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Impact of Road on Rural Poverty

Evidence Form Fifteen Rural Villages in Ethiopia

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List of Acronyms

ADLI	Agriculture Development Led Industrialization
ERA	Ethiopian Roads Authority
ERHS	Ethiopian Rural Household Survey
ERTTP	Ethiopian Rural Travel and Transport Programme
EVS	Ethiopian Village Studies
GDP	Gross Domestic Product
GTP	Growth and Transformation Plan
IFPRI	International Food Policy Research Institute
MOFED	Ministry of Finance and Economic Development
PASDEP	Plan for Accelerated and Sustainable Development to End Poverty
RSDP	Road Sector Development Programme
SSATP	Sub Saharan Africa Transport Programme
URAP	Universal Rural Access Programme
WB	World Bank

Abstract

A major road sector investment program has been under way in Ethiopia since 1997 which led to significant improvement in road accessibility. As a low-income country with no railway and water transport systems, road transport is of ultimate importance for the Ethiopian economy. The purpose of this paper is to assess empirically the effect of this public investment program on the welfare of rural households in Ethiopia. It looks specifically at the rate of poverty reduction and growth rate of household consumption in response to change in road accessibility. The paper combines a panel data of rural households in Ethiopia with a provincial level panel data of road density to estimate the impact of road on poverty and consumption. Alternative econometric estimation methods have been used to assess the robustness of the association between road infrastructure and rural wellbeing. After controlling for household characteristics and geographic determinants of economic performance, we find that the poverty headcount ratio declines with improvement in road accessibility of rural villages. The study also shows that better road connectivity not only increases the likelihood of crossing over the poverty line but also enhances the rate consumption growth significantly. The study went further to examine some of the mechanisms through which road might improve the standard of living in rural areas. We find that rural households with better road network are not only more likely to use modern fertilizers but they also make intensive use of fertilizers. Moreover, the paper finds evidence that the overall productivity of farm households increases significantly with the degree of road access.

Relevance to Development Studies

Public infrastructure plays a fundamental role for the development of a country. Evaluating the impact of public investment on economic performance is an integral part of the design of development policies and strategies so that such interventions would lead to poverty reduction and sustainable development. Discovering the efficiency and equity implications of road infrastructure and the mechanisms through which it affects the wellbeing of households has important contribution to the academic and policy discussion on the role of government in economic development. The author believes that the paper contributes to this discussion and the findings would encourage further research in this field.

Keywords

Road Access, Poverty, Consumption growth, impact channels

Chapter 1
Introduction

Physical infrastructure is often indicated as a key input to economic growth both in developed and developing countries (Roberts et al, 2006). In many developing countries especially in Sub-Saharan African transport sector and infrastructure fall far behind that of developed countries[1]. Recently, enhancing transport infrastructures has been a vital strategy for sustainable development and poverty reduction in developing regions. In Sub-Sahara Africa about 36 countries are currently involved in transport sector development by endorsing the Sub-Saharan African Transport Policy Program (SSATP) in 2004/2005. The major objective of this program is to harmonize transport policies and strategies to facilitate economic growth and poverty reduction which is consistent with the pro-poor growth initiative (SSATP, 2005). Reducing poverty by half is one of the Millennium Development Goals in 2015. There is wide recognition that the poor not only have low level consumption but they are also less connected with inadequate access to basic services. The international community has thus been providing considerable support to build roads, rail ways, bridges, power plants, and some basic infrastructures with the objective of promoting economic growth. It is therefore very important to examine empirically the impact of road infrastructure on growth and poverty.

Better road access would contribute to economic growth by reducing transport cost, travel time and vehicle operating costs. Roads can increase rural households' access to agricultural inputs and product markets. It also facilitates utilization of existing socio-economic services such as education and health which enhances the human capital accumulation of the poor. Moreover, roads play a vital role to enhance productivity by fostering technology and information flows. In addition, roads create employment opportunities for the local people through facilitation of small businesses and industries in the long run while providing temporary employment opportunities through road construction works.

Ethiopia is the second most populous Sub-Saharan African country characterized by land lockedness, mountainous terrain with relatively high poverty rate. Hence, road transport infrastructure is expected to play a critical role for economic development in the country and to reduce poverty. Ethiopia has experienced rapid expansion in road infrastructure since 1997 as the result of the Road Sector Development Program. Massive amount of capital has been invested by the government with the support of international donors for the provision of all-weather roads that improve regional connectivity.

The objective of this paper is to assess the effectiveness of the massive public investment program on road infrastructure on poverty reduction in rural Ethiopia. The paper also examines how household consumption responds to improvements in road accessibility and identifies some of the channels through which the benefits of roads are realized. The paper uses both the incidence of poverty and real consumption expenditure per capita as response variables using household level panel data from rural Ethiopia. The paper is organized as follows. Chapter two provide background information on recent economic developments in Ethiopia as well as improvement in road infrastructure. Chapter three reviews the literature on the impact of road on poverty and consumption growth. Chapter four describes the data. Chapter five provides some

[1] See annex V

descriptive statistics including preliminary evidence on the impact of road access on poverty and consumption growth. Chapter six discusses the theoretical framework and the econometric models to estimate the impact of road access. Chapter seven discusses the estimation results. Conclusion and policy implications are presented in the last chapter.

Chapter 2
Background

2.1 Economic Development in Ethiopia

Ethiopia is an agrarian economy where agriculture provides employment for about 80% of the population (PASDEP, 2006) and constitutes for about 48% of overall GDP in 2004/05(IMF, 2006a). The agricultural system in the country is mainly rain-fed subsistence farming. . Ethiopia is among the poorest countries in the world and its per capita income is much lower than the Sub-Saharan African average of US$1225 (World Bank, 2012). Although the incidence of poverty has been declining nationally, it still remains quite high at 30 % in 2011(MOFED, 2012).[2]

Ethiopia made the transition to a market economy in 1991 through successive economic reform measures along the lines with the World Bank and IMF reform agenda. Key feature of this reform during the early 1990s involve liberalization and deregulation of the economy, greater private sector participation and macroeconomic stabilization. Starting from the mid-1990s the government followed an Agricultural Development Led Industrialization (ADLI) strategy.

For the last six years since 2003 the country has shown fast economic growth about 11% per annum (World Bank, 2012). In 2005/06 the government has designed and endorsed a plan for accelerated and sustainable development to end poverty (PASDEP). The plan was to bring economic growth and to achieve Millennium Development Goals. Ensuring rural economic growth and poverty reduction is one of main thematic objectives of this plan which is now followed up by the Growth and Transformation Plan (GTP) since 2010. The economy has been growing at about 5% during 1995-2002 and by more than 8% annually since 2002. The GTP is designed to achieve pro-poor growth as well as meet the Millennium Development Goals. The major objective of the plan is to strengthen modern and productive agricultural economy in which industries and technologies play a leading role (MOFED, 2010). Government underlined the expansion and provision of quality infrastructures to achieve the MDGs.

Transport infrastructure has been playing substantial role in the economy especially since the federal government's decision to launch a Road Sector Development Program in 1997. In the past few years, every poverty reduction strategic plans have given priority to improve accessibility of public goods especially for the rural households.

2.2 Road Sector Development in Ethiopia

The Road Sector Development Program (RSDP) has been one of the major national development initiatives of the Ethiopian government starting from 1997. The RSDP encompasses different packages involving road projects at the federal, regional and community level. Three successive RSDPs have so far been completed. The first phase was carried out form 1997 to 2001; the second phase was from 2002 to 2007 and the third phase was from 2007-2010. In 2011 the country has rolled out the fourth phase of the RSDP.

[2] Based on MOFED (2012) estimation the proportion of household under poverty line in 2011 has declined by 24% from year 2004.

During the past three phases of accomplishment (1997-2010) Ethiopia has shown great improvement in the road sector through constructing, major maintenance, upgrading and rehabilitating of road networks. Over the fourteen years of the program a total of 57950 Km road construction work has been carried out of which about 20668 km were federal roads while 36428 km are regional roads. During this period 3662 km of link roads have been constructed, 5931 km of roads were upgraded and about 2380 km roads were rehabilitated. The total cost of the RSDP for the period 1997-2010 was about USD 7.3 billion which is about 79% of planned budget. Of the total disbursement 34% was spent on rehabilitation and upgrading of trunk roads while 39% was for construction and upgrading of link roads and about 9.4% for expansion and maintenance of regional roads. The remaining 15% is spent on federal road maintenance, institutional support projects and construction of community roads. About 71% of the RSDP spending is financed from domestic source while 29% was development aid obtained from the World Bank, European Union, Government of China, African Development Bank and other international donors (ERA, 2011). Government of Ethiopia is the largest financer which covers about 57% of spending for the RSDP.

The focus of the first RSDP was rehabilitation, maintenance and upgrading of existing roads while the following phases focused on upgrading and construction of new roads. Hence, government intervention in the RSDP has significantly improved transport networks and accessibility as compared to the pre-RSDP period. Table 1 summarizes the achievement of the RSDP as reported by the Ethiopian Roads Authority.

Table 1: Road Network Improvement in Ethiopia during RSDP (1997-2011)

Indicators	Base Year (1997)	RSDP I (1997-2002)	RSDP II (2002-2007)	RDPIII (2007-2010)	RSDP IV* (2010/11)
Total Road Network(Km)	26550	33297	42429	48793	53997
Proportion of Rural roads in good condition	21%	28%	46%	53%	54%
Proportion of Total Road Network in good condition	22%	30%	49%	56%	57%
proportion of area more than 5 km form all weather road	79%	75%	68%	64%	61%
Rural Road Access Index (share of Pop. Living within 2km all-weather road access[3]	13%	17%	21%	25%	27%
Road Density/1000 sq.km[4]	24km	30km	39km	44km	49km
Road Density/1000 population	0.49km	0.49km	0.55km	0.58km	0.66km
Average distance to all weather road	21km	17km	13km	11km	10km

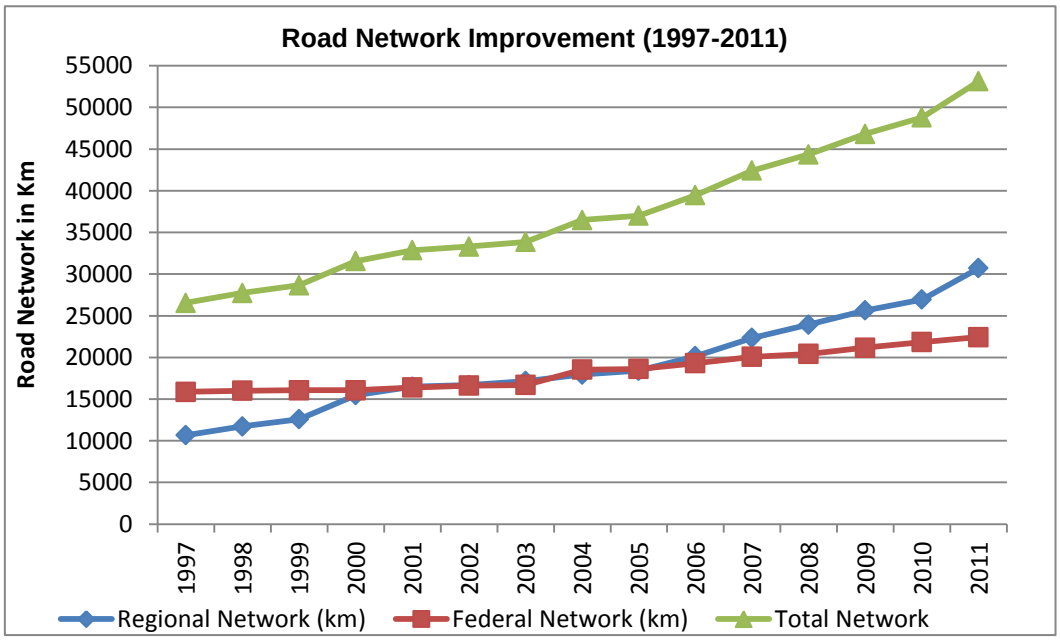
***Source*:** Ethiopian Roads Authority 2007, 2010 and 2011
Note: * the figure indicates one year assessment.

[3] Rural Access Index = (length of road network)*(habitable land area)*(distribution of roads)*(distribution of population) and hence it is a better accessibility measure (World Bank, 2006). For comparison with other African countries refer annex-IV

[4] Road density is calculated as :(Σ(all road km)/ country Area) X1000. But note it assumes that all roads are evenly distributed in the country. Our paper also uses Woreda road density/1000 sq km excluding community and earth roads. Here, we also assume all roads in the Woreda are evenly distributed.

Table 1 shows the improvement in road networks in Ethiopia. The share of population living within 2 km of an all-weather road has increased from 13% in 1997 to 27% in 2011. This shows people have been getting better access to markets and other socio-economic services such as health and education. The road density per thousand square km doubled from 24Km to 49km during the same period. The data also show a decline in distance to all weather roads from 21Km in 1997 to 10Km in 2011.

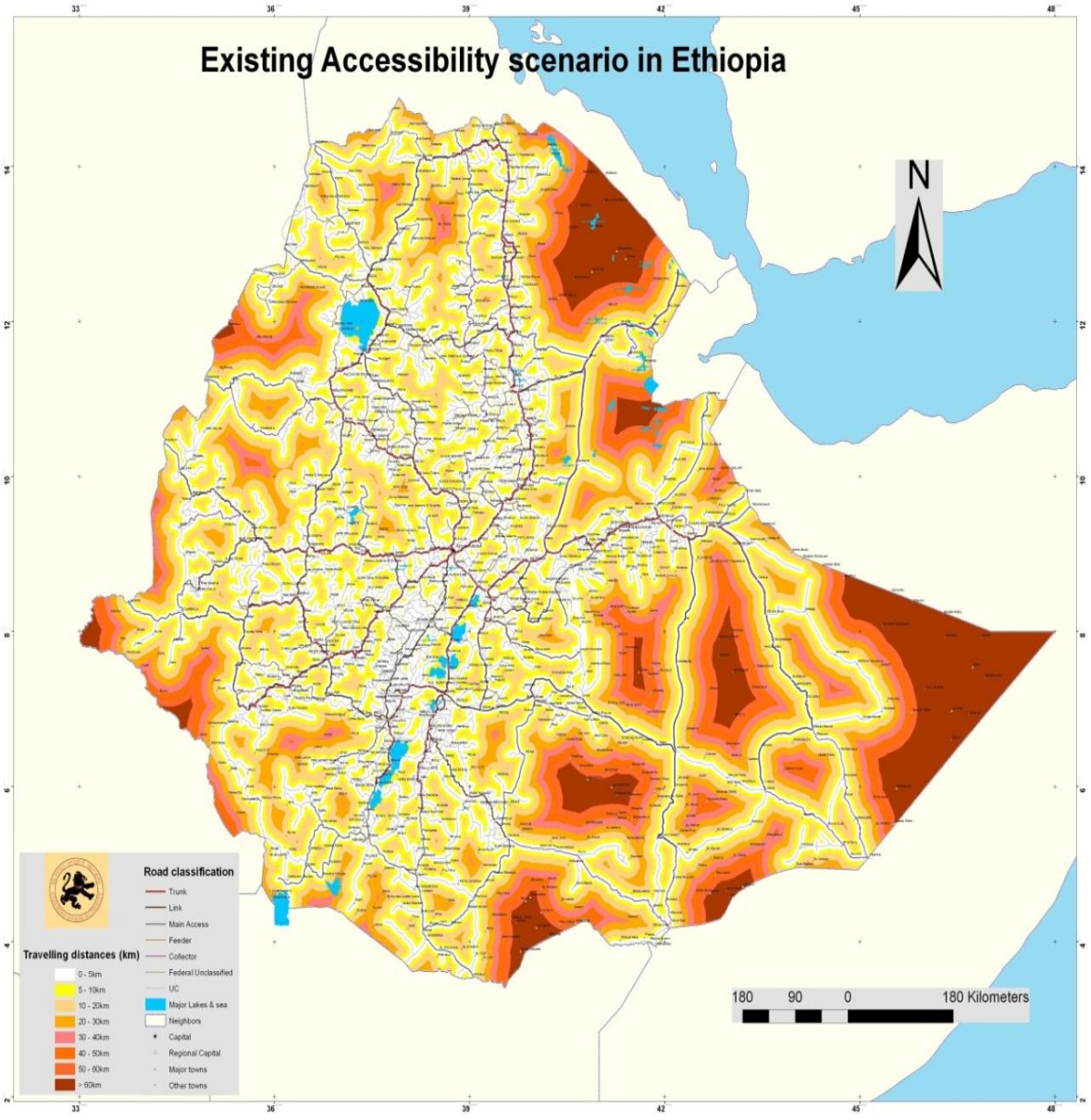
Figure 1 : Regional and Federal Road Network Improvement in Ethiopia (1997-2011)



Source: ERA (2011)

Figure 1 shows steady and significant enhancement of road access in Ethiopia since 1997. The increase in regional road networks has been more than that of federal roads showing the priority given to rural roads. Since the launch of RSDP, more than 30,000 km of rural roads have been constructed and about 22431 km of federal roads has been accomplished. These mass constructions increased the total road network from 26,550 km to 53,995 km excluding dry-weather roads built by rural communities. Constructions of lower grade rural roads under the government's Rural Travel and Transport Programme (ERTTP) has contributed to the accessibility of rural areas and increased the proportion of the population living within 2 km of all-weather roads. After 2010, the government has launched a new Universal Rural Road Access sub-program to address the rural accessibility and connectivity in which about 854 km of Woreda roads has been constructed(ERA,2011). Map (1) shows the road accessibility of the country up to 2006.

Map 1 : Road Accessibility in Ethiopia (2006)



Source: Ethiopian Roads Authority

The road network in Ethiopia has shown improvement since 1997. However, as depicted on Map 1 there are places which have low access to all weather roads which are represented in brown colors. As shown on the map road access declines especially as one move to the outskirts in the north and north eastern regions in the country. Most regions around central part of the country have better road access. In poor road access areas households may travel more than 10 kilometers to get all-weather roads. The largest share of total road network is found in Southern part of the country, especially SNNPR followed by Oromiya region

Oromiya is the largest region located at the center nearby the capital city where road accessibility has significantly improved and majority of households in this region live within 2 to

5kilometers from all-weather roads. However, most places in other regions especially in the rural areas have still low road accesses and poor connectivity to major road networks.[5]

Currently Ethiopia has reached at the road density of 49.09 km per thousand square km which falls far behind the average road density of lower middle income countries which is about 0.3 km/sq.km (IRF, 2006). Therefore, it needs further attention by the government and international donors to enhance the road infrastructure in the country

2.3 Road Placement Decision

Government's decision to assign roads in different regions is not random but it depends on a set of criteria to bring balanced economic development all over the country. The federal and regional authorities have established a list of decision criteria to construct new roads and to upgrade and maintain the existing ones.

Ethiopian Roads Authority applies five main criteria for the preliminary selection of new roads projects. Every new road project is approved based on these set of criteria and each criteria carries respective weight. The first criterion to construct a new road is creating access to areas with high economic development potential such as agriculture potential. The second criterion is providing roads access to surplus food and cash crop production places to ensure food self-sufficiency in the country. The third condition is to build roads which link existing major roads with each other and the fourth criteria is to create accessibility by providing roads to large and isolated population centers. The fifth criterion focuses on constructing roads for establishment of economic equity by focusing on emerging regions.

Similarly, the federal authority has followed other set of criteria to prioritize the selection of upgrading and maintenance projects. Road projects which are primarily selected for maintenance are: high traffic volume roads, roads that create better connectivity, roads in poor condition, roads that link import /export corridors and link roads which give access to economic potential and resource abundant areas.

Road construction decisions are made primarily by the federal government but regional authorities have also their respective mandates to construct and maintain rural roads. Therefore, the road placement decision is undertaken by both authorities by prioritizing based on the selection criteria and available budget. Community roads are constructed by mobilizing rural households under the authority of rural administrations. In this case, allocation of federal and link roads as well as rural roads do not directly involve the choices of individual households although rural households participate in community roads. Hence, we consider access to roads as exogenous for individual households because it is not a choice variable for particular households. However, roads are endogenous to the selection criteria set by the federal and regional government and hence it is crucial to control for these effects to get unbiased estimation on impact of roads.

[5] The road network in Ethiopia has shown remarkable increase, however the regional distribution of the road remains similar as it was in 2006. Annex-.II shows the regional distribution of the road network in Ethiopia in 2011.

Chapter 3
Literature Review

'Physical isolation is a strong contributor to poverty. Populations without reliable access to social and economic services are poorer than those with reliable access.' (World Bank, 2006)

In addition to the more direct inputs to the production process such as human capital, physical capital and intermediate inputs, road infrastructure plays a crucial role for economic growth .Road creates favorable condition for resource mobilization and efficient allocation of resources through better connection of centers of demand and production.

There are different perspectives and theories on the importance of infrastructure for economic growth. The Keynesian economists asserted that public expenditure on infrastructure can generate demand and facilitate production in the economy. In contrast, neo-classical economists are supply driven and in their theory of endogenous growth infrastructure can be one of the inputs in the production function (Button, 1998; Aschauer, 1989). Regarding Public capital road investment is the main intermediary input for production in the country.

3.1 Impact of roads on Poverty and Consumption

Better access to roads could have a considerable role on economic growth in the country especially for countries which have very low initial road density and even more so for the land locked countries like Ethiopia. A number of studies have looked at the impact of road on economic growth. A recent study by Worku (2011) analyzed the impact of roads sector development on economic growth in Ethiopia. The study used time series data on the country's road network and GDP growth over the period 1971-2009. The author use total road network per worker and he also tests the significance of paved and gravel roads independently. Results from a two-step GMM estimator show that paved roads have positive and significant impact on economic growth while gravel roads do not. Although he finds a positive impact of road on overall GDP, it does not show the variation in road access in different parts of the country and how this might affect economic performance at lower levels of administrative units. It would be interesting to find out, as we try to do in this paper, whether investment on road infrastructure has contributed to poverty reduction in rural Ethiopia where about 80% of the population resides.

Recognizing the fact agriculture is the source of the rural poor, increasing their access to market, technology and agricultural inputs is vital to alleviate rural poverty. A study by Renkow et al.(2004) shows that physical remoteness brings economic isolation and this increases fixed transaction cost incurred by farm households in Kenya. They use maximum likelihood model to estimate how transaction costs and market participation is responsive to rural infrastructure. Therefore, they underline public infrastructure facilitate market integration and minimize the transaction cost. A major limitation of Renkow et al. (2004) is that they do not have a direct measurement of the road accessibility of rural villages. They rather classify villages into those that are served by trucks and those served by non-motorized vehicles. Their finding that remoteness increases fixed transaction costs is only significant for villages served by trucks.

Dercon et al. (2009) use panel data from fifteen rural villages in Ethiopia and examine the impact of agricultural extension program and roads access on poverty and consumption growth.

The study finds based on GMM estimation that access to all-weather roads reduces poverty by 6.9% and it increases average consumption growth by 16.3% after controlling for regional fixed-effects and seasonal shocks. While this is interesting, the authors use a very crude measure of road access, basically a dummy variable indicating whether the household has access to all-weather road to the nearest town. This road accessibility measure does not capture the actual change in roads through upgrading, maintenance and construction of new roads. While we use the same data source as Dercon et al. (2009), our paper uses a relatively better indicator of road access which varies over time.

Similarly, a study by Jalan and Ravallion (2002) has found robust results on geographic poverty trap of rural households using longitudinal data from 1985-90 on 5600 farm households in rural China. They hypothesize that consumption growth is a function of a household's own capital and geographic capital. The study takes road density per ten thousand population as one of the geographic variables which affect the productivity of private capital. Using GMM estimation, the authors find that roads have positive and significant impacts on consumption growth in China. In addition the study emphasizes consumption growth needs road density level to exceed 6.5Km per 10,000 population.

Khandker and Koolwal(2011) examines the impact of rural roads in the long run by using household level panel data from Bangladesh between 1997and 2005. They estimate the benefit of road projects on consumption expenditure before and after the project in control and treatment villages. Results from GMM estimation show positive and significant outcomes of roads on per capita expenditure in the short-run especially for extremely poor households. However, in the long-run large benefit will be accrued to higher-income groups due to the increasing rate of return to rural investments and expansion of non-farm employments. They also identified the initial difference in the households' characteristics and quality of roads determines the long-run impact of the roads.

Other studies by Mu and Dominique(2007); Khandker et al(2006); Stifel et al(2012) and Wondemu and John(2010) are also found significant impact of roads on poverty reduction and economic growth using impact evaluation techniques and panel data estimation by taking specific road projects.

3.2 Channels of Road Access Impacts

Road is one of prominent inputs for production process. Few scholarly contributions have been made to emphasize the mechanisms through which the benefits from road access are realized. Understanding channels through which road access reduces poverty and bring economic growth is essential for policy makers and development practitioners. There are various channels through which roads benefit rural households. The effect of roads on poverty and economic growth is transmitted through reducing transportation cost, improving the connectivity of rural households to different markets and urban centers. Farm households who have poor road access are likely to sell their outputs at lower price at the farm gate. In addition, roads empower farmers by giving them access to better technologies, lower input costs, higher output prices and off-farm employment opportunities (Binswanger et al, 1993; Decron et al, 2009). In addition, roads contribute to consumption smoothing during shock periods and also plays important role on income distribution. However, none of these studies provide empirical evidence on the

proposed mechanisms through which road affects rural welfare. The current research paper contributes by providing some insight on these channels using Ethiopian data.

Another perspective by Biehl (1991) indicates that productivity and wage of a region increases with the proportion of infrastructure endowment. The argument is that regions with advanced infrastructure such as road network could have better regional integration and factor mobilization leading to productivity and economic growth (World Bank, 1994; World Bank, 2009). Empirical study by OECD (Égert, B, 2009) shows the contribution of infrastructure including road to the long-run productivity and income growth is more significant compared to investment on other capital.

A study by Fan and Chan-Kang (2005) exhibited rapid development of express ways and especially low standard feeder roads contribute to poverty reduction and economic growth in China. The study shows how investment on roads increase agricultural productivity and improve non-farm employment and this can also lower food prices which are very important for poor households in particular. Similar studies on China by Fan et al. (2002) indicated that government spending on productivity improving investments such as research and development (R&D); education, irrigation and basic infrastructures such as roads, electricity and telecommunications have high contributions to increase agricultural productivity and poverty reduction. Among these, investment on roads has biggest return in non-farm economy by increasing employment opportunity and rural wages. They assert that impact of road on poverty reduction is channeled mainly through non-farm employment.

Another perspective is that road can benefit rural households by enhancing the value of their asset. A study by Jacoby (2000) examined the distributional effects of rural roads in Nepal and estimates the outcomes of low transportation cost. He argued that road access decreases transport cost which in turn increases non-farm wages and land values. The study also tries to examine the distribution of road benefit across different income groups in Nepal and found much of rural benefit accrues to the poor households but the extent is not large enough to reduce the income inequality. It is difficult to explore this channel of transmission in countries like Ethiopia where there is no land market.

3.3 Theoretical Framework

Based on the literatures we have discussed in previous sections, the paper tries to examine the impacts of roads on rural poverty and consumption growth at the micro-level. This empirical work in this research is established from basic poverty and consumption theoretical arguments reviewed above. Our study hypothesize that poverty incidence of a household can be determined by household and individual characteristics, community and regional level characteristics as well as road infrastructure. Here, the paper argues that the probability of households to fall below the poverty line is determined not only by their asset or capital variation but also by the connectivity of the geographic location in which they hold their factors of production.

Most poverty analysts do not evaluate the mechanisms by which accesses to public infrastructures affect households' welfare. Access to basic services such as health care, credit, input and output markets and technology is a major determinant of rural well-being. Most importantly, access to roads and transport services have vital role in facilitating the provision of these basic services even to physically isolated households.

Furthermore, the provision of road infrastructure creates traffic movements of road users. There are three major types of traffics which emerge due to improvements of road network. These traffics are first, a normal traffic which is traffic by already existing users before construction or upgrading of roads. Second, generated traffic can appear because of the decrease in vehicle operating costs and travel time following better road accesses. Therefore, previous road users increase their frequency of trips over the road. In addition, improved road access brings emergence of new industries and economic activities along the road corridors. Consequently induced traffics occur in relation to new economic activities. Third, road users can switch roads in search of shortest and better links to reduce their vehicle operating costs and save travel time. Hence, in relation to the increase in the traffic flows households will have higher consumption expenditure. The increase in road access enhances the provision of economic opportunities and accessibility of goods and services to the households. In this circumstance, roads play critical role to increase consumption of goods and services.

Consumption expenditure pattern is mainly determined by permanent income structure of the household. However, households' consumption may fluctuate due to transitory shocks and economic strikes. Households have different risk coping mechanisms like borrowing, savings or resource pooling to adjust their consumption during shock periods. However, these smoothing mechanisms can be effectual in the provision of public infrastructure which enhance households' communication and stable social bondages. Road is one major public infrastructure that develops socio-economic relationship of the rural community by expediting social interactions such as market, community resource pooling and labor sharing activities.

Furthermore, it is the fact that majority of rural farm households are producer as well as consumer. But, agricultural productions are exposed to various challenges such as seasonal fluctuations, shocks, imperfect and or missing market especially for land, labor, credit and insurances. The Farm household in Ethiopia is typical model whose production maximization encountered with the adverse situations. The separability assumption of household's consumption and production decision is difficult to attain in the places where there is lack of access[6]. Hence, any production maximization of the households attached with consumption decisions. However, the extent of substitution is determined by the elasticity of which household's response to policy interventions taken by the government (Singh et al., 1986).

Therefore, government investment on rural road infrastructure creates favorable condition to achieve household production maximization objective by reducing production and consumption costs and availing them competitive market condition.. Specifically in a situation where there is limited market for land and labor, access to productivity enhancing inputs are strictly necessary to enable households to achieve economic growth and skip from poverty trap.

Most of previous studies exhibited that roads have a positive and significant impact on consumption growth and poverty. However, it is not clear whose consumption has been growing faster. In fact it is plausible to imagine roads to increase consumption growth in general but not necessarily that of the poor. The objective of this paper is to examine the impacts of roads on poverty and consumption growth especially for poor rural households. This paper is unique in the various matters. Unlike most other papers we use a direct measurement of road access that varies over time by using Geographic Information System (GIS). In addition, our study tries to evaluate factors that affect road placement decisions while most studies did not. This is important

[6] The household model is briefly discussed by de Janvry et al.(1991)

because the road access could be correlated with overall economic potential of specific geographic locations. Furthermore, the study discuss cross cutting issues on how road facilitate pro-poor growth. Such a detailed analysis of road accessibility and its effects on poverty and consumption would contribute to the academic literature and policy discussion on the role of infrastructure.

Chapter 4
Data and Descriptive Analysis

This study is based on two major data sources. Data on household consumption and poverty status as well as household characteristics are obtained from the Ethiopian Rural Household Survey (ERHS) from 1994-2004. This is a panel data collected by Oxford University in collaboration with Addis Ababa University. The other dataset is on road access which is obtained from the Ethiopian Roads Authority. It provides information on federal and regional roads based on which a road density indicator is constructed at the Woreda level using GIS analytical tools.

4.1 ERHS Sampling Method

The ERHS is a unique longitudinal data which covers 1477 households selected from nine rural communities/villages. The survey has been done on 15 peasant associations[7] and random sampling is applied to select households in each village. In order to stratify the representativeness of the sample, farming system were used rather than administrative boundaries and hence this can be related with agro-ecological zones in the country. The sample Peasant Associations (PAs) are selected from four regions and 15 Woredas in Ethiopia. The sample is self-weighting and each individual represents the same number of persons from the main farming systems. The sample data could not be nationally representative but it can generally represent non-pastoralist farm households in the country since large samples are taken from each village (Dercon and Krishnan, 1998). Hence, the analysis results could be interpreted with due attention to sampling proportion and the data limitation. Table 2 summarizes the sampling framework in ERHS.

Table 2 : Sampling Frame of Ethiopian Rural Household Survey

Agro ecological zone	Population share in 1994 (%)*	Sampling share in 1994 (%)
Grain-plough complex Highlands		
North Highlands	21.2	20.2
Central Highlands	27.7	29
Grain-plough /hoe complex		
Arsi/Bale	9.3	14.3
Sorghum Plough/hoe Harrarghe	9.9	6.6
Enset Growing places(with or without coffee/ cereals)	31.9	29.9
Total	100	100

Source: ERHS (2009), * CSA population estimates
Note: * rural pastoralist population is about 10% of rural population

Ethiopia is divided in to nine ethnic base administrative regions and five agro-ecological zones. Our study based on fifteen villages from three main agro-ecological zones of the country which are Dega, Woyna Dega and Kolla. The villages are located in Tigray, Amhara, Oromiya and SNNP region but most peasant associations' settlements are initially based on agro-ecological setups and hence, it could be erroneous to make generalization about characteristics of the

[7] The peasant associations and villages are interchangeably used in the literature.

regional administrative provinces. Table 3 depicts characteristics of the peasant associations in our sample.

Table3 : Sample villages of Ethiopian Rural Household Survey

Region	Woreda	Survey villages	No. of households	Mean Rainfall(mm)	Description
Tigray	Atsbi	Haresaw	800	558	Poor and Drought prone area
	Sebhassasi	Geblen	2150	504	Poor and Drought prone area
Amhara	Ankober	Dinki	138	1664	Affected by 1984/85 famine and poor accessibility to the village
	Enemay	Yetemen		1241	Highland , cereal producer and surplus area
	Bugena	Shumsha	800	654	Poor area near to Lalibela
	Basso na warana	Debre Berhan	250	919	Highland place near town
Oromiya	Adda	Sirbana Godeti	900	672	Agriculturally rich area and food surplus area
	Kersa	Adele Keke	245	748	Highland area and food sufficient place but affected by drought in 1985/86
	Dodota	Korodegaga	450	874	Poor cropping place
	Shashemene	Turufe Kechemane	790	812	Rich cereal highland place
SNNPR	Cheha	Imdibir	842	2205	Densely populated and enset producers
	Kedida Gamela	Aze Deboa	1000	1509	Densely populated and high seasonal migration
	Bule	Adado	1900	1245	Densely populated but rich area
	Boloso	Gara Godo	200	1150	Enset producers and affected by famine in 1983/84
	Daramalo	Doma	450	919	Resettlement and remote place

Source: Community survey ERHS, Bevan and Pankhurst (1996a) and Dercon et al (2008).

Each village in table 3 shows distinct socio-economic characteristics which could influence at large the incidence of poverty over time. Peasant Associations in Tigray region like Atsebe Wemberta and Saesi Tsaedaemba are vulnerable to drought while villages from SNNPR are densely populated. For instance, Do'oma is one of the sample villages which is densely populated and affected by shortage of rainfall. This village is a resettlement place and there is high competition of land acquisition and the land resource is mostly restricted to men only (Bevan and Pankhurst, 1996b). Hence, due to these and repeated natural shocks these villages have relatively high proportion of poor than others.

Table 4 provides statistical summary of variables which we use to estimate poverty and consumption growth in fifteen rural villages.

Table4 : Statistical Summary of Variables

Variable	Observation	Mean	Standard Deviation
Distance to the nearest town(Km)	7517	11.73	6.02
Road density/1000sq.km	7917	86.32	47.27
Agriculture potential(dummy)	7917	0.61	0.49
Poor	7104	0.41	0.49
Real per capita consumption	7913	83.07	81.21
Age of household head	7167	48.51	15.85
Sex of household head	7012	0.76	0.43
Household size	7175	5.83	2.83
Asset(cost of household goods)	7108	339.61	4314.74
Land holding(hectare)	6979	1.42	1.53
Livestock unit	7130	2.69	3.21
off farm participation(dummy)	7278	0.4	0.49
Fertilizer use(kilogram)	5653	43.03	78.5

Source: ERHS (1994-2004)

The data on the table 4 shows there are rural towns around the sample villages and households in these villages could travel more than 12 kilometers to reach to these towns in search of market for farm inputs, other goods and services. The road density in these villages is about 12 km per 1000 sq. km so that they may need to walk more than 5 km to get road access. About 41% of the sample is poor households and the average per capita consumption of these households is 83 Birr per month. Majority of the sample is male headed households and they are accounted to 76%. Large household size is the typical characteristics of these villages. The study is mainly based on farm households and about 61% of the places are agriculture potential areas. Households in these villages have large variation in asset ownership and most of these households have small household goods. Land is important production asset of these households and a household could have a plot about one hectare while they have small number of livestock. In addition to own land cultivation households are engaged in off-farm activities and 40% of these households participate in off-farm activities. However, 89% the off-farm employments are farming on other person's plot by payment in cash or labor sharing agreement. The variables of interest are analyzed in detail in the following sub-sections.

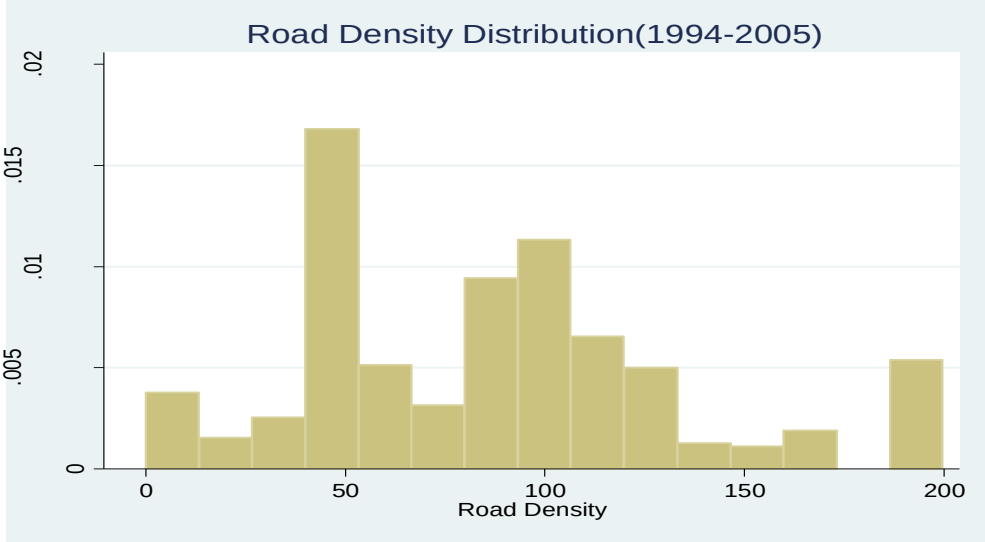
4.2 Road Access (1994-2004)

The main focus of this research is to examine and estimate the impact of rural access on households' poverty and consumption expenditure. Rural accessibility is measured by different mechanisms. According to Roberts et al. (2006) a common approach to evaluate the rural access is taking proportion of people living within 2km of all- weather roads. However, it is difficult to find road data at lower administrative level to implement this approach to show the rural access index in the sample villages. For that reason, we use road density to measure rural accessibility by taking length of roads per thousand square kilometer by assuming any increase in the road density

per 1000 sq. km increases the proportion of area within 2 km of all-weather roads. The road data is taken from four rounds starting from 1994 to 2004 and it includes seasonal and all weather regional and federal roads.

An alternative approach to see the importance of road access is analyzing households' physical isolation form basic socio-economic services Access to market and towns are relevant to rural households to get market and modern inputs for agricultural production. This paper examine the importance of road infrastructure for physically isolated households and its impact on their input utilization More than 90% of the sample villages have relationships with the nearest town apart from their own village in search of market, agricultural inputs and non-farm employments. Hence, distance to these towns has major impact on the economic performance of the rural households. According to the ERHS community survey in 1997 about 60% of the respondent community got improved access to towns due to provision of better roads since 1992. Of these respondents about 66% reported this improvement is due to better road access along with improved transportation while 33% said it is due to better road access. Figure 2 shows the road distribution among the survey area.

Figure 2 : Road Density Distribution Chart (1994-2004)



Source: ERA road data

Roads are expensive projects and it can take long period to construct a road. Even after completion of a road project, its impact may take long period to emerge (Kingombe, 2011). Hence, our analysis period in this study is too short to see a gigantic change in the road density and on its impact. The change in the road density over the study period was very slow particularly in some Woredas and changes are observed in places where road constructions have been done during the last period. Figure 2 shows the road density change during the study period has left skewed distribution and this shows most of Woreda has road density between 50 and 100 per 1000 sq.km while there are few places which have shown increases up to 150 per 1000 sq.km and more. The road density in the survey Woredas is displayed in appendix III. Roads placements among these Woredas are diversified based on the government resource and primary objective. In fact, some places may have higher road density due to small administrative area while some others might be prioritized based on government road placement criteria.

4.3 Poverty in Rural Ethiopia: Fifteen Villages Assessment

4.1.1 Poverty scenario in Sample Villages

The data shows the poverty line is 50 Ethiopian Birr per capita per month (Dercon and Krishnan, 1998). Identical baskets of goods are taken to compute the poverty line over time. We use this poverty line to measure the percentage of households who are poor.

Table 5 summarizes the poverty indicators in sample villages. According to the ERHS about 35% of the rural population is poor in 2004. . This represents about a 10 percentage points drop in the incidence of poverty from its level in 1994[8]. It also shows the impact of negative shocks on poverty as indicated by the spike in poverty after the 1995 drought. The table also shows a significant decline in the poverty gap and modest change in the severity of poverty.

Table5 : Poverty Index in Sample villages

Year 1994-2006	Head Count Index	Poverty Gap Index	Poverty Severity Index
1994	45.1	17.1	8.6
1995	52.4	22.6	12.8
1997	32.9	11.7	5.7
1999	35.5	12.7	6.3
2004	35.6	13.1	6.7

Source: Author's calculation using ERHS

4.1.2 Rural Consumption Growth

The well-being of the poor could be measured in various ways, but the most common approach to show households welfare is consumption expenditure or income. Taking consumption expenditure is more comprehensive than income because households could have different source of income and hence they may forget the amount of money they earned but it is relatively easy for them to recall their daily consumption expenditures. In addition, households might be less forthcoming to disclose their income as they are for their consumption. As shown in previous section large proportion of the rural households is poor and consequently real per capita consumption expenditure of these households is quite low. According to ERHS (2009) the consumption expenditure comprised food and non-food monthly expenditures. It includes only direct consumables and foods purchased, gift or farmers own stock. However, expenditure on education, health and extraordinary contributions are excluded. Table 6 compares the consumption pattern of rural poor with the non-poor households over the study period.

[8] This decline in poverty in the survey villages could be representative for the poverty index in the country since 1994(see annex-I).

Table6 : Average monthly consumption of rural households (1994 -2004)

Real per capita consumption (Birr)							
Year	Poor		Non-Poor		Total		
	mean	Standard Deviation	mean	Standard Deviation	Mean	Standard Deviation	N
1994	31.0	10.8	111.4	72.6	75.9	68.8	1584.0
1995	28.1	12.1	108.2	101.1	67.0	79.5	1584.0
1997	32.3	10.9	122.4	133.3	93.0	114.2	1584.0
1999	32.0	11.0	122.5	86.3	89.8	81.7	1584.0
2004	31.4	11.6	126.2	101.0	91.8	91.9	1584.0
Total	30.7	11.4	119.0	102.1	83.5	89.2	7920.0

Source: ERHS

As shown in table 6 average per capita consumption has been increasing since 1994. However, this growth is mainly for the non-poor households. The increase in overall consumption shows non-linear pattern and this is probably due to transitory shocks or other time varying household and geographical variables such as road infrastructure which will be estimated by this research.

4.4 Data Limitations and Correction Mechanisms

There are several limitations the study encountered to use the ERHS data. The limitations on the data create some inconveniences to interpret some coefficients especially on consumption growth and productivity estimation results. However, this paper tries to solve some of the problems using different correction techniques according to the limited resource available. The estimation findings in this paper are robust and give relevant picture of the reality in rural households.

One of the complexities using ERHS data is the attrition of the household. The attrition rate from the first round up to round 6(2004) is about 13.2 percent which is about 1.3 percent per year. Attrition of households can depend on the village's characteristics. For instance, Do'oma is among the villages in the sample and the attrition of households in this village is probably because it is a resettlement village and hence some households in the sample might return back to their original villages (Dercon and Hoddinott, 2009; Bevan and Pankhurst, 1996b).

Based on the survey questionnaire we observe two approaches have been applied to replace the dropouts of households from the rural survey. The first one is replacing the dead and left household heads with new household heads from the same households. For instance, between 1994 and 1995 about 8 percent of replacement is due to change in household head due to death, illness or transfer of headship (Dercon and Krishnan, 1998) The second strategy that is applied in the survey is replacing the left or dismissed households by other new households. The first strategy might not affect the number of the households in the sample but it can change the household characteristic such as age and sex of the head. However, the later strategy can increase the number of households in the sample. In addition, both ways of substitution mechanisms, especially the second one may manipulate the poverty status of the household in the sample.

The second challenge encountered by the researcher is missing observations and variables. There are some variables which have large amount of missing observations such as education level and input uses. In addition, due to the inconsistency on the questionnaires used by each survey some variables are not clearly observable in some rounds. Households' consumption information is one of the variables which have several missing and unbalanced observations. For instance, in 1994 the consumption data is collected from 363 households due to difficulties on the survey condition and of these data on both food and non-food consumption is collected for only 213 households.

Even the non-missing observations for example age is inconsistent along with the survey period and household relationship status. Hence, the data on these variables are not simply taken but some corrections have been made by the researcher. The expedient measure taken to overcome the discrepancy of age variable is by adding the survey year difference on the initial age of the household head at the base year (1994) for those who continued since first round. Moreover, household heads whose ages are below 15 are very unrealistic which might indicate erroneous measurements or data entry. Therefore, the analysis excludes these observations form the regression.

Third concern which could affect the result in this research is unevenness of survey period. The survey has been conducted at different cycles and the gaps between consecutive rounds are unbalanced. This can create gaps to perform consumption growth estimation and the regression could take these gaps as missing values. Therefore, the estimation result especially consumption growth estimation should be taken with this gaps and missing information.

Moreover, our analysis would be more refined if the road data we use were at the village level. There are some challenges we encounter to use village level data. The road network in the country is mainly collected and documented by Ethiopian Roads Authority. Regional roads have their own records and report to the federal authority annually. However, since we cannot find data at the village level we construct road density at the Woreda level using Geographical Information System (GIS). The study takes roads constructed before 2004 and clips each road length by the individual Woreda and calculates the total length of roads per thousand square kilometer area. The analysis excludes community roads, other unclassified trails because there is no clear record for the length and construction period of these roads.

Chapter 5
Impact of Roads on Poverty and Consumption Growth

5.1 Road Access and Vulnerability to Poverty

This chapter analyzes the impact of public investment on roads on the likelihood of poverty and real consumption growth. The majority of rural households are vulnerable to poverty due to limited access to transport, health, education and other socio economic services. It can be argued that the lack of road access undermines provision of these basic services and their efficient utilization by rural communities.

Rural poverty declined during the study period. Nevertheless, some households could fall back into poverty if they are not well connected in economic and social networks. The vulnerability of these households is highly determined by their geographic characteristics apart from their productive asset and individual characteristics. In order to see the vulnerability of households to poverty in relation to road access, villages are grouped into three categories as shown in Table 7.

Table7: Road Access and Poverty Transition (1995-2004)

Woreda Road density/ 1000 Sq.Km	Initial status	Transition Status		
		Poor	Non-Poor	N
<50	poor	0.57	0.43	327
	Non-Poor	0.24	0.76	427
	Total	**0.38**	**0.62**	**754**
50-100	poor	0.59	0.41	1192
	Non-Poor	0.38	0.62	1114
	Total	**0.49**	**0.51**	**2306**
>100	poor	0.52	0.48	701
	Non-Poor	0.22	0.78	1353
	Total	**0.32**	**0.68**	**2054**

Source: Author's own assessment from ERHS
Note: Transition probabilities add to 1 (100%) row wise.

Table 7 shows that 52 percent of poor households in areas with relatively high road density (>100) will remain poor in the next survey round which is well below the 59 and 57 percent among households living in villages with less 100km road density. In other words, about 48 percent of households with better road access will become non-poor in the next round while only 43 and 41% of households will become non-poor in the villages with lower road density. The table therefore provides preliminary evidence that poverty tends to be more persistent for households in low road access although the gain in poverty reduction is not monotonic.

5.2 Impact of Road on Consumption Growth

Based on the data in chapter three, we have seen how households' consumption pattern changes over time. Here the paper identifies the relationship between consumption and road infrastructure growth. Consumption of rural households is basically depends on observable household characteristics such as age, sex and household size. In addition, consumption can be affected by household's own capital or wealth and other unobservable heterogeneous

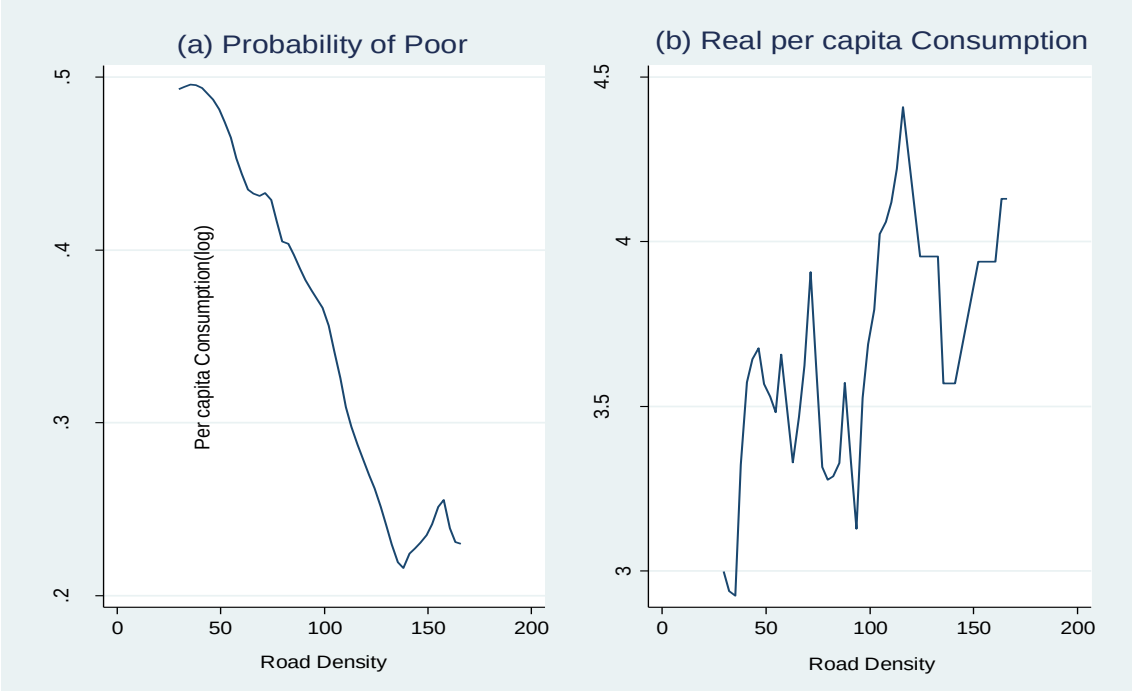
characteristics of the rural households. However, provision of public facilities such as roads is important to facilitate production and consumption processes.

The data shows road and the consumption expenditure of rural households is associated. Households in better access villages have larger consumption expenditure than households in poor road access areas. However, this consumption variation is highly visible among the non-poor households. Non-poor households who have better road access have average consumption 5 % higher than those with very small access. Nevertheless, poor households with higher road access have average consumption 3% larger than poor with little access. From this we can understand that better road access could increase consumption expenditure but it creates further question about who is benefiting more form road.

5.3 Non-Parametric Estimation

We have been argued that roads could play important role to improve welfare of the rural households. We can show the correlation between road and poverty using non-parametric estimation technique. This technique helps to simply visualize rural poverty at different levels of road access. The Kernel density regression is applied using the Nadaraya-Watson nonparametric regression technique[9]. The non-parametric regression line connects the conditional mean of poverty at different points in the distribution of road density (Chambers et al., 1983). Figure 3 displays the kernel regression of poverty, consumption and road density.

Figure 3 : Non-parametric Regression of Poverty and Consumption on Road Density



Source: Author's calculation from ERHS, ERA

[9] We are using the Epanechnikov kernel density function.

From figure 3, panel (a) we can observe the proportion of poor households is inversely related with road access. The poverty incidence declines as the road density increases. Hence, we understand that households who lives in more road accessible areas are less likely to be poor compared to households with low road access. Panel (b) of Figure 3 shows that average per capita consumption rises with road density. Hence, we argue that consumption of households has a positive relationship with their access to road infrastructure. In fact the consumption trend is not monotonic probably because of different factors which affect households' consumption such as shocks. However, the overall average consumption moves upward as the road density increases.

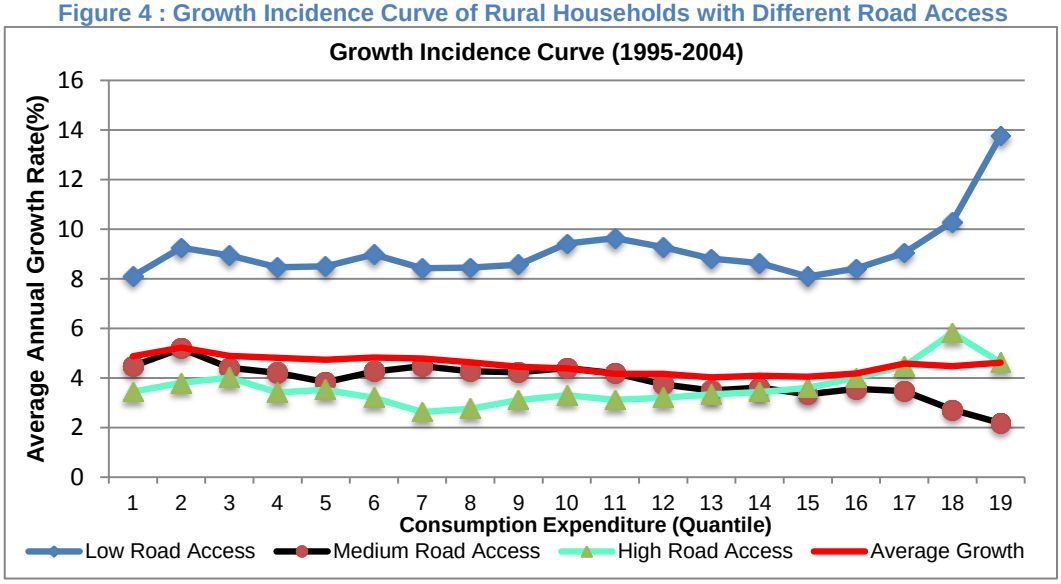
Regardless of other determinants, the graphs simply show the non-linear association of the increase road density and poverty and consumption. The impact of road on poverty and consumption growth is econometrically estimated in chapter seven by controlling for possible variables which affects the likelihood of poverty and consumption growth.

5.4 Is road part of pro-poor growth process?

So far our data shows that the relationship between road access and poverty and consumption growth is as expected. Identifying the role of roads in poverty reduction and pro-poor growth is critical for policy makers and transport strategist in developing countries. We now want to assess whether road infrastructures facilitates pro-poor growth or are the non-poor benefiting more from road projects.

To assess the growth pattern, we classify the study villages into low, medium and high road accesses. Accordingly, households are also categorized based on their consumption quintile. We then calculate the Growth Incidence Curve as per Ravallion and Chen (2003). This method essentially allows us to compare the growth in consumption at different percentiles. Growth is deemed to be pro-poor if consumption growth at the lower percentiles (including the poor) has been higher than growth in consumption at the upper percentiles. Figure 4 shows the growth incidence curve for rural Ethiopia using annual consumption growth in 2004 relative to 1995.

Figure 4 : Growth Incidence Curve of Rural Households with Different Road Access



Source: Author's calculation from ERHS and ERA road data

Figure 4 suggests that the growth process in rural Ethiopia was pro-poor since 1995-2004 especially for the bottom 40% of rural households. This pro-poor tendency is revealed mainly for households with medium and high road accesses, the pro-poor nature of growth being clearer in areas with medium road access. On other hand, households with low road access have also experienced higher annual growth in consumption but the rate of growth is clearly higher among richer quintiles than the poor ones. This could be the similar evidence with that Khandker and Koolwal(2011) found from Bangladesh.

In general, based on the data and qualitative analysis it is plausible to deduce road access has tendency to nurture a pro-poor growth process in the rural Ethiopia. However, this paper is confined to analyze the impact of road on poverty and consumption growth in depth and it tries to identify some of the mechanisms with the support of empirical evidences.

Chapter 6
Model Specification and Empirical Strategy

6.1 Model Specification

Based on the theoretical set up in chapter two this chapter outlines the specification of the empirical model to estimate the impact of roads on poverty and consumption growth. This also paves the way for further investigation on the mechanisms through which the impacts of road are realized.

First, the paper estimates the impact of roads on the incidence of poverty with a binomial probability model. Hence the likelihood of households to be poor can be estimated as:

$$\mathbf{Pr}(\boldsymbol{Y_{it}} = \mathbf{1}|\boldsymbol{X}) = \boldsymbol{\beta'X_{it}} \qquad \boldsymbol{Eq(1)}$$

Where Y_{it} is a dummy variable that takes the value 1 if the household is poor and zero if non-poor. X_{it} refers to a vector of household and location specific variables which determine a households' probability of being in poverty. The assumption is that we observe the outcome variable Y_{it} if an underlying latent variable y_i^* is above a certain threshold. This latent variable is assumed to be a linear function of X_{it}:

$$Y_i = \begin{cases} 1 \; if \; y_i^* > 0, \\ 0 \; if \; y_i^* \leq 0 \end{cases} \quad \text{Where;}$$

$$\boldsymbol{y_{it}^* = \beta_o + \beta_1 hhchx_{it} + \beta_2 asset_{it} + \beta_4 road_{it} + \beta_5 popn_{it} + \beta_5 shock_{it} + \beta_5 geochx_i + \varepsilon_{it}} \qquad \boldsymbol{Eq(2)}$$

A household's likelihood of poverty is determined by household characteristics ($hhchx_{it}$) such as age and sex; household size ($hhsize_{it}$); asset ($asset_{it}$) such as land, livestock and other household assets. Poverty outcome is also driven by aggregate factors such as road density ($road_{it}$); Woreda population ($popn_{it}$); incidence of negative shock; and other unobserved individual and geographic characteristics ($geochx$). Most poverty determining factors in the model specification are slow to adjust and some of them are fixed in their characteristic. Using fixed-effect estimation would difference out time invariant variables and capture only variation within a household over time. This approach does not allow us to estimate the coefficients of time invariant variables although it may reduce the endogeneity of some covariates including roads. But we argue that individual rural households are too small to influence government's decision on the allocation of roads. That means roads are exogenous at the household level. However, road allocation is not exogenous to Woreda fixed effects such as population and agricultural potential and other unobserved effects. Accordingly, our strategy is to use random-effect logit estimation technique to estimate the road impact across households over time.

The random effects logit model would allow us to estimate if road access increases significantly the proportion of households who cross over the threshold poverty line. However, we also want to know how access to roads affect household's exact level of welfare. For the latter we use real per capita consumption growth as our dependent variable. In chapter four, we have shown preliminary evidence on the positive relationship between road access and consumption

expenditure. However, we want to show if this effect is statistically significant after controlling for the impacts of other determining factors.

The empirical model for the estimation of consumption growth is based on Euler model. Households' consumption pattern is like a random walk and expectation of future consumption is a function of current consumption (Chao, 2007). Hence, assuming two period and future expected consumption will be:

$$E_1 U'(c_2) = \left(\frac{1+\delta}{1+r}\right) u'(c_1) \quad (1)$$

Where, δ is subjective time preference; r is constant interest rate and $\mathrm{E_1}$ is conditional expectation at a time $\mathrm{t} = 1$. Assuming a quadratic consumption utility function and $\delta = \mathrm{r}$ equation (1) will be:

$$E_1 U'(c_2) = u'(c_1) \quad (2)$$

Adjusting equation (2) applying rule of expectation and generalize will yield:

$$c_{it} = c_{it-1} + \omega_{it} \quad (3)$$

Where, $\mathrm{c_t}$ is consumption at time t, $\mathrm{c_{t-1}}$ is one period lagged consumption and some random difference ω_{it}. However, ω_{it} is not pure random but composed of individual fixed-effects ($\mathrm{u_i}$) and some random error term which is individually and independently distributed (i.i.d). Hence,

$$c_{it} = c_{it-1} + (u_i + \varepsilon_{it}) \quad (4)$$

The time variant individual difference in consumption can be a function of individual characteristics (age), demographic characteristics, productive assets, wealth and other geographic variables (Jalan and Ravalion, 2002). However, the lagged period consumption in the right hand side of equation (3) is correlated to the error term (ω_{i}) through $\mathrm{u_i}$. If we use two period lag of the consumption on (3) hence, we will have

$$c_{it-1} = c_{it-2} + \omega_{it-1} \quad (5)$$

But, $\omega_{it-1} = (u_i + \varepsilon_{it-1})$

By subtracting equation (5) from (4) we will get:

$$\Delta c_{it} = \Delta c_{it-1} + \varepsilon_{it} - \varepsilon_{it-1} \quad (6)$$

Hence, the consumption growth is modeled as:

$$\Delta c_{it} = \Delta c_{it-1} + f(hhchx, asset\ or\ wealth,\ econ\_activity\ , road\ , shocks, regional\ chx) \quad (7)$$

Equation (7) indicates consumption growth of a household is determined by the difference in the lag consumptions and current consumption. However, the current consumption of the household is a function of household characteristics; household size; asset or wealth (i.e. land, livestock, and other household assets); economic activity (i.e. off-farm); road access; shocks; and other regional time variants.

Even if the fixed-effect is differenced out from the model the lagged difference on the right hand side becomes endogenous through c_{it-1} . However, to get unbiased estimator all the right hand side variables should be exogenous. We have already shown that the lagged dependent variable is not exogenous. However, in addition to the lagged consumption household asset and household size are probably endogenous to consumption growth because there could be third factor which increases both consumption and households' asset simultaneously. One solution to endogeneity problem in panel data estimation is to use internal instruments. For instance we can instrument (Δc_{it-1}) by the second lag of consumption (c_{it-2}).To use instrumental variables the basic requirement is that the instrumental variables should not be correlated with the error term of the equation. The method is proposed by Arellano and Bond (1991) and it can be shown that C_{it-2} is not correlated with $\varepsilon_{it} - \varepsilon_{it-1}$ in equation 6 and 7. Similar instruments can be used for the other endogenous variables. The idea is to use lagged levels as instruments for contemporaneous differences.

Accordingly, we use Arellano Bond (1991) Generalized Method of Moments (GMM) estimator since it uses instruments from already existing variables. For endogenous variables in the right hand side the estimator uses two periods lag variables as GMM-type instruments while other exogenous variables are taken as standard type instruments for the level and difference equations in the model. The estimator gives unbiased and efficient result on consumption growth and any enodogeniety which could be originated from village or household fixed-effects are differenced out by the two stage estimator.

6.2 Choice of Covariates

Choice of covariates in the model specification is based on the theoretical framework presented in chapter four. The paper mainly uses household level panel data, which includes five rounds of ERHS from 1994 to 2004. Based on the available data and literatures we have reviewed (Jalan and Ravallion, 2002; Decron et al, 2009; WBI, 2005), the paper selects relevant variables to estimate the impact of roads on poverty and consumption growth.

The models controls for household characteristics. For instance the age of the household head is important as it captures the knowledge and experience of the head. Gender of the household head would show us if there are disadvantages against female headed household heads. Consequently we need to control for the impacts of these variables on the likelihood of poverty and consumption expenditure[10]. Moreover, the assets possessions of the household such as land, livestock and other assets could its ability to increase productivity as well as the possibility to smooth consumption during adverse shocks.

However, the productivity of household asset could be determined by other location specific factors. Hence, we control for geographic characteristic such as distance to the nearest town, Woreda population, individual and village level shocks and unobserved heterogeneities of the villages in the poverty model.

While rural households mainly engage in farm activities they might want to support their main income through non-farm activities. Hence, to capture the effect of off-farm participation

[10] There are other several variables which might affect the likelihood of poverty for instance schooling. However, these variables are not included in the estimation because they have few observations and less variation over time. Therefore, the inclusion of these variables may not change the findings but reduce the observation very significantly

we include a dummy variable that takes the value one if the household is participating in off-farm activities.

After controlling for the above variables, the major focus of this paper is to show the effect of roads on poverty and consumption growth. Roads may have effects on reduction of poverty incidence however the extent of which road affects the wellbeing of households can be measured by its effect on the consumption growth. The impact of road on poverty might be significant but it is important to understand the significance of road on household expenditure needed to fulfill their minimum basic need.

Chapter 7
Results and Discussions

According to the model specified in chapter six, this section presents estimation results of impact of roads on poverty and consumption growth. We have also discussed that the impacts of road can be achieved through various channels and in this chapter we also assess empirically some of the mechanisms through which the impacts of roads are realized.

7.1 Effect of Roads access on Poverty

In the poverty model we specified, our outcome variable is a dummy variables which takes the value one if the household is poor and zero otherwise. The paper uses binomial logit model to estimate the impact of roads on poverty. Table 7 reports the results from panel logit estimation on the likelihood of poverty and the results are presented for two different specifications. Both specifications control for household characteristics, other regional and Woreda characteristics but only the second specification controls for the impact of shock variables on poverty.

The marginal effect reported in Table 7 shows that male headed households are less likely to be poor as compared to female headed households. In addition, we found household size has significant positive effect on the likelihood of poverty. As would be expected, the probability of poverty declines as the household's possession of assets and livestock increases. These results are consistent with findings from other previous studies.

However, even within similar household characteristics, the result suggests that road has negative and statistically significant effect on the likelihood of poverty. The result from the first specification shows that for each percent increase in the road density, the probability of household being poor declines by 29 percentage points on average.

The result suggest access to off-farm employment reduce the likelihood of poverty at 5 percent significant level. The relationship between the road access and off-farm employment is straight forward, road access widen business activities and off-farm employments because it decrease the cost for factor mobilization.

Furthermore, households' wellbeing could be threatened by transitory shocks on their asset, environment or economy. The estimation result shows none of the shock variables have significant impact on likelihood of poverty except drought. The explanation we might suggest for this result is first households could have risk coping strategies to minimize the effect. Access to road infrastructure could also offset the negative impact of shocks through providing other compensating economic opportunities. After controlling for the effects of shocks in the second specification, the impact of road on poverty remains unchanged with a small increase in the coefficient. Our estimation result exhibits one percent increases in the road density decreases the probability poverty by 30 percentage points and this result is robust and significant at one percent significant level. The magnitude of the road coefficients in this study is larger than similar studies found in Ethiopia. This is because our study use actual road density while others for example Dercon et al (2009) use dummy for the existence of all-weather road to the nearest town. Therefore the coefficients cannot be compared directly.

Table 8: Panel Logit Estimates of the Probability of Poverty (Random-effects)

Explanatory Variables	Poor (1)	Poor (2)
Household Characteristics		
Age of head	0.0005	0.0001
	(0.0004)	(0.0004)
Sex of head(Male=1)	-0.0500***	-0.0525***
	(0.0163)	(0.0184)
Household size	0.0568***	0.0580***
	(0.0026)	(0.0027)
Land holding	-0.0057	-0.0109
	(0.0068)	(0.0081)
Asset(log)	-0.0528***	-0.0507***
	(0.0054)	(0.0061)
Livestock unit(log)	-0.0905**	-0.0893***
	(0.0126)	(0.0125)
Road density(log)	-0.2869***	-0.2953***
	(0.0320)	(0.0371)
Off- farm participation(d)	-0.0314**	-0.0353**
	(0.0132)	(0.0138)
Woreda population(log)	-0.6358***	-0.6786***
	(0.0976)	(0.1123)
Time Dummies(1994-2004)	yes	yes
Woreda Fixed-effects	yes	yes
Shock Variables		
Drought(d)		0.0499**
		(0.0214)
Flood(d)		0.0373
		(0.0377)
Pest/crop disease (d)		-0.0130
		(0.0320)
Input price shock(d)		0.0018
		(0.0343)
Output price shock(d)		0.0279
		(0.0380)
Observations	6079	5354
Number of households	1538	1287
Log likelihood	-3227.0254	-2846.3246

Note: Coefficients are Marginal effects; Robust Standard errors in parentheses.
(d) for discrete change of dummy variable from 0 to 1
* Significant at 10 %, ** Significant at 5%, *** Significant at 1%

In general, our study found road access has significant effect on the likelihood of rural poverty and the results are unbiased with robust standard errors. We control for possible factors

that affect road placements and poverty in the regression. In addition, the sample is pure random so that it is unlikely to have endogeneity problem in the finding. First, we believe that there is no chance for individual households to put direct influence on the road placement decisions. Second, road placement decisions are taken by the federal or regional administration and hence our study controls for regional and Woreda effects. Third, one can argue that both households and road settlement may follow the economic potential areas however vast majority of the rural population in Ethiopia is bonded socially and culturally and hence it is too costly to households to relocate themselves to other community or peasant association in search of economic favor such as agricultural potential[11].

7.2 Effect of roads access on consumption growth

From previous section we have got common understanding about how access to road increases the chance of households crossing the poverty line. However, we are also interested to assess further the impact of road on households' well-being in general. Hence, this section shows the impact of roads on welfare though its impact on per capita consumption growth.

Based on the model specified in chapter six the paper estimates growth in per capita consumption using system GMM. The estimation results are reported in Table 8 with robust standard errors. In our model we have endogenous variables in the right hand side and the variables are correlated with unobserved variables that also affect the outcome variable simultaneously. Hence, the estimation technique we use controlled this endogeneity problem by using 57 instruments for the level and difference equations in the system model. These instrumental variables are valid instruments and uncorrelated with the error term in the right hand side. The Sargan overidentification test suggests not rejecting the null hypothesis of instrumental validity at p-value of 14 percent. Even though the instruments are not correlated with the error terms, there would be certain bias if the error term is autocorrelated which undermines the use of instruments. Therefore, we undertake Arellano-Bond autocorrelation test to support the instrumental validity of the regression. The test shows there is a first-order autocorrelation in the error term as would be expected but there is no second order correlation in the error terms .This evidence justifies the two period lag instruments we used in the system regression.

[11] We test if there is a strong correlation between households'' resettlement and road placements but we found no evidence support this argument.

Table 9 : GMM Estimates of per Capita Consumption Growth

Variables	Per capita Consumption Growth	Standard errors
Lagged dependent variable:		
Real consumption per capita(log)	0.000	0.024
Household characteristics:		
Sex of head(d)	0.103**	0.043
Age of head	-0.002	0.006
Age square of head	0.000	0.000
Household size	-0.106***	0.016
Land holding(log)	0.218***	0.036
Asset value(log)	0.001	0.019
Livestock(log)	0.015	0.013
Access variables:		
Road density (log)	0.130***	0.024
Off-farm participation(d)	0.037*	0.021
Time dummy(1994-2004)	yes	yes
Woreda population(log)	0.093**	0.039
Shock variables:		
Drought(d)	-0.081**	0.035
Flood(d)	-0.053	0.052
Pest and crop disease(d)	-0.087	0.053
Input price shock(d)	0.006	0.050
Output price shock(d)	0.021	0.064
Village average consumption(log)	0.551***	0.025
Constant	-2.080***	0.511
Observations	5864	
Number of households	1291	
Number of Instruments	57	
Sargan test(P-value)	45.251(0.1388)	
Arellano–Bond test:		
AR(1)(P-value)	-17.929 (0.0000)	
AR(2)(P-value)	-0.2229 (0.8237)	

Note: * Significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors
(d) for discrete change of dummy variable from 0 to 1

As shown in table 9, per capita consumption growth is mainly determined by household characteristics and access to roads and related opportunities. The result indicates road access has positive and significant impact on per capita consumption growth[12]. The estimation result indicates that a one percent increase in road density increases consumption growth by 13 percent which is significant at 1% significant level. Jalan and Ravallion(2002) found the effect of road density per ten thousand population on consumption growth is smaller than what it is found in

[12] The significant effect of road on consumption growth is similar even after we tried alternative specifications which do not include the lagged period consumption.

our study. Even though China has better road access than Ethiopia, the higher population density makes the road density per capita very small. Both studies suggest road has significant effect on rural households' consumption growth despite we cannot compare two measures directly.

Households are different in consumption level probably due to their variance in characteristics and asset holding. However, road access has also distinguished impact on consumption growth. The estimation result suggests household characteristics with significant impact on consumption growth are sex, household size and land holding. Consistent with previous estimation household size has negative and significant impact on consumption growth. In previous estimation we found no significant impact of land on poverty while it has significant effect on consumption growth.

In addition, the result shows that shock variables have no significant impact on consumption growth except drought. Drought can adversely affect household consumption growth and it is significant at 5%. The paper also examines the effects of roads to adjust the consumption growth during shocks. Households have various coping mechanisms to adjust their consumption during shock period. The paper does not capture these mechanisms directly but the coefficient of the village average consumption indicates there is a probability of risk pooling at the village level which could help to mitigate the effect of negative shocks. After controlling for the effects of shocks and possibility of households' coping mechanisms, we found the impact of roads on consumption growth is positive and significant. This is quite interesting because we also included time dummies to control the effect of overall growth in agricultural output in the country.

The poverty and consumption growth estimation exhibit the fact that road infrastructure is playing fundamental role not only to reduce the proportion of poor but to increases the overall consumption expenditure of rural households in Ethiopia. The estimation result confirm the magnitude of the road effect on consumption growth is substantial and even more than it is obtained from households own capital. The overall results show households own capital such as land, asset or livestock could improve their living standard. Nonetheless, household productivity of own capital is resolutely influenced by the externality created by public infrastructure such as roads.

7.3 Mechanisms of Road Impacts

From previous section, we recognized that the poverty status and consumption growth of rural households are responsive to variation in road access. However, it is not clear so far through which mechanisms road affects the welfare of the households. We have discussed about various channels through which road affects households' poverty and consumption expenditure. However, due to the confined access to data and resources, the paper tries to identify one of the channels through which the roads enhance productivity. We want to show a mechanism through which farm households improve their productivity with road infrastructure. The paper focuses on crop producers who produce mainly teff, wheat, sorghum and barley. The underlined assumption of our analysis is that rural farm households do not reach at optimal stage and hence every increase in input utilization will bring enhancement to total output.

Based on the assumption, first we want to test how the increases in production contribute to improve welfare to the household and then we explore how road access improves modern input utilization by farm households. Therefore, we take output per adult as a dependent variable to

measure productivity and total output is measured by using constant crop prices in 1994 which vary across peasant associations.

Farm households use various inputs to produce these crops however some households may not produce any of these outputs even if they have some of the inputs. Using OLS in this case leads to biased coefficients because it does not take into account the probability that some household may not produce any crop at a point in time. Hence, in order to show the impact of road access for all households who may or may not produce these crops we need to use the Tobit model. Table 10 displays the result from the Tobit model with bootstrapped standard errors.

Table 10 : Tobit Estimates of Crop Production per Person

Variables	Tobit Production per adult	Standard error
Inputs		
Land	0.2023***	0.0376
Land rent expenditure(log)	0.0439	0.0733
Labor highering expenditure(log)	0.0346	0.0348
Oxen owned by household	0.3506***	0.0668
Oxen rent expenditure(log)	0.0223	0.1000
Fertilizer expenditure(log)	0.1658***	0.0262
Pest expenditure(log)	0.0746	0.0488
Seed expenditure(log)	0.0454	0.0318
Road density(log)	1.2456***	0.2953
Shocks		
Drout	0.1530	0.1596
Flood	0.1802	0.2280
Input price shock	0.0425	0.3798
Pest or crop disease	0.2973	0.3996
Acro-climate		
Kolla(d)	-2.2964***	0.4209
W/Dega(d)	0.5749**	0.2523
Woreda fixed_effects(d)	***yes***	
Constant	-3.5860***	1.1361
sigma_u	0.0000	0.1765
sigma_e	2.2746***	0.0688
N	2144	
Number of Household	1121	
Log likelihood	-3638.7602	
Left-censored(0)	725	

Note: * Significant at 10%; ** significant at 5%; *** significant at 1%, Robust standard errors
(d) for discrete change of dummy variable from 0 to 1
Coefficients are not marginal effects

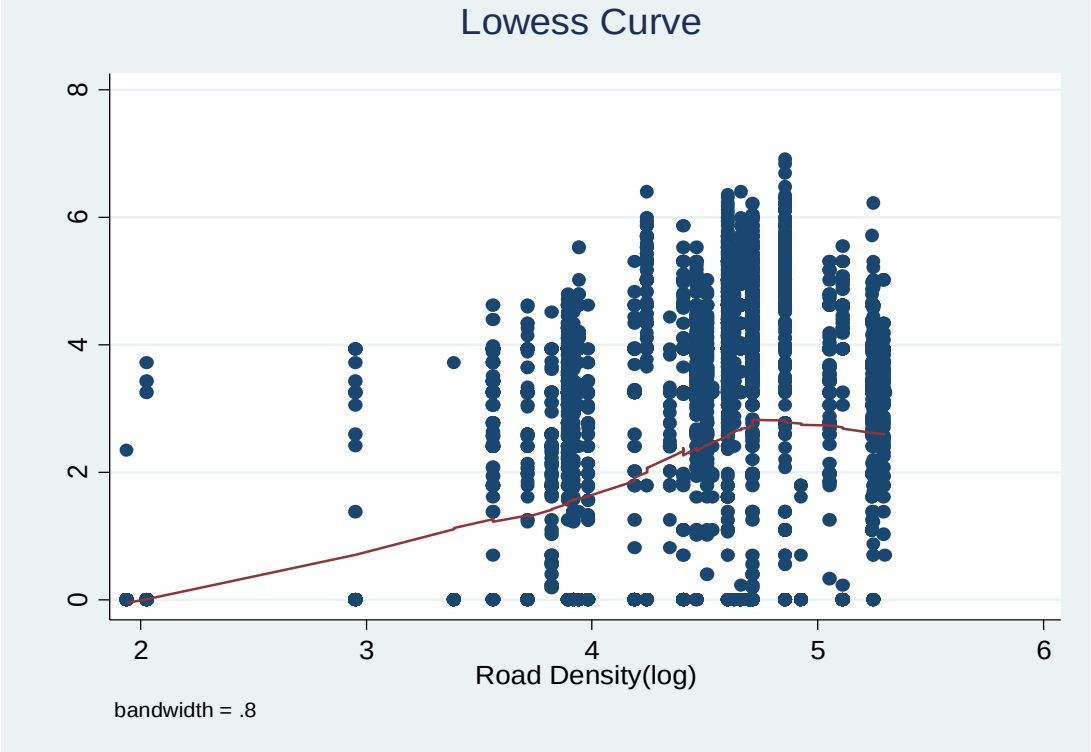
As shown in table 10 the output per adult in a household is mainly explained by the input uses by the households and accesses to roads. The results indicate that rural households with larger land holdings and more oxen are more productive. Using fertilizers is also crucial for output per unit of labor. However, the externality that accrued from production environment is

correspondingly essential to the household to increase its productivity. The estimation result shows that productivity is highly elastic with respect to road access. Therefore, we can observe access to roads significantly increases productivity even after controlling the effects of main production inputs.

Consequently, we can say road increases the farm productivity probably through creating access to inputs or markets but it also plays vital role in reducing transportation costs and trigger information and technology spillovers. Based on the available data and resource, the paper examines how road accesses increases modern farm inputs utilization.

The data shows that the most common modern input that farmers use to enhance their productivity is fertilizer. The application of fertilizer by the farm household can be determined by their land size, input availability, access to the input and other regional unobserved characteristics. Hence, the paper estimates the impact of road access on utilization of fertilizer to enhance their productivity. First, it is important to see if there is systematic relationship between fertilizer utilization and household's road access. Figure 5 a locally weighted Scatter plot smoothing commonly known as Lowess to shows the average amount of fertilizer use as road access increases.

Figure 5 : Lowess Estimates of Fertilizer Use and Road Density



Source: Author's Calculation from ERHS & ERA

Figure 5 shows there is a systematic positive relationship between road density and fertilizer use by the household. Hence, it presumably indicates the use of fertilizer by the farm household is determined by the road access they have. Here, two things may come across with the farmers utilization of modern inputs like fertilizer. The first thing we need to understand is that farmers are not risk takers so that they might be less willing to apply fertilizer they do not have more

access and information about it. Second, the amount of fertilizer use constrained by access to and cost of input. Therefore, having this couple of concerns in mined the paper wants to show first if the road access has impact on farm households probability of using fertilizer and then it examines to what extent the road access influences the amount of the input actuall used.

Table 11 : Estimates of the Probability and Intensity of Fertilizer Usage

	Probit	Tobit
	Fertilizer use probability	**Fertilizer used amount**
Land	0.2702***	0.2124***
	(0.0443)	(0.0364)
Access indicators		
Road Density(log)	0.5818***	0.4075***
	(0.1714)	(0.1047)
Distance to nearest town (km)	2.7299***	3.1196***
	(0.2481)	(0.1533)
Input price shock(d)	-0.5032*	-0.7076***
	(0.3028)	(0.1511)
Agroclimate		
Kolla(d)	36.2878***	41.9984***
	(3.3383)	(2.0843)
w/Dega(d)	14.4705***	16.0446***
	(1.1266)	(0.7047)
Woreda fixed-effects	Yes	Yes
Time fixed-effects		
1994	-9.5049	-0.7663***
	(1357.8248)	(0.1083)
1995	-11.7469	-4.4521***
	(1357.8249)	(0.1280)
1997	-9.5697	-0.9935***
	(1357.8248)	(0.0952)
1999	0.2716	0.6931***
	(2106.4569)	(0.0918)
Constant	-40.6886	-54.3129***
	(1357.8307)	(2.7072)
Observations	4729	4729
Number of Household	1202	1202
Left censored		2108
Log likelihood	-972.7735	-6259.303

Note: * Significant at 10%; ** significant at 5%; *** significant at 1%, standard errors are in parenthesis
(d) for discrete change of dummy variable from 0 to 1. Coefficients are not marginal effects

Table 11 reports the probability that a farm household uses modern fertilizer on the first colum and the change in the amount of fertilizer applied by in the second column. The

probability of household's fertilizer application is estimated using the Probit model while the Tobit model is used to estimate the amount of fertilizer applied over time.

The result on the table indicates road access has significant impact on both the probability of using fertilizer and the amount used by the households. This shows that even after controlling for other determining factors, accessibility to roads plays a significant role in increasing farmers' propensity to use e modern fertilizer. Moreover, of those who already uses fertilizer, households who have better road access uses more fertilizer than those who have less access.

However, we have got no support for conventional wisdom that distance to the town decrease households' probability and amount of using chemical fertilizer. Instead, our estimate indicates more distant villages have higher likelihood to use fertilizer. The possible explanation for this could be households close to towns are less engaged in crop production but participate in off-farm activities. In fact, farmer's access to towns and urban centers could help them to get modern inputs and decrease the cost to use it. Concurrently, roads are important for households to get to the nearest towns to buy modern inputs and to sell their outputs. In this circumstance, our result indicates physical isolation is not significant for those who has road infrastructure and households who live in places far from towns could use more fertilizers.

Chapter 8
Conclusion

This paper has examined the impact on poverty of a massive government investment program on road infrastructure. The data allows us to examine the impact at household level using road access at Woreda level. Access to roads has a decisive impact on the likelihood of poverty among rural households. In line with the empirical evidence we found, roads are imperative for poverty reduction and consumption growth in rural areas.

This study shows households who have better road access accrue more benefit than those with no access. Both the descriptive statistics and the econometric models provide evidence that expanding road networks decrease the likelihood of poverty. As compared to the magnitude of other determining factors, the effect which we found form road is not trivial. The government's focus on road infrastructure has therefore contributed for poverty reduction in the country.

In addition, the study also supports the view that government could facilitate rural economic growth through better road access. Moreover, we found consumption mainly depend on productive assets which are subjected to transitory shocks and economic fluctuation. In this regard, the role of roads to minimize the impact of these adversities and smooth household consumption is very substantial.

Furthermore, the study investigates some of the mechanisms through which road affects the rural wellbeing. We examine the effect of road access in promoting rural productivity per capita. The evidence we found showed there is a strong and positive association between road access and productivity specifically on crop producers. We expect that the impact of roads on production is multidimensional and exhibited through various aspects for example minimized transaction cost, knowledge spillover, low input price. Accordingly, our research found that the probability and quantity of fertilizer use improves with the degree of connectivity of the village in which they live in. This is consistent with the notion that expansion of agricultural technology is a function not only of access to inputs but also of access to markets for the improved output.

Based on the overall assessment the road sector development program that has been undertaken by the Ethiopian government with the support of international donors was instrumental in moving the rural economy forward. Government investment on better roads contributed to agricultural productivity and higher economic growth in the country in recent years. In developing countries like Ethiopia investment on road infrastructure is an indispensable strategy to sustain economic growth and reduce poverty.

Our results do not necessarily imply that further investment on road infrastructure will continue to have the same poverty reduction effect in the future. For villages which already have road access, building more roads may give them alternative routes to markets but it may not necessarily increase their output and productivity. Perhaps further studies shall be needed to investigate the impact of road in the long-run and better road access indicators could strengthen the observations we made in this paper. Moreover, our paper only provides the outcome in

terms of poverty reduction and consumption growth and one needs to have a careful cost-benefit analysis before making the argument for more investment spending on roads. Having said that, the low road density in Ethiopia even compared with other developing countries suggests that building more roads and other transport infrastructure are likely to have strong payoff.

Appendices

Annex I
Poverty Indicator in Ethiopia (1995-2011)

	Poverty indices over time				Change (%)	
	1995/96	1999/00	2004/05	2010/11	2004/05 over 1999/00	2010/11 over 2004/05
National						
Head count index	0.455	0.442	0.387	0.296	-12.4	-23.5
Poverty gap index	0.129	0.119	0.083	0.078	-30	-5.5
Poverty severity index	0.051	0.045	0.027	0.031	-39.8	14.4
Rural						
Head count index	0.475	0.454	0.393	0.304	-13.4	-22.7
Poverty gap index	0.134	0.122	0.085	0.080	-30.8	-5.5
Poverty severity index	0.053	0.046	0.027	0.032	-40.6	17.0
Urban						
Head count index	0.332	0.369	0.351	0.257	-4.7	-26.9
Poverty gap index	0.099	0.101	0.077	0.069	-23.6	-10.1
Poverty severity index	0.041	0.039	0.026	0.027	-33.5	5.1

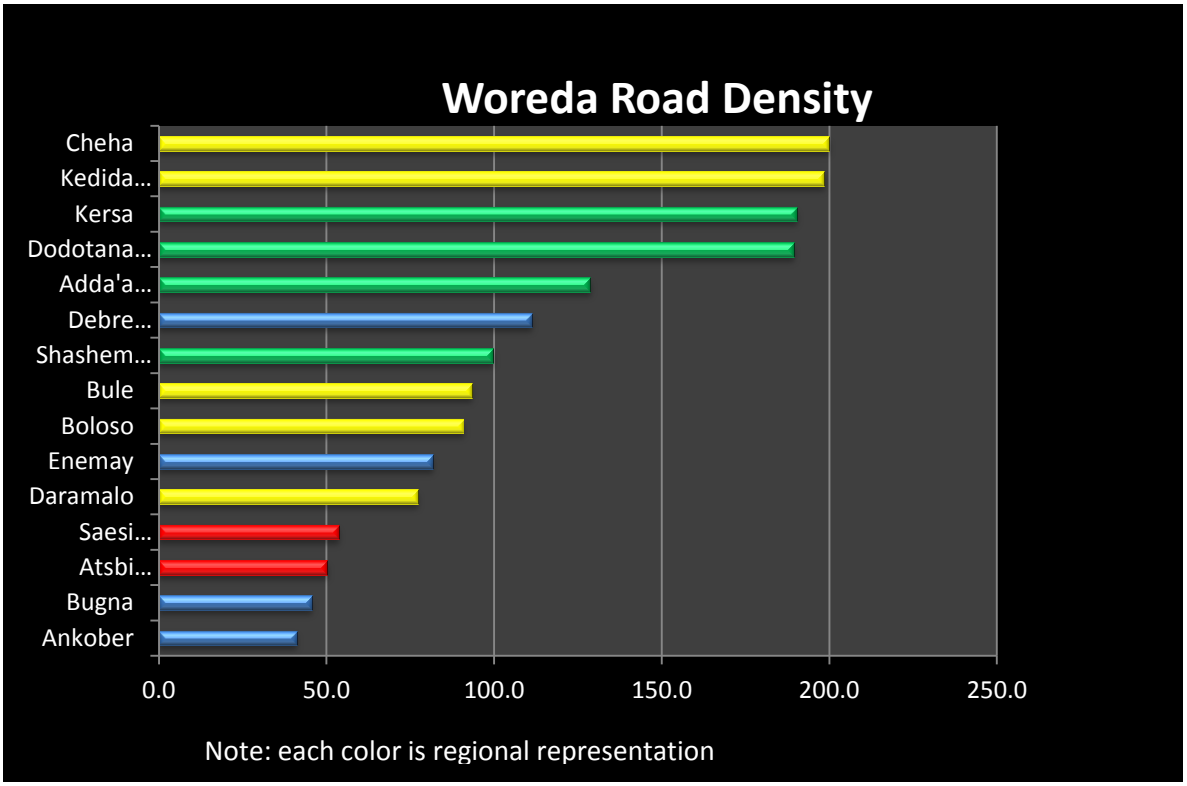
Source: MOFED, 2012, HICE survey of 1995/96, 1999/00, 2004/05, and 2010/11

Annex II
Regional Distribution of Road Network in Ethiopia

Region	Total Regional Road Network (km)	Percentage Share
Tigray	1,486	4.8
Afar	1,101	3.6
Amhara	3,983	13.0
Oromiya	8,646	28.2
Somali	2,622	8.5
SNNP	10,033	32.7
Benishangul-Gumz	1,590	5.2
Gambella	973	3.2
Dire Dawa	278	0.9
Total	**30,712**	100

Source: ERA(2011)

Annex III
Chart of Road Density by Woreda



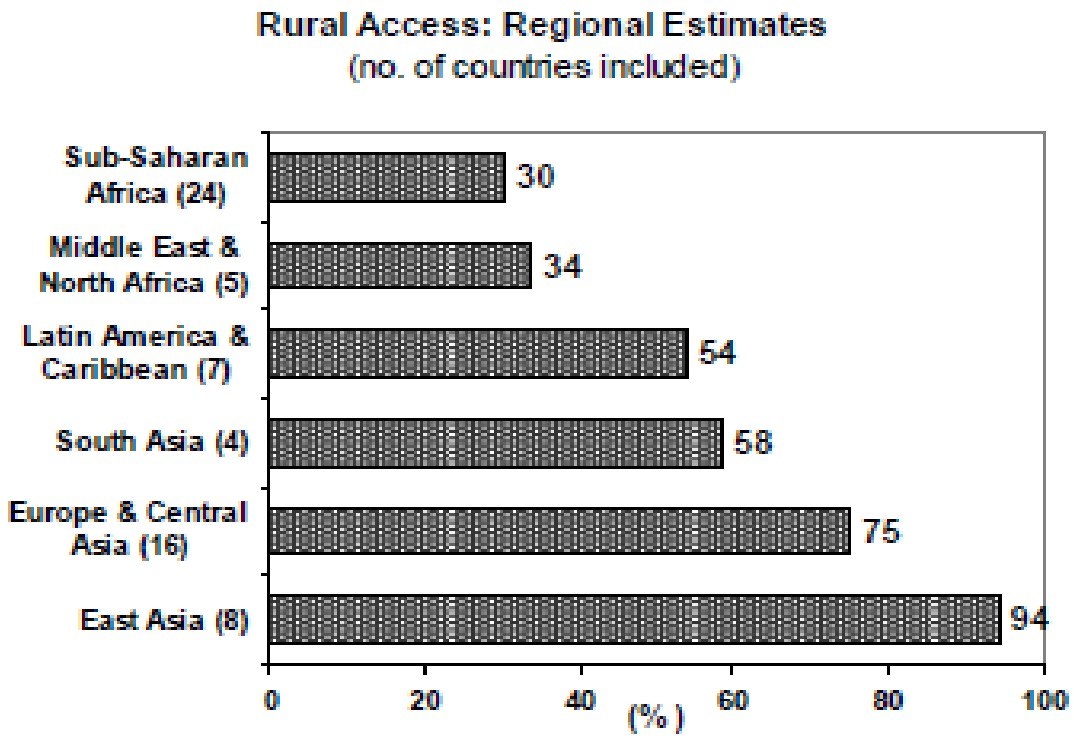
source: Author's GIS abstraction from ERA Road Data and Regional Roads Authority
Note: Road density excludes earth and community roads and shows figure in sample Woredas

Annex IV
Rural Accessibility Indicator in Africa

Country	Region	IDA/ Blend	Survey	Year (1994-2004)	Rural access indicator	Total population	Rural population	Rural population with access	Rural population without access
Angola	AFR	IDA	model	2003	42%	13,522,112	8,696,070	3,652,349	5,043,721
Benin	AFR	IDA	CWI	2003	32%	6,720,260	3,726,916	1,192,613	2,534,303
Burkina Faso	AFR	IDA	SSATP	2003	25%	12,109,229	9,976,140	2,494,035	7,482,105
Burundi	AFR	IDA	PS	1998	19%	7,205,982	6,489,290	1,232,965	5,256,325
Cameroon	AFR	IDA	PS	2001	20%	16,087,472	7,851,330	1,570,266	6,281,064
Chad	AFR	IDA	**	2001	5%	8,581,741	6,439,945	321,997	6,117,948
Congo, DR***	AFR	IDA	SSATP	2003	26%	53,153,360	53,153,360	13,819,874	39,333,486
Ethiopia	AFR	IDA	SSATP	2003	17%	68,613,472	57,215,536	9,726,641	47,488,895
Gambia	AFR	IDA	PS	1994	77%	1,420,895	958,183	737,801	220,382
Ghana	AFR	IDA	CWI	1997	44%	20,669,260	13,004,106	5,721,807	7,282,299
Guinea	AFR	IDA	SSATP	2004	22%	7,908,905	5,621,270	1,236,679	4,384,591
Kenya	AFR	IDA	PS	1997	44%	31,916,850	20,328,672	8,944,616	11,384,056
Madagascar	AFR	IDA	PS	1997	25%	16,893,904	11,583,474	2,895,869	8,687,606
Malawi	AFR	IDA	IS	1997	38%	10,962,012	9,222,363	3,504,498	5,717,865
Mali	AFR	IDA	model	2003	14%	11,651,502	7,891,563	1,104,819	6,786,744
Maurtius	AFR	IBRD	model	2003	70%	1,222,188	692,614	484,830	207,784
Namibia	AFR	IBRD	**	2001	57%	2,014,546	1,361,398	775,997	585,401
Niger	AFR	IDA	SSATP	2003	37%	11,762,251	9,157,618	3,388,319	5,769,299
Nigeria - 8 states	AFR	Blend	CWI ++	2002	47%	43,336,868	34,742,392	16,328,924	18,413,468
Sierra Leone	AFR	IDA	model	2003	65%	5,336,568	3,265,446	2,122,540	1,142,906
South Africa	AFR		IS	1993	21%	45,828,700	18,699,392	3,926,872	14,772,520
Tanzania	AFR	IDA	PS	2000	38%	35,888,960	23,197,834	8,815,177	14,382,657
Uganda	AFR	IDA	model	2003	27%	25,280,000	22,178,144	5,988,099	16,190,045
Zambia	AFR	IDA	model	2003	64%	10,402,959	6,663,095	4,264,381	2,398,714
AFR Total	24					468,487,986	342,116,151	104,251,967	237,864,184

Source: World Bank (2006)

Annex V
World Comparison of Rural Access



Source: World Bank estimate, World Bank (2006)
Note: Rural Access in East Asia would be 86 if China excluded from the figure.

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