1521	2176
2015	670	1506	2176
Total	1325	3027	4352

Source: Own Computation with ERSS/ESS Panel Data

The summary statistics in Table 4 demonstrate that most of the households (82.3%) are male-headed, while the remaining (17.7%) are female-headed from both treated and control groups in the year 2011. The survey also shows that the age of HHs ranges from a minimum of 18 years to a maximum of 97 years. Furthermore, 16% HHs were below the age group of 30 years, while 48.9% were between the age of 30-50 and the rest 35.1% above the age of 50 years.

Moreover, out of sampled households, the majority of the respondents were still male-headed in 2015. The proportion of male-headed sample households was less by 1.2 percent, which is 81.1% and the remaining 18.9% were female-headed households. As shown in Table 4, in 2015, the majority of the respondents 1100 (50.7%) fall under the age of 30-50 years. The result indicates that most of the household heads are under productive age. In addition, 11.5% of respondents fall under the age of 30 years followed by 37.8% above the 50 years age category.

Table 4:

Summary Statistics of Households' Demographic Characteristics

	2011				2015			
Variables	Frequency	Percent	Mean	SD	Frequency	Percent	Mean	SD
Sex of HH Head	2176				2176			
Male	1790	82.3			1765	81.1		
Female	386	17.7			411	18.9		
Age of HH Head	2175		44.75	14.98	2171		46.36	14.64
<30	347	16			250	11.5		
≥ 30 & <50	1063	48.9			1100	50.7		
≥ 50	765	35.1			821	37.8		

Source: Own Computation with ERSS/ESS Panel Data

Table 5 revealed that, in 2011, HHs' nearest market ranges from 1 KM to 256.3 KMs with average of 64.83 KMs and a standard deviation of 45.94 KMs. In the same year under consideration, the land holding size of HHs was a minimum of 0.001 hectare and a maximum of 9.75 hectares. On average, any HH has 2.53 hectare of land with a standard deviation of 2 hectares.

Regarding the extension program, in 2011, 712 HHs (32.72%) were in the extension program while 1464 HHs (67.28%) did not use the program. From the 2011' observation, we have learnt that 26.42% of HHs which is 575 in number has enjoyed credit facility while the rest 73.58% (1601) did not do so. HHs has total livestock of 6.36 units on average with a standard deviation of 6.03 while the actual number ranges from 0 to 47 units.

In 2015, the HHs travels on average 65.32 KMs to reach into the nearest market with a standard deviation of 46.12 KMs. The result shows that the average distance increases by 0.49 KM and the SD by 0.18 KM in 2011 and the actual minimum distance increases by 0.9 KM while the maximum distance remains the same that of 2011. When we come to land holding size, the average and SD increases by 0.01 and 0.08 hectare respectively from 2011, while the minimum holding size decreases tremendously but the maximum increases by 0.23 hectare.

Extension program participation in the year 2015 shows big improvement as it increases by 6.25% resulting 38.97% for extension package user and 61.03 for otherwise. The proportion of HHs who enjoyed credit facility in 2015 has declined sharply by 8.54% from the base year. Further research

may be needed to understand the issue with the credit facility. The mean livestock holding is 7.2 units with a standard deviation of 6.7 units which shows improvement when we compare it 2011 by 0.84 and 0.63 units in mean and SD respectively.

Table 5

Summary Statistics of Households' Socioeconomic Characteristics

	2011				2015			
Variables	Frequency	Percent	Mean	SD	Frequency	Percent	Mean	SD
HH distance to nearest market	2171		64.83	45.94	2176		65.32	46.12
Land Size	2176		2.53	2.00	2176		2.54	2.08
Extension	2176				2176			
Yes	712	32.72			848	38.97		
No	1464	67.28			1328	61.03		
Credit	2176				2176			
Yes	575	26.42			389	17.88		
No	1601	73.58			1787	82.12		
TLU	2176		6.36	6.03	2176		7.2	6.7

Source: Own Computation with ERSS/ESS Panel Data

Looking at the education level of the respondents in Table 6, on 2011 majority of them were below primary education 1273(58.5%), followed by primary education complete 839(38.56%), and secondary education 56(2.57%). The respondents who have the certificate and diploma constituted about 6 (0.28%) and 2(0.09%), respectively. In the year 2015, respondents with preschool education were less by 2.94%, which is 55.6%, compared to 2011. Moreover, HHs who enrolled in primary education and secondary education were 41.40% & 2.71% with increment of 2.84% and 0.14% respectively. For certificate holders, the result remains the same at 0.28%. Diploma holders decreased to 0.05 % from 0.09%.

Table 6

Summary Statistics of Educational Level 2011/2015

Educational Level	2011		2015	
	Frequency	Percent	Frequency	Percent
Preschool	1273	58.50	1209	55.56
Primary	839	38.56	901	41.40
Secondary	56	2.57	59	2.71
Certificate	6	0.28	6	0.28
Diploma	2	0.09	1	0.05
Total	2176	100%	2176	100%

Source: Own Computation with ERSS/ESS Panel Data

Comparison of Mean of Explanatory Variables (Covariates)

Table 7 presents the comparison of means of variables using a t-test for Treated and Control groups for the year 2011. These characteristics seen are the continuous variables that are used in the explanatory variables of this study. With the above test, in the year 2011, both educational level (the highest grade a HH completed) and Tropical Livestock Unit (TLU) were statistically significant differences (at 5%) between the treated and controlled group.

Table 7

Mean comparison for continuous variables using t-test for treated and control groups

	Obs.	Unit	Mean of Treated	Mean of Control	Diff.	t Value
Age	2175	Years	44.39	44.91	-0.52	0.7412
Education Level	2176	Years	2.04	1.78	0.26	-2.0836**
HHs' distance to the nearest markets	2171	KMs	64.39	65.02	-0.63	0.2930
Land Size	2176	Hectare	2.52	2.53	-0.01	0.1637
Tropical Livestock Unit	2176	Units	5.87	6.58	-0.71	2.5023**

Notes: **statistically significant at 5%.

Source: Own computation with ERSS/ESS panel data

T-test for the year 2015, in table 8, shows that there is a statistically significant difference between the treated and controlled group in the age of HH head at 5% while educational level, distances to the nearest market, and land size show statistically significance at 1% level.

Table 8
Mean comparison for continuous variables using t-test for treated and control groups

Continuous Variables	2015					
	Obs.	Unit	Mean of Treated	Mean of Control	Diff.	t Value
Age	2171	Years	47.55	45.84	1.71	-2.5160**
Education Level	2176	Years	2.19	1.75	0.44	-3.5473*
HHs' distance to the nearest markets	2176	KMs	53.95	70.38	-16.43	7.7754*
Land Size	2176	Hectare	2.80	2.43	0.37	-3.8938*
Tropical Livestock Unit	2176	Units	7.24	7.18	0.06	-0.1897

Notes: *&**statistically significant at 1% & 5%.

Source: Own computation with ERSS/ESS panel data

In summary, the average age of HH head of treated groups increases by 1.71 years in 2015 whereas educational level increased for both years by 0.26 in 2011 and 0.44 in 2015 for treated groups. This implies that the better the accessibility, the more enjoyed by HHs. The other tremendous significance was observed in HH's distance to the nearest market as it declined by 16.43 KMs on average in the year 2015. This depicts that the construction of roads in 2015 is better than by far that of 2011. Moreover, the average land holding size of treated groups increases by 0.37 hectares which are considered to be the most valuable assets of HHs.

The chi-square comparison of the mean of variables by treated and controlled groups for the total sample is presented in the following table (Table 9). These characteristics seen are the categorical variables that are used in the explanatory variables of this study. Based on Pearson's Chi-Square test, a statistically significant difference exists between treated and control extension program

participation at 1% level. From mean comparisons in Tables 8 and 9[3], it can be observed that the treated groups are significantly distinguishable in terms of variables that are used to characterize them such as age, educational level, distance from the nearest market, land size, TLU, and extension program participation on one hand. On the other hand, the two groups are not distinguishable significantly on their sex of HH head and HH access to credit.

Households' Wellbeing Indicators

Mean Comparison of Outcome Variables: - The existence of the significant difference between the mean of the treated and control groups is compared using the two-sample t-test on the outcome variables. The outcome variables which are indicated in the conceptual framework are total expenditure by households, commercialization index, and poor dummy. Hence, this section is allocated for mean comparisons of each outcome variable by applying the first t-test method for continuous variables which are total expenditure and commercialization index, and then the chi-square test for the categorical variable which is a poor dummy.

As can be observed from Table 10, with a t-test for continuous outcome variables, there is a statistically significant difference at 1% level between treated and control groups in their total expenditure. On average, the treated groups total expenditure is 725.20 birrs which is higher than that of the control group by 204.70 birrs. This implies that being in treatment increases HHs' expenditure since the availability of a variety of goods and services allowed HHs to have tastes for new technologies and items.

The other outcome variable result, which is the commercialization index, shows that the difference in outcomes between treated and control is statistically significant at 1% level. That is, HHs who have access to the road sold their output by a 3% difference from that of HHs who have not access.

[3] See appendix

Table 10

Mean comparison for continuous outcome variables for treated and control groups

Participation dummy	Frequency on Support	Frequency off Support		Mean	SD	Max
Control	3018	9	.08562668	.31063567	.059346	.52310682
Treated	1321	4	.11123616	.32777643	.0592765	.525376

Notes: *statistically significant at 1%. Source: Own computation with ERSS/ESS panel data

Table 11 shows that Pearson's chi-square test for a poor dummy is statistically significant at 1% which shows that poverty reduces for those HHs who have access to the road. This depicts that the economic activity HHs, due to accessibility to roads and basic facilities, improves as there is employment creation during the construction of roads, better health service, and easy mobility of HHs to get non-farm income during the slack season, etc.

Table 11

Mean comparison for continuous outcome variables for treated and control groups

Outcome Variables	Total Sample Population					
	Obs.	Unit	Mean of Treated	Mean of Controlled	Diff.	t Value
Total expenditure	4352	Birr	725.20	520.50	204.70	14.6195*
Commercialization Index	4203	Percent	20	17	3	4.0478*

Notes: *Statistically significant at 1%. Source: Own computation with ERSS/ESS panel data

To summarize, mean comparisons of outcome variables based on the t-test of continuous variables and Pearson's Chi-square of categorical variables in Table 10 and Table 11 respectively, show that all the outcome variables have a significantly higher proportion at the significance level of 1 %. This means that for the next econometric analysis, the selected outcome variables better explain the result.

3.3 Econometric Result

Propensity Score Matching:

Variables choice for the propensity score model is based on the findings of factors affecting the HHs' well-being due to road accessibility and the tests performed before running the model. The findings with these methods are initially based on the theoretical and empirical relations, the conceptual framework, and the data availability at hand for the possible covariates. The dispersion of the estimated Propensity score (pscore) generated using the logistic regression was presented using tables and graphically showing both treated and comparison groups. Table 12 shows that the control group has a mean pscore of 0.31063567 with a standard deviation of 0.059346 ranging from minimum value of 0.08562668 to a maximum of 0.52310682. Among the treated groups, the predicted propensity score ranges from a minimum value of 0.11123616 to a maximum of 0.525376 with a mean pscore of 0.32777643 and a standard deviation of 0.0592765.

The ideal condition for the common support is that propensity score distributions between treated and control groups would overlap entirely (Lanehart *et al.*, 2012). In other words, the region of common support shows the range of the overlap region of the treated and control groups (See Figure 1). From the control group, 69.35% which is 3018 out of 4352 HHs, and 1321/4352(30.35%) from the treated groups are on the common support. Hence, it is only 3% (11/4352) HHs are off the common support that is contributed by 9 and 4 HHs from the control and treated groups respectively.

Table 12

Summary Statistics of Propensity Scores for treated and control groups

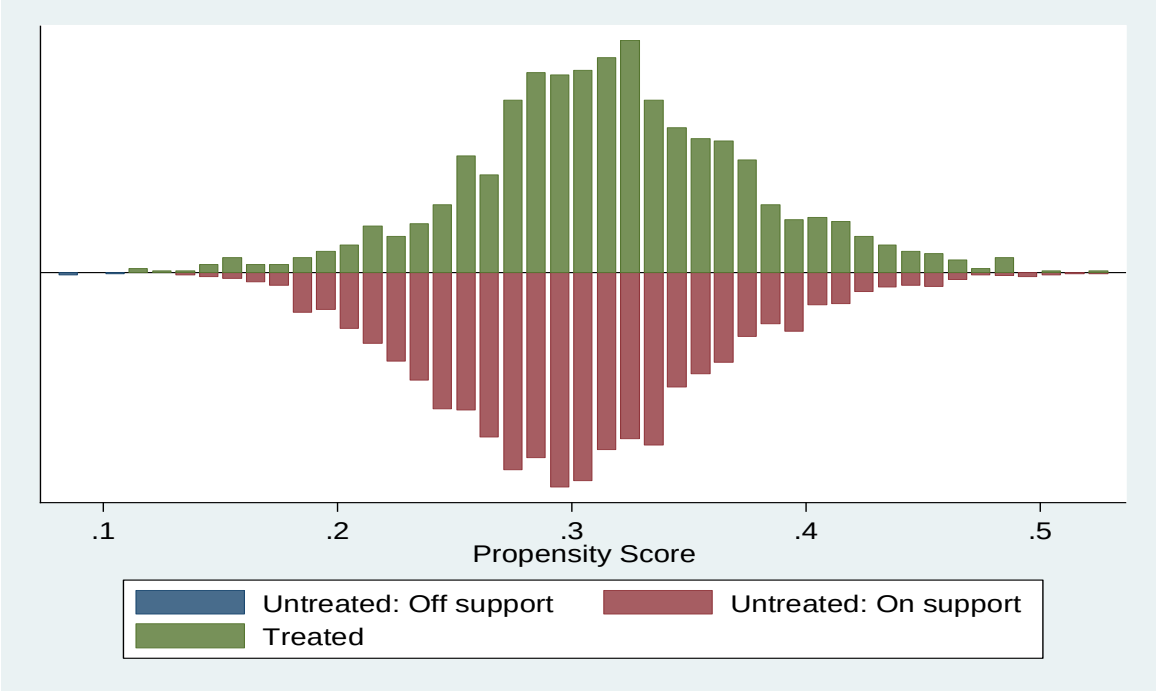
Outcome Variables	The total sample population of 4347			
Controlled	Observation	Percent of Treated	Percent	of
	Chi-square test			
Poor dummy				
Dummy: Yes=1	845	23.79(201)	76.21(644)	21.6103*
No=0	3502	31.98(1120)	68.01(2382)	

Source: Own computation with ERSS/ESS panel data

The common support area overlap between participants and non-participant groups can also be inspected via employing the histograms. The histogram in Figure 3 displays that there is a wide area of overlap between the treated units and the control units which is on support by using histograms in various colors. The upward histogram with green color shows the matched treated units, the red downside histogram indicates the matched untreated groups, and the downward blue color histogram shows an unmatched control group. This confirms the existence a sufficient overlap of the participant and nonparticipant units to get a quality match. Henceforth, the assumption of common support $0<(Ti=1|Xi)<1$ has been satisfied (Khandker *et al.* (2016) and Baum (2013). From the figure on propensity score distribution, we can observe that there is much overlap between the two groups. The region of common support is [0.11123616, 0.525376**].**

Figure 1

Estimated propensity score distribution



Source: Own computation with ERSS/ESS panel data

Difference-In-Differences for Outcome Variables:

As observed in Table 13 below concerning about one of the outcome variables (poor dummy), from 2167 observations in 2011(base year), HHs who are in treated groups are 651 while the remaining 1516 are in control groups. In 2015, 667 HHs are in treatment whereas 1504 are in control totaling 2171 HHs. One can easily understand that in the base year, the difference between the treated and control group was insignificant but in 2015 the difference shows significance at 1% level. The DD at the end shows that there is a statistical difference between 2011 and 2015 HHs with a t-value of 1.83 at 10% level of significance which means that road accessibility helped in the reduction of poverty with a coefficient of -0.046 which is almost a 5% reduction in poverty.

The outcome indicates comparable aftereffects of the discoveries of Dercon et al, 2009 when they learn about the Impact of agricultural extension and roads on poverty and consumption growth in fifteen Ethiopian villages as they discovered that access to good roads reduces the likelihood that a household is poor by 6.9 percentage points.

Table 13

Difference in Difference Estimation for Poverty (Poordummy)

Outcome Variables	Poordummy	S.Err		
T	P>|t|			
2011				
Control	0.026			
Treated	0.006			
Diff (T-C)	-0.020	0.018	-1.12	0.262
2015				
Control	0.177			
Treated	0.112			
Diff (T-C)	-0.065	0.018	3.70	0.0000*
Diff -in- Diff	-0.046	0.025	1.83	0.067***

Notes: *&***statistically significant at 1% & 10%.
Source: Own computation with ERSS/ESS panel data

Total expenditure which is one of the covariates revealed a big difference between 2011 and 2015 HHs. In 2011 and 2015, 654 & 667 HHs were treated and 1517 & 1504 were in control respectively from the total figure of 2171 for each year. As can be seen in Table 14, in 2011, HHs who were treated spent Birr 457.35 whereas 315.43 Birr was the total expenditure of HHs in the control

group. This resulted Birr 141.92 Birr in difference for the year under consideration. When come to 2015, HHs expenditure rose by 35% for the treated group and resulting total expenditure of 617.54 Birr. For the same year for the control group, the increment was Birr 80.98 which is 26%.

The t value for the difference in differences for total expenditure displayed 3.03 which is statistically significant at 1%. This implies that HHs who have road accessibility spend better than of HHs who have no access with Birr 79.21. This result was previously shared by other scholars. For example, Khandker *et al.* (2009) said that the overall economic returns to road development can be measured by summing over the gains through transportation cost savings, higher output and lower input market prices, and higher productivity. While there is no easy way we can summarize these benefits in one return estimate, such gains ultimately translate into higher household expenditure (both food and non-food), as well as human capital investment (in children, for example). The results show that the returns to road investment for household per capita expenditure are about 11 percent in Bangladesh villages, a substantial gain in terms of higher consumption and income for rural households. This means that rural households in villages targeted by the road development project have on average an 11 percent higher consumption per capita per year.

Table 14

Difference in Difference Estimation for Total Expenditure

Outcome Variables	tot_exp	S.Err		
T	P>|t|			
2011				
Control	315.429			
Treated	457.349			
Diff (T-C)	141.921	18.423	7.70	0.0000*
2015				
Control	396.410			
Treated	617.542			
Diff (T-C)	221.133	18.554	11.92	0.0000*
Diff -in- Diff	79.212	26.134	3.03	0.002*

Notes: *statistically significant at 1%. Source: Own computation with ERSS/ESS panel data

Table 15

Difference in Difference Estimation for Commercialization Index

Outcome Variables	Commindex	S.Err		
T	P>|t|			
2011				
Control	0.226			
Treated	0.275			
Diff (T-C)	0.049	0.011	4.35	0.0000*
2015				
Control	0.237			
Treated	0.242			
Diff (T-C)	0.005	0.011	0.46	0.644
Diff -in- Diff	-0.044	0.016	2.75	0.006*

Notes: *statistically significant at 1%.
Source: Own computation with ERSS/ESS panel data

One of the covariates is the commercialization index which is tabulated under Table 15. The commercialization index measures the extent to which household production is oriented toward commercialization. It ranges from 0 to 100%. A value of zero signifies a totally subsistence-oriented producer. The closer the index is to 100%, the higher the level of commercialization. From the total of HHs in 2011, 1457 were in the control group while 627 were in treatment. As we look at 2015, the figure is 1463 for control groups while 646 HHs were treated. The total HHs were 2084 and 2109 for the years 2011 and 2015 respectively.

The difference in 2011 revealed that HHs who were in treatment sold their output by a 5% increment that those in the control group. When we see the difference in difference, the result showed a t-value of 2.75 at 1% level of significance. This means that HHs who have better access sold their output better than those who have not even though the coefficient has a negative sign. Though the magnitude of the result is different from this study result; the study done by Ageya and Omondi (2016) shows that the good type of roads accessible by the respondents is positively associated with Household Commercialization Index with the coefficient being highly significant at 1%.

Quantile Difference-In-Differences with Outcome Variables

In order to see what proportion of HHs are real beneficiaries of the treatment, it is customary to run quantile DD of some outcome variables.

Quantile Difference-In-Differences of Total Expenditure & Commercialization index: - The results observed for values that are estimated at the .8 quantile in Table 16 showed that 80% of the HHs' expenditure due to road accessibility is significant at 1% level of significance. For the year 2011 alone the total expenditure of 80% of HHs in the treated group was higher than that of the control group by Birr 191.37. When we see the year 2015, the difference in total expenditure of 80% of HHs was Birr 405.80 which is more than double the folds of the year 2011 expenditure. The difference in differences of 80% of HHs was Birr 214.44 at t-value of 5.04 which is significant at 1% level of significance.

In addition, the same depicted values that are estimated at the .4 quantile revealed that 40% of HHs' commercialization index increased due to road accessibility at 0.6%, t value of 16.65, and 1% of the significance level. The first 40% of HHs in treatment have enjoyed road accessibility as their total value sold from their total expenditure increased better than those who did not get the access. The result clearly indicated that, as stated earlier, road accessibility improved the total expenditure and commercialization index of HHs even with the use of quantile regression.

Table 16

DiD Estimation for Total Expenditure & Commercialization index

Outcome Variables	tot_exp at .8 qdid	S.Err						
T	P>|t|	Commindex at .4 qdid	S.Err					
T	P>|t|							
2011								
Control	441.032				0.001			
Treated	632.399				0.001			
Diff (T-C)	191.367	29.892	6.40	0.0000*	0.000	0.000	0.95	0.342
2015								
Control	551.603				0.038			
Treated	957.405				0.043			
Diff (T-C)	405.802	30.243	13.42	0.0000*	0.006	0.000	24.47	0.0000*
Diff -in- Diff	214.435	42.511	5.04	0.0000*	0.006	0.000	16.65	0.0000*

Notes: *statistically significant at 1%.

Source: Own computation with ERSS/ESS panel data

Checking Robustness of DD with Fixed Effects Regression

There are many ways which measure the DD estimate. One of them is to use a fixed-effects regression instead of ordinary least squares (OLS). Fixed-effects regression controls for household's unobserved and time-invariant characteristics that may influence the outcome variable. The Stata "xtreg" command is used to run fixed-effects regression. In particular, with the "fe" option, it fits fixed-effect models. Before regressing the fixed model, this study generates an additional variable i.e., access date (interaction variable between accessibility indicator & date) to produce a vector of the different coefficient on time which is the indicator of the fixed effects.

Fixed Effects Regression for Total Expenditure

The results of the fixed effects in Table 17 show that, after controlling for the effects of time-invariant unobserved factors, HHs who got access to the road has higher expenditure than HHs who are in the control group. Treated HHs expenditure rose by 79.21 real terms at t value of 3.03 which is highly significant at 99% of the confidence interval. The figure clearly shows that it is consistent with what has been observed during interpreting DiD

Table 17

Fixed Effects Regression for Total Expenditure

Variables	Total Expenditure			
	Coefficient	SE	T	P>|t|
accessability_indicator	141.9206	18.42269	7.70	0.000*
Accessdate	79.21201	26.13417	3.03	0.002*
Sex of HH Head	94.71994	15.85821	5.97	0.000*
Age of HH Head	.2610353	.411907	0.63	0.526
Education Level	20.60865	2.264595	9.10	0.000*
HHs' distance to the nearest markets	-1.549996	.1311412	-11.82	0.000*
Land Size	12.57099	3.065582	4.10	0.000*
Extension Program Participation	75.31771	12.93532	5.82	0.000*
HH Access to Credit	18.08677	14.81245	1.22	0.222
Tropical Livestock Unit	12.12869	.9784108	12.40	0.000*
Constant	355.9194	27.69579	12.85	0.000*

Notes: *&**statistically significant at 1%&5%.

Source: Own computation with ERSS/ESS panel data

Fixed Effects Regression for Commercialization Index

Results in Table 18 show that, after controlling for the effects of time-invariant unobserved factors, HHs who are in the treated group have a 4.4 percent positive impact on the household's commercialization index, and the impact is very significant with t value of 2.75 at 1% of the significance level. This outcome is exactly the same as that of the results obtained in analyzing DiD.

Table 18

Fixed Effects Regression for Commercialization Index

Variables	Commercialization Index			
	Coefficient	SE	T	P>|t|
accessability_indicator	.0493572	.0113418	4.35	0.000*
Accessdate	-.0441156	.0160387	-2.75	0.006*
Sex of HH Head	.0203913	.0097338	2.09	0.036**
Age of HH Head	-.0002284	.0002522	-0.91	0.365
Education Level	.0034500	.0013898	2.48	0.013**
HHs' distance to the nearest markets	-.0005438	.0000799	-6.80	0.000*
Land Size	-.0009070	.0018860	-0.48	0.631
Extension Program Participation	-.0228822	.0079573	-2.88	0.004*
HH Access to Credit	-.0507044	.0091121	-5.56	0.000*
Tropical Livestock Unit	-.0025842	.0006063	-4.26	0.000*
Constant	.2315089	.0169759	13.64	0.000*

Notes: **statistically significant at 1%&5%. Source: Own computation with ERSS/ESS panel data

Conclusion and Policy Implications

This study has tried to investigate the effect of road accessibility on households' well-being in rural Ethiopia by using proxy indicators like the commercialization index, total expenditure, and poverty indicator. In doing so, the paper tried to characterize households based on road accessibility, to see the impact of road accessibility on the poverty level of households, and to show the effect of road accessibility on the commercialization level of households. By using the Ethiopian \Rural\ Socioeconomic Survey (ERSS2011 & ESS2015), data analysis was carried out using descriptive statistics and econometric analysis was done by combining propensity score matching with the difference-in-differences method. Then after, the robustness of difference-in-differences was checked using fixed effects of regression.

The descriptive analysis was done by using mean, standard deviation, frequency, percentage, t-test, and chi-square test in order to compare the value of key variables. The findings of the econometric analysis showed the t value of the commercialization index is 2.75 at 1% level of significance. In addition, the t value for the difference in differences for total expenditure displayed 3.03 which is statistically significant at 1%. Moreover, the difference-in-differences result of the poverty indicator revealed that there is a statistical difference between 2011 and 2015 households with a t-value of 1.83 at a 10% level of significance which means that road accessibility helped in the reduction of poverty with a coefficient of -0.046 that is almost 5% reduction in poverty.

The results of the fixed effects showed exactly the same result as that of the difference-in-differences for households who got access to the road has higher expenditure and commercialization than households who are in the control group. The endeavor that the government and other stakeholders exerted so far to increase road accessibility is found to have a positive and significant impact on improving the well-being of the rural society of Ethiopia. But when we compare it to even the African country's standard, it is found to be amongst the lowest-ranked countries. So as to benefit from the development of such infrastructure and thereby improve the living standard of society, the following recommendations are forwarded:

- ✓ Since Ethiopia is an agrarian economy, much of its agricultural products have to be delivered on time for the intended purpose. Therefore, the government in collaboration

with international donors must expand the overall road network (taking into account both coverage and quality) to overcome the accessibility issue as the previous results revealed impressive outcomes for better life of rural society.

- ✓ Currently, roads favor the highest and the middle-income group in total expenditure and commercialization, respectively. Thus, to help the poor benefit from roads, constructing feeder roads will be of paramount importance to reduce their poverty and market access challenges by way of creating more employment opportunities during the construction process.
- ✓ As a normative statement, we suggest that proper and effective allocation of resources while managing such kind of infrastructure development projects should be a priority.
- ✓ Further and detailed studies should be done in order to see the overall effect of road accessibility not only in terms of its impact on poverty and commercialization but also on other outcomes of interest.

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