

**Ethiopian Economics Association (EEA)
and
Ethiopian Strategy Support Program
(ESSP) of IFPRI**



**PROCEEDINGS OF THE
FIFTEENTH INTERNATIONAL CONFERENCE
ON THE ETHIOPIAN ECONOMY**

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- ❁ Partners of all activities of EEA are the African Capacity Building Foundation (ACBF), the Friedrich Ebert Stiftung of Germany (FES), Think Tank Initiative of the International Development Research Center (IDRC) of Canada, and Civil Society Support Program (CSSP).

- ❁ The 15th International Conference was Co-organized by the Ethiopian Strategy Support Program (ESSP) of the International Food Policy Research Institute (IFPRI).

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FOREWORD

The Ethiopian Economics Association (EEA) is happy to issue two volumes of the proceedings of the 15th International Conference (the 26th Annual Conference) on the Ethiopian Economy that was held from July 20 – 22, 2017 at EEA Multi-purpose Building Conference Hall. EEA has been organizing annual conferences on the Ethiopian Economy every year as part of its overall objectives of promoting the development of economics profession in Ethiopia and contributing to the policy formulation and implementation process of our country through research, training, public dialogue forums and publications and dissemination activities.

EEA had launched its international conference series in June 2003, after organizing 11 annual national conferences. This series has proved to be an excellent forum at which not only resident Ethiopian researchers, but also Ethiopian researchers based abroad as well as non-Ethiopian researchers throughout the world conducting research on Ethiopia, or more widely, present and discuss research findings.

This year's conference, as was last seven years, is co-organized by the Ethiopian Strategy Support Program (ESSP) – the collaborative program of the International food Policy Research Institute (IFPRI) and the Ethiopian Development Research Institute (EDRI). It was also co-sponsored by IFPRI, EDRI, Friedrich Ebert Stiftung of Germany, UNECA, UNDP, International Growth Center (IGC), USAID, AKLDP Ethiopia, the World Bank, Population Reference Bureau (PRB), and European Union (EU). The contribution of EEA's partners that includes the African Capacity Building Foundation (ACBF), Think Tank Initiative of the International Development Research Center (IDRC) of Canada and the Friedrich Ebert Stiftung of Germany is also critical for the organization of this important conference and other activities of the Association.

At the conference about 80 presentations were made in five plenary and five parallel sessions with the attendance of about 956 persons in three

days. That is the conference attracted about 486, 250 and 220 participants during the first, second and third days of the conference, respectively. Out of the total 80 presentations, about 44 were presented by partner institutions like (IFPRI-ESSP), International Growth Centre (IGC), United Nation Economic Commission for Africa (UNECA), the World Bank, EDRI, AKLDP Ethiopia/Tufts University, UNDP, Young Live Ethiopia, Addis Ababa University and Population Reference Bureau (PRP) and etc. The rest 36 papers were presented by individual researchers.

The conference was opened by H.E. Ato Hailemariam Desalegn, X/Prime Minister of the Federal Democratic Republic of Ethiopia at the presence of higher dignitaries and invited guests. The presence of H.E. Ato Hailemariam Desalegn, demonstrates the value of the conference to the economic policy making process of the country. The year also marked as Silver Jubilee of the Ethiopian Economics Association.

The editorial committee reviewed papers that were presented for the publication of the proceedings of the conference and communicated its comments and suggestions including editorial comments to authors. After passing all these process and language editing, the editorial committed selected 18 papers to be included in the proceedings. All these papers are organized into two volumes. Volume I consists of Macroeconomics, Industry and social Sectors issues while Volume II consists of Agricultural and Natural Resources related topics.

At this juncture, on behalf of the Ethiopian Economics Association, I would like to thank the Ethiopian Strategic Support Program (ESSP) of the International Food Policy Research Institute (IFPRI), for being a regular co-organizer of the EEA's International conferences since 2010. My appreciation also goes to the authors of the papers and the conference participants whose active participations made the conference meaningful and dynamic. The many professionals who dedicated their time to the conference and served as chairpersons deserve due thanks for their special contributions.

I would like also to thank IFPRI, EDRI, Friedrich Ebert Stiftung of Germany, UNECA, UNDP, International Growth Center (IGC), USAID, AKLDP Ethiopia, the World Bank, Population Reference Bureau (PRP), and European Union (EU). The contribution of EEA's partners that includes the African Capacity Building Foundation (ACBF), Think Tank Initiative of the International Development Research Center (IDRC) of Canada.

The organizing committee and staffs of the EEA deserve a special recognition for their enthusiasm and perseverance in managing the conference from inception to completion. I also want to extend my personal gratitude to the members of the Executive Committee of the Ethiopian Economics Association for the dedicated services and the leadership they provided to the Association.

Our special thanks go to our partners who have shared our vision and provided us with generous financial support to operationalize the activities of EEA. These include; the African Capacity Building Foundation (ACBF), Think Tank Initiative of the International Development Research Center (IDRC) of Canada and the Friedrich Ebert Stiftung of Germany.

I would like also to extend my sincere gratitude to H.E. Ato Hailemariam Desalegn, former Prime Minister of the Federal Democratic Republic of Ethiopia for his an insightful opening address; and other senior government officials who spared their busy schedule and participated in the conference.

Finally, I would like to convey the message that our Association is willing to seek new ways of addressing the economic problems and to be of better service and to meet the expectations of its members and the public at large.

Tadele Ferede (PhD)
President
Ethiopian Economics Association

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External shock and Monetary Policy in Ethiopia: Evidenced from a narrative approach

Esubalew Asmare Sahilea¹

Abstract

This study investigates the effects of the recent oil and food price shocks on the main macroeconomic variables and analyzes the responses conducted by the National Bank of Ethiopia. Due to problems of identification in the statistical approach, the study uses the Narrative approach of analysis (developed by Romer C. and Romer D. (1989)). The study found that oil and food price shock of 2006-2009 is highly correlated to movements in price of energy and food in Ethiopia. Both consumer price index and pump price for diesel fuel exhibit similar trends with global food price and global energy price indexes. During the period, inflationary pressure has reached its peak with the headline inflation about 36.4 percent during July 2008. Given the accommodative nature of monetary policy, and vigorous economic activity, output gap has become positive and real saving interest rate exhibits negative rate until effective monetary policy had conducted as of April 2008. The National Bank of Ethiopia supported by fiscal and administrative strategies, has conducted effective monetary policies by raising the reserve requirement ratio by 500 basis points and the liquidity requirement by 1000 basis points effective April 2008. This has brought significant decrease to inflation; an increase in real interest rates and cool down the vigorous economic activity to its potential level. Clear transmission of monetary policy is found for all channels. The study suggests the use of fiscal policy and administrative strategies in compliment to monetary policies.

Key words: External shock, monetary policy, Channels of transmission, macroeconomic performance, Ethiopia

¹ A PhD student in Economics at University of Cape Town-South Africa. I am very grateful for Paul Reding (Emeritus Professor) from University of Namur, Belgium for his valuable comments and contributions.

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3. Introduction

External shock, defined as the unexpected and unpredictable events that originate from outside a country that affect a nation, either positively or negatively (UN, 2014), may have economic, political, social, cultural and natural forms including, energy costs, famine, war, share prices, economic policies, uncertainties, natural disaster, etc. These may have various consequences for different countries based on different contexts.

Specific to commodity price shock, the rising of the international oil and food price becomes a permanent reality, with oil price attaining its climax in 2008, followed by the increase in food price over the same period (IMF, 2008). Unless properly managed by the concerned body it will have consequences of dislocating the economy of a given nation depending on its position in the shock (source of shock or recipient of the shock) and other macroeconomic situations. The consequence will be strong and negative on main macroeconomic variables if the country is dominantly oil importing (e.g., Hamilton, 1983; and Burbidge & Harrison, 1984; Pérez de Gracia, 2003) and highly vulnerable for food price shocks that will have effect on poverty and welfare status of residents. This has been very true to lower income countries like Ethiopia.

As an importer of oil products, Ethiopia has been suffering a lot for oil price shocks. According to Birouke T., Frehiwot F., and Zewdu A., (2012) the nation is highly vulnerable to fluctuations in the world price of crude oil because of its high oil energy intensity and complete dependence on imported oil.

The study also adds the transmission of oil price shock to food price rise, decrease in purchasing power of Birr and its effect on welfare of households “Higher fuel prices raise food prices reducing the purchasing power of the birr and in turn affecting the welfare of households since fuel and food are core elements of household budgets in Ethiopia.p-12”.

Associated with these, monetary authorities of nations are faced with dilemmas of increase in price and decrease in output due to adverse demand

and supply effects. In the case of both demand shocks and permanent supply shocks, policy makers can simultaneously pursue price stability and stability in economic activity. Following a temporary supply shock, however, policy makers can achieve either price stability or economic stability, but not both (Mishkin, 2007).

In line with these, this study will try to assess the effects of the recent oil and food price shocks on main macroeconomic variables (output level and inflation) and analyze the responses conducted by the National Bank of Ethiopia.

1.1 General objective of the Study

The main purpose of the study is to see the recent oil and food price shocks, its effects on main macroeconomic variables and the responses conducted by the National Bank of Ethiopia.

Specifically this paper intends to;

- Review on the theoretical dilemmas of monetary authority to commodity price shocks
- Assess the trend of energy and food price index and main macroeconomic variables
- Analyze the monetary policy responses of the National Bank of Ethiopia

1.2 Methodology Data

Sources of data

Subjected to relevance and availability of data, the most important variables that are used includes world energy price index, world food price index, domestic inflation (Consumers price index), Real GDP (2010=100) at constant prices, monetary aggregates including broad money supply, credit to the private sector, monetary policy variables including the reserve requirement ratio (RRR), the liquidity requirement ratio, minimum deposit and lending rates, the money market interest rate, bank interest rate, and the official and real exchange rate.

As a source of data the study has dominantly relayed on the National Bank of Ethiopia (NBE) and Ethiopian Central Statistics Agency. Besides, data for world commodity price including oil price and food price were collected from IMF and WB (via the Macro bond data provider).

Method of Analysis

Usually studies on the analysis of monetary policy, mainly of the effectiveness of monetary policy are analyzed using statistical approaches of VAR, SVAR, IRF, VD, and GC². However, the use of such techniques has limitations on the ground that such statistical techniques may face with identification problems. According to Romer C. and Romer C. (1989), statistical techniques like VARs “probably have not played a crucial role in forming most economists’ views about the real effects of monetary disturbances is that such procedures cannot persuasively identify the direction of causation” (p. 121). Furthermore, sometimes (not always), monetary policy may not be an exogenous effect that could mislead the conclusion.

On the other hand, Romer C. and Romer D. (1989) have developed a technique called *Narrative Approach* that allows having a vast body of information that cannot be employed in conventional statistical tests to be brought to bear on this question. It is this additional information that enables to solve the problem of identifying the direction of causation between monetary factors and real economic sector.

This study therefore, uses this approach of analysis which is based on the historical record of variables that identifies a significant policy shocks and try to deeply look the transmission of policy shocks to real sector of the economy.

² VAR-Vector autoregressive regression: treat all variables as endogenous
SVAR- structural VAR model: helps to see the shocks originated from exogenous variables.

IRF-Impulse response function: helps to see the response of endogenous variables to the shocks originated from exogenous variables

VD- variance decomposition: helps to see the share of exogenous variable for variation in an endogenous variable.

GC- Granger causality: Helps to see the direction of cause-effect relationships

2. Theoretical Aspects of Dilemmas to Monetary Policy with Emphasis to LDC's

2.1 Shocks to Oil Price

Theoretical considerations reveal that, as too many products, crude oil is an important input factor in the value added chain of most agricultural products (machinery fuel, fertilizers, transport). Price rise in energy inputs (like oil) raises the costs of producing food commodities. Higher oil prices may also raise the price of processing, storing, and distributing food to retail customers.

Moreover, as to many policy makers and researchers, the increased reliance on bio fuel production due to considerations of energy independence and environmental preoccupations is also suspected to have created a new link between crude oil and food prices movements. In line with this, the main channels through which oil price can have effect on the economy can be seen as short run demand and supply effect.

Demand effect: A higher oil price reduces aggregate demand by reducing spending on the domestic economy. It reduces spending by consumers after high payment for energy use. They must cut back on purchases of other goods and services which lead a decline in the overall spending on the domestic economy. Partly offsetting these effects of higher oil price could be the increase in the income of oil producers, that could raise the demand for domestic products, but those beneficiaries of oil price spend only part of their income on domestic products. As a result, higher oil price will likely reduce domestic spending. Other things held constant, real output and price level will decline.

Supply effect: The supply effects of higher oil prices are more pervasive than the demand effects. A higher oil price reduces aggregate supply by increasing the overall cost of production. A higher cost of production discourages investment which ultimately reduces total output of the economy. Faced with an increase in the price of oil, producers will tend to rise prices for a given level of output or, alternatively decrease output for a given price level. As a result aggregate output declines and the price level rises.

Combined effect on output and price: the combination of demand and supply effect implies that higher oil price lead to a decline in output and to an increase in inflation. Demand and supply effect reinforce each other in reducing output. Considering that the effect on aggregate demand can be offset by the increase in the income of others, and, on the other hand, that oil is not only an input in the production of energy but also of many more goods and services it can be argued that the supply effect dominates the demand effect. This makes external price shocks result in an inflationary effect on the domestic economy. Hence, in the short run- until the economy can come back to its equilibrium, oil price increase can harm a lot by decreasing real output, increasing unemployment and increasing inflation.

Emphasis on Developing countries

The adverse economic impact of oil price shocks on oil-importing developing countries is greater than on developed countries. This is because developing countries have a more energy intensive and less efficient production technology. Besides, the availability of limited alternative sources of energy exacerbates the vulnerability to oil price shocks (IEA, 2004). According to the United Nations conference on trade and development (UNCTAD 2008), oil importing developing countries suffer from high levels of unemployment and exacerbating budget-deficit problems.

Tradeoffs to Monetary policy

There are doubts whether monetary policy can reverse inflationary situation in an economy particularly created due to cost push rather than inflation created due to demand pull factors³. Economists like Munn, et al, (1991) indicated that monetary policy is more powerful on inflation driven by excessive expansion of the money stock rather than on inflation driven by cost push. Therefore, the trade-off is particularly stark in the case of a shock that causes inflation and output to move in different directions (cost-push or supply shock domination).

³ Cost push inflation is inflation caused by an increase in prices of inputs like labour, raw material (oil price), etc.

Demand-pull inflation is asserted to arise when aggregate demand in an economy outpaces aggregate supply

These leave the central bank of an oil importing country with limited options when an oil price shock hits:

- It can use contractionary policy to keep inflation from rising. This will cause real GDP to decrease, or at least to lag behind the growth of potential real GDP that will cause the unemployment rate to increase.
- It can use expansionary monetary policy to try to offset the impact of oil prices on real output and employment. However, this will accelerate inflation.
- It can compromise by doing nothing that is, accommodating the price rise without trying to mitigate the output decline. The result will be intermediate between Cases 1 and 2, that is, there will be some increase both in inflation and unemployment.

None of these options is however, completely satisfactory and hence, the central bank's chosen course of action will depend on the perceived costs of variability in output and inflation respectively.

2.2 Shocks to Food Price

With regard to shocks from global food prices, the price rise can reinforce by the adverse supply shock of oil shown above. By increasing the cost of production, the rise in price of oil can lead to a decrease in output of food commodities for a given price level. Therefore, the adverse supply shock resulted from an increase in cost of inputs consequently lead for an increase in the price of food. Furthermore, an increase in the global food prices can be associated with many factors including, bad weather condition, food hoarding and panic buying practices, an increase in demand for production of bio fuels, speculations, etc.

These rises in food prices are a cause of major concern because they bring significant and immediate setbacks for poverty reduction, social stability, inflation and a rules-based trading system. These are particularly important for developing countries where food consumption constitutes a major share of spending. Since food represents a relatively large share of developing countries' consumption baskets, this results insignificant inflationary

pressures and hurts the living standards of poor net consumers that ultimately pose difficult policy dilemmas to the governments.

Unlike the conventional wisdom among economists that short-run problems associated with high prices of staple foods are best dealt with by appropriate macroeconomic instruments and targeted safety nets, there are however, substantial policy dilemmas and challenges faced by governments in the developing countries (Nora L., 2009).

Tradeoffs to monetary authority

To deal with inflationary pressure from global food price shocks, the monetary authorities can have options but with dilemmas.

...to accommodate the price increases as a one-time spike in the rate of inflation or to stick to the inflation target through tight monetary policy. Tight monetary policy has a dampening effect on economic activity. However, accommodation puts the hard-won credibility of central banks at risk and this risk has to be weighed against the costs of tight monetary policy in terms of foregone output. Also, for countries in which wage and price indexation is common, it will be hard to prevent the initial increase in inflation from becoming entrenched. But given that fulfilling the inflation targets may mean that nonfood prices must fall in nominal terms, governments find it hard not to acquiesce to some degree of accommodation. Without it losses in economic activity are likely and this, in turn, would exacerbate the impact on poverty. In addition, the recessionary impact of tight monetary policy might reduce the fiscal resources available to compensate the poor through targeted safety nets (Nora L., 2009 P 16).

On the other hand according to Nora L. (2009) we could think of that countries can use their available international reserve to appreciate the exchange rate through which they can reduce the pressure of inflation from outside. This however, has its own negative consequences to the domestic economy by discouraging the export sector which ultimately can hurt the growth of the economy.

In addition to the above policy dilemmas, absence/limited scale of safety net programs, cash transfer programs, inappropriate design of these social security programs to incorporate the new poor make the situation worse to the developing countries which were the case in Ethiopia in 2008 social security programs. Nora L. (2009).

Hence, confronted with unpalatable macroeconomic choices, lacking or inadequate safety nets, and uncertainty about the evolution of international food commodities prices, it requires a deep analysis of how monetary authority should respond for such shocks most importantly to the developing world, paying much to the situation. Given those significant and negative consequences of external commodity price shocks to the macro environment as well as welfare cost of price fluctuation to the society and tradeoffs to the response of the monetary authority, a reasonable analysis to the responses of monetary policy and channels through which it can affect the economy is vital to see the real effects of the policy response on the economy. In line with this, the project will try to describe the response of National Bank of Ethiopia to the recent price shocks using a historical record of data on main macro variable, Policy variables and Price shock variables. Nora L. (2009)

3. Empirical Literatures on responses of Monetary Authorities

There are various works on the response of monetary policies to external price shocks at the regional level unlike to that of national level. A study by (Andrew B., et al, 2013) on the monetary transmission mechanism in Kenya, Uganda, Ruanda and Tanzania have shown a clear evidence of monetary transmission mechanism with some level variation across countries which can be attributed to deviations in their policy regime. Using non statistical approach of analyzing the responses, the study reveals that monetary policy responses to the external shock have clear effects to macroeconomic variables.

Another study focused on food price rise of external shock by (Michal A., et al, 2013) in Kenya indicates that while imported food price shocks have been an important source of inflation, both in 2008 and more recently, accommodating monetary policy has also played a role, most notably through its effect on the nominal exchange rate.

At national level however, studies are few. Even those available are far related works. For example (Birouke T., et al, 2012) tries to show that oil price rise has significant impact on the Ethiopian economy in general, that does not indicate the response of monetary policy to such shocks.

A study by Anteneh G. (2014) examined the effect of shocks to monetary policy on output and price using a VAR approach and concludes that a positive shock to reserve money increases output while it decreases the price level significantly. But this study is also not related to external shock but only analyzes the effect of monetary policy shocks to output and inflation.

Therefore, given the above potential adverse consequences of external price shocks on macroeconomic variables mainly inflation and output which is strong in developing countries, and the dilemmas of reaction of monetary policy, as well as the lack of studies on the responses of monetary policy, this study has focused on assessing the reactions of the National Bank of Ethiopia's monetary policy to the recent shocks of oil and food price rise's

4. The Ethiopian Financial Sector and Monetary Policy Framework

4.1 The Ethiopian Financial Sector

Financial intermediation among its broad based functions and contributions to the economy are it serves as a mechanism by which monetary authorities can implement policies and influence the functioning of the economy. Therefore, it is vital to determine the structure of the financial sector for a better analysis of the effectiveness of monetary policies.

The Structure of financial sector

As part of a small open rapidly growing economy, the Ethiopian financial sector has long been regarded as shallow, with low coverage of financial services and high regulation from the government. It is also closed from foreign competition, which could limit opportunities for competition, capital injection, foreign exchange access and banking technology and skills. In addition, there is a lack of more sophisticated financing mechanisms such as leasing, equity funds, etc. (Getnet, 2014).

Financial Intermediaries

As of 2013, Ethiopian financial intermediaries consist of 3 public banks, including the Development Bank of Ethiopia, 16 private banks, 14 private insurance companies, 1 public insurance company, 31 microfinance institutions and over 8200 Saving and Credit Cooperatives (SACCOs) in both rural and urban areas. The ownership structure of microfinance institution is mixed, with the big microfinance institutions partially owned by regional states, some by NGO's and some by private owners.

The microfinance sector is relatively well developed but not strictly supervised. At last counts, about 31 MFIs, reaching 2.4 million people, operated in the country and have become a major source of financial services to many farmers and businesses. Some unlicensed NGOs are also active in the delivery of microfinance services through informal channels. The non-banking sector remains largely undeveloped, except for 14 insurance companies with about 252 branches across the country.

Financial Market Situation

Generally speaking, financial markets in Ethiopia are in their early stage of embryo, unlike the country's growth performance. There is a primary market for the issuing bonds and treasury bills at the government level. Yet, secondary markets are very illiquid. The interbank money market, established in 2001, is poorly developed and largely illiquid, featuring only a few participants and small transaction volumes.

Capital markets are in their early stages of development. While no stock market is present, the Ethiopian Commodity Exchange (ECX) was opened in 2008, trading coffee, sesame, haricot beans, wheat and maize. In early 2011, there were more than 60,000 shareholders in Ethiopia, but the holder of the share cannot exchange in the market due to inexistence of secondary market for share trading and retreading (Tiruneh L., 2012). This creates non-liquid share and discourages new investors to participate in the development of the country.

In the aim of financial inclusion, structural changes have been made in Ethiopia to allow the development of banks and this increases participation of

private sector in opening private banks (though not permitted to foreigners) and enhances access to financial services. In the opposite side, there is no stock market and the financial market is at an infant stage accommodating limited amount of transactions (Zwedu, 2014). Authorities are therefore currently working on a strategy to develop capital markets in the country through the Financial Sector Capacity Building Project.

4.2 Monetary Policy Framework

Objective/ Target: The principal objective of NBE's monetary policy is maintaining price and exchange rate stability and support sustainable economic growth, on the ground that price stability is a proxy for macroeconomic stability, which is vital for private economic decisions. Exchange rate stability is important to maintain competitiveness in the international trade and matters for foreign reserve position and domestic money supply (NBE, 2009).

Intermediate target: The monetary policy of the National Bank of Ethiopia sets money supply as an intermediate target to achieve its objectives. In line with these objectives, NBE takes the broader definition of money, or M2, as money supply target, where Money (M2) is a measure of the domestic money supply that includes M1⁴ plus Quasi-money (savings and time deposits), overnight repurchase agreements, and personal balances in money market accounts. Therefore, the current target is to ensure that the money supply growth is in line with nominal GDP growth rate (NBE, 2009).

Operational strategy: To achieve the intermediate target, the National Bank of Ethiopia uses the growth of base money⁵/reserve money as an operational target. The NBE wants to influence the base money largely on a day-to-day basis, through its monetary policy instruments and this helps to link instruments of monetary policy to the intermediate targets. The base money represents the first impulse in the transmission process of monetary policy (NBE, 2009).

⁴ Narrow money (M1) is a measure of money stock intended primarily for use in transactions. It consists of currency held by the public, traveler's checks, demand deposits and other checkable deposits.

⁵ Reserve money (Base money) is defined as the sum of currency in circulation and deposits of commercial banks at NBE.

Monetary Policy Instruments

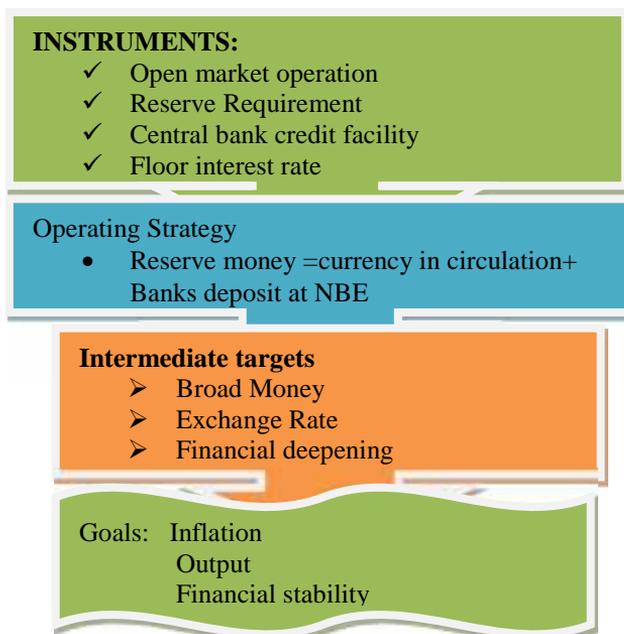
Open Market Operation: The NBE uses sale and purchase of bonds or government securities as one of its monetary policy instruments.

A standing central bank credit facility: The NBE provides commercial banks an assurance when confronted with short of funds in the clearing and a lack of alternatives for rising immediate funds. Commercial banks therefore, can settle the clearing with the central bank's funds at a reasonable interest rate, which has a clear relationship with short-term market interest rates.

Other monetary policy instruments

- Reserve requirement
- Setting of floor deposit interest rate (until interest rate is fully deregulated)
- Direct borrowing/lending in the inter-bank money market and introducing re-purchase agreement (repo/reverse repo operations),
- Use of selected credit control when necessary, and
- Moral Suasion to curb inflation expectation (NBE, 2009)

Figure 1: Monetary Policy: Instruments, Strategy and Goals



Source: Own presentation

Exchange Rate Regime: Considering the underlying economic situation of the country, managed floating exchange rate regime is being practiced in Ethiopia since 1992 (NBE, 2009).

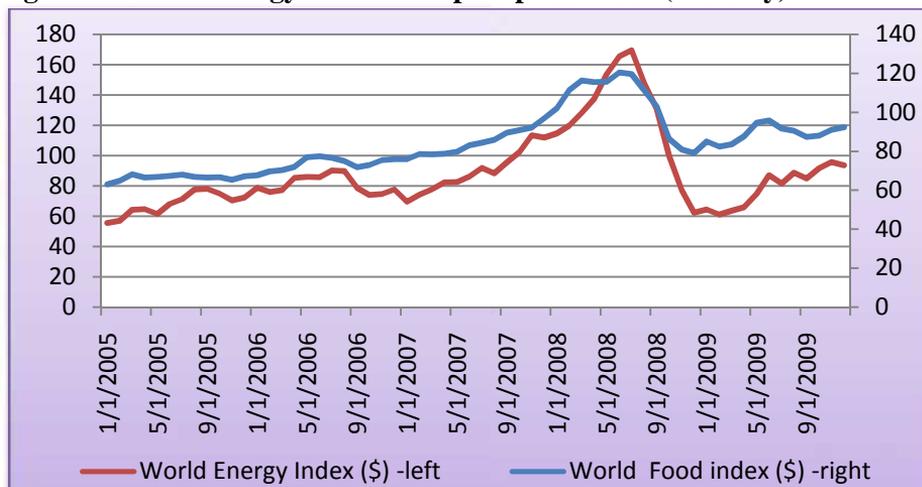
5. Facts Related to the External Shock

5.1 What happened to world commodity prices?

Over the last few decades, prices of oil and food have shown a steep rise until recent times where it goes back to a declining trend. Commodity prices soared during the 2000s, increasing by more than threefold between 2003 and 2011.

The rising of the international oil price becomes a permanent reality, with oil price attaining its climax in July 2008 when the international transaction export price index rises by 70% relative to its base year value in 2010. In the same way, the international transactions export prices for energy Index rises by 26 percent in July 2006, 28 percent in July 2007, 138 percent in July 2008 and 14 percent in July 2009 as compared to the index in July 2005 (see Figure 2).

Figure 2: Global energy and food export price index (monthly)



Source: (IMF) own computation

According to the African Development Bank, (2009), a barrel of crude oil was trading between US\$18 and US\$23 in the 1990s while it crossed the US\$40 mark in 2004 and rose to about US\$60 from 2005. During the summer of

2007, the price of one barrel of crude oil jumped above US\$70 and even crossed the US\$147 mark in July 2008.

Concerning the food price shock, it followed similar pattern to the energy price shocks over all periods. The international transactions export price index for food rose by 20.62 percent in 2008 relative to the base year (2010). In the same way, the value of the index rose by 14 percent, 24.5 percent, 75.93 percent and 34 percent for July 2006, July 2007, July 2008 and July 2009 respectively relative to price level in 2005.

On the other hand, according to the United Nations Food and Agriculture Organization (FAO), in the period 1996 to 2006, world food prices rose on average by only 0.05% per semester in real terms. From 2007 to 2011, they have risen by an average of 2% per semester, that is, by 25 times more. The period beginning in 2006 (or post-great moderation) has been characterized by two price surges: the FAO price index increased by 54% between January 2006 and June 2008, declined of 34% between June 2008 and December 2008, then rose by 53% before stabilizing in December 2010. In line with these, Figure 2 illustrates this with a sharp increase in oil and food prices and a positive co-movement of food and oil prices.

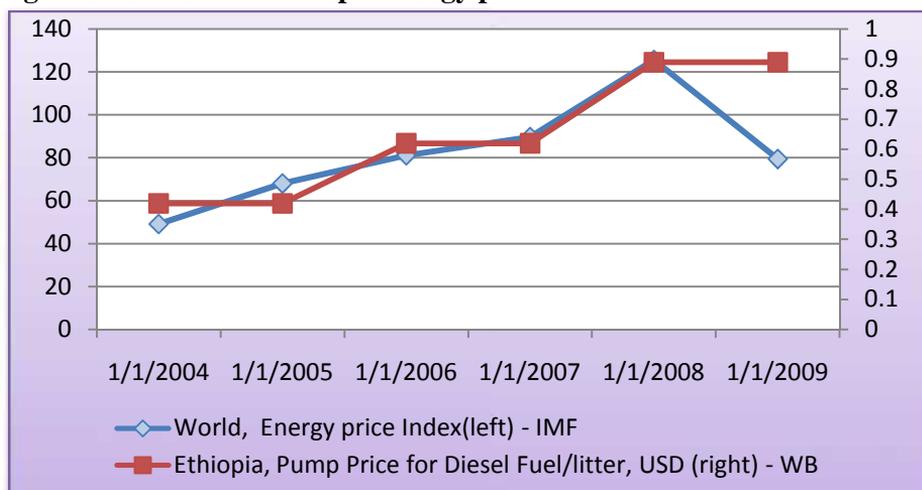
5.2 Implication of Commodity Price Shocks to Ethiopia

Following the commodity price shocks, the macroeconomic environments of many low and middle income countries had experienced negative shocks. According to IMF 2008, as a result of strong and persistent increases in international oil prices or in food prices, a large group of low and middle-income countries is experiencing a substantial weakening of their balance of payments, an acceleration of inflationary pressures, and a substantial weakening of their reserve position. Empirically, for net oil and food importing poverty reduction and growth facility (PRGF) eligible countries, the combined adverse effects of shocks on their balance of payments rose by an additional 1½ percent of GDP on average during May-July 2008 (IMF, 2008).

Effect on Price of food and fuel: Ethiopia, as one of the low-income country, has exhibited an increase in the price of oil and food during the commodity price shocks. During the shock (early IV quarter of 2007 to late III quarter of

2008), the pump price for diesel per litter has increased by 111.9 percent from its value in 2005 (Figure 3). To note here that, even though the world energy price index has shown a steep decrease after its peak in 2008, the decrease in Ethiopia was not significant. This could be attributed to the lifting of oil subsidy program of the government during the same period. A close examination of Figure 3 reveals that the international and domestic oil prices have a strong correlation in that the two prices moves together. Until the end of August 2008, the gap between domestic and international prices (can be understood as the gap between the two lines in Figure 3) was very minimal since the government has been subsidizing oil prices. From September 2008 onwards however, the government suspended the oil price subsidy scheme resulting in widening of the gap between international and domestic price of oil. Besides, the gap was precipitated by the decline in the foreign exchange value of the Ethiopian birr from the end of 2008 onwards.

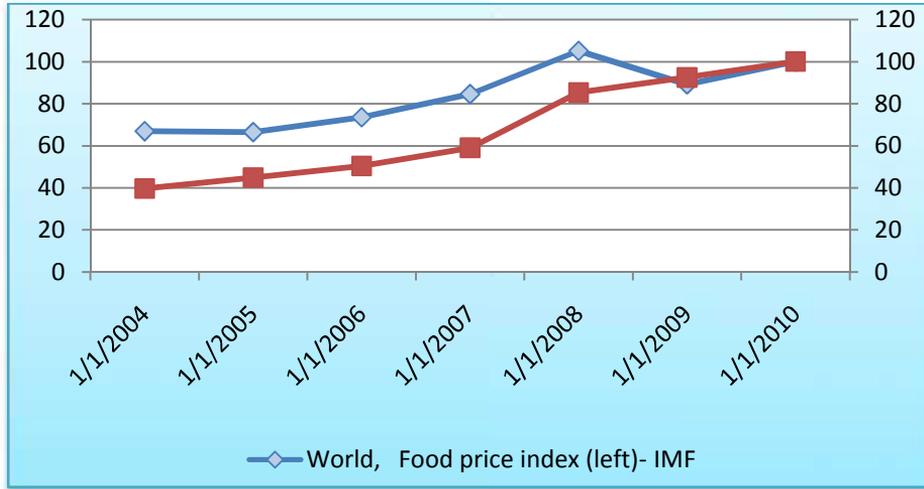
Figure 3: Global and Ethiopia energy price index



Source: WB (2015) and IMF (2015) own construction.

Similarly, following food price shocks, the consumer's price index has shown an increasing trend over the period's shocks. It has increased from 90.1 percent to 106.22 percent in the shock period-between early fourth quarters 2007 to late third quarter 2008 (Figure: 4).

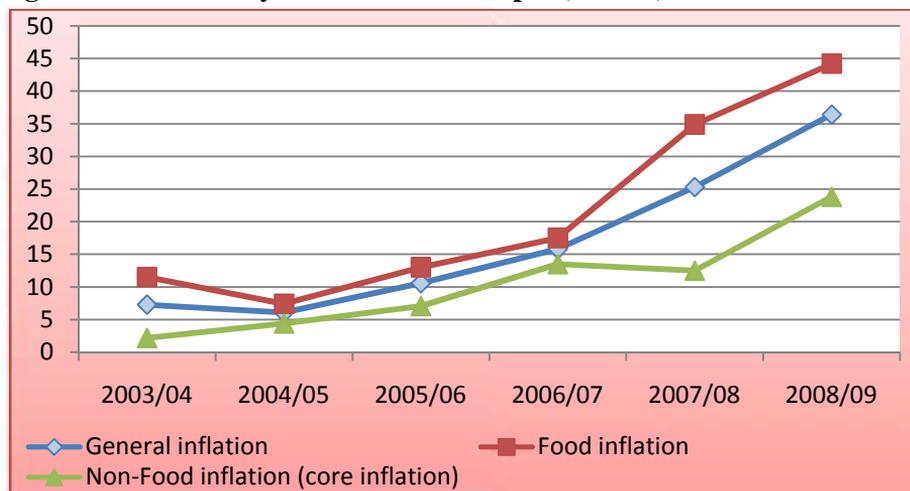
Figure 4: Global – Ethiopia food price index



Source: WB (2015) and IMF (2015) own construction

Inflationary Effects: Associated with the rise in the prices of oil and food commodities, the inflationary situation of the country has exhibited similar patterns. Even though historically Ethiopia has been one of the low inflation economies with average inflation rate of less than 5 %, since 2006/07 however, Ethiopia has no longer been considered a low inflation country. On a year-by-year basis, annualized headline inflation reached 15.8 percent, 25.3 percent, and 36.4 percent in 2006/07, 2007/08 and 2008/09 respectively (Figure 5). The major causes were then high fuel and food prices shocks, weaker foreign exchange earnings, and rising demand for imports that depleted international reserves of the country. The highest price increase was observed in food, housing, fuel and transport services. The rise in the annualized headline inflation was largely attributed to the rise in international food and oil price rise according to NBE consecutive annual reports.

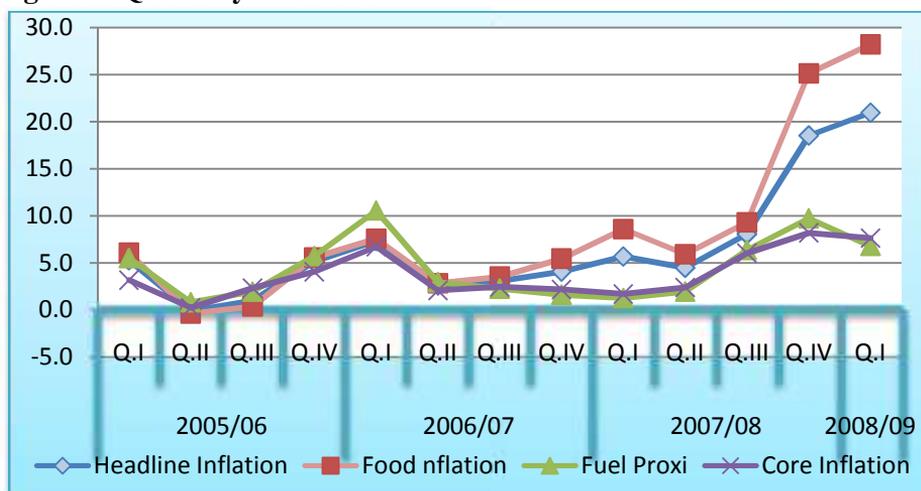
Figure 5: Inflationary situations in Ethiopia (annual)



Source NBE, own computation

On a quarterly basis, the first quarter of 2006/07 exhibited a significant rising trend in headline inflation rate greater than 6 % where it is moderated to 2.1 percent in the second quarter of the same year and starts to rise in the third and fourth quarters until it reach 5.7 percent in the first quarter of 2007/08 (Figure 6). The change in both food and nonfood inflation has contributed to the movement in the general inflation rate. Rapid economic transformation and accompanied structural changes as well as rising world commodity prices have contributed to higher domestic prices. Core inflation (nonfood inflation) varies mainly due to fuel price index inflation that rises and falls with the international situation.

Figure 6: Quarterly inflations

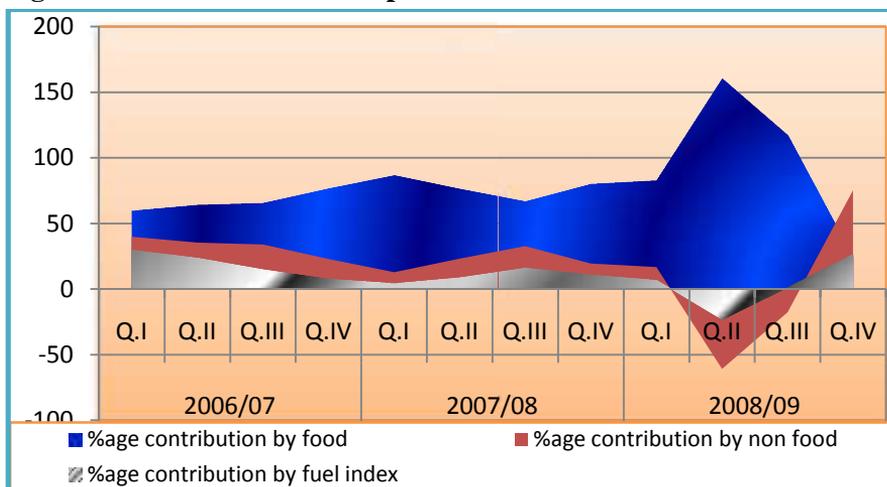


Source: NBE, own computation

In terms of contribution to the headline inflation, food inflation constitutes the largest share throughout the study period (Figure 7). In part, it can be attributed to the weight attached to it (52.01 percent). On the other hand, nonfood inflation, as observed from Figure 7, is largely influenced by the change in the price of oil. This implies that nonfood inflation is sensitive to oil inflation as evidenced by Fekadu (2005), who indicated oil price increase has a significant impact on the core inflation (nonfood inflation). Further, according to African development bank (2011), among the drivers of short-run inflation in Ethiopia is the rise in oil price.

Other Documented Effects: In addition to effects on price of commodities and inflation, external shocks are also documented to have a deteriorating effect on other macro- and micro- environments of the nation. Ahmed (2007), Birouke, Frehiwot, and Zewdu (2012), revealed that oil price shocks have a deteriorating impact on private consumption and investment, a depreciation impact on Birr (Ethiopian currency), adversely affects public investment, rise in price of tradable goods, and a contractionary effect on the output of manufacturing and service sector associated with the shifting of resources from oil intensive sector to other sectors.

Figure 7: Contribution of components to the headline inflation⁶



Source: NBE, own computation

With regard to food price shocks, the study by Elisa T., (2011) indicates that, due to the loss of purchasing power and its impact on expenditures distribution, in both rural and urban areas a larger proportion of individuals would have been pushed below the poverty line. Their estimates indicate the increase in food prices represents a higher share of poverty impact in urban areas than in rural areas, which can be attributed to higher share of food expenditure in urban than in rural counterparts.

Fiscal Policy Responses: As a coping strategy for oil price increase, price subsidies and petroleum product tax reduction are the two most commonly used methods of partially offsetting higher oil prices in the international market. Ethiopia spent more than 7.7 billion ETB (794 million USD) on fuel subsidies to stabilize the oil market between August 2006 and January 2008

⁶ Food inflation has weight of 52.01 percent to the headline inflation; core inflation has weight of 47.99percent to the headline inflation. Besides, fuel index which includes fuel and power, beverages, house rent, construction materials, water, has weight of 75% to the core inflation and has weight of 20.56% to the headline inflation.

The contribution of components to the headline inflation is constructed by considering their relative weight.

$$\text{E.g. percentage contribution of food inflation to the headline inflation} = \frac{\text{food inflation} \cdot \text{its weight (52.01)} \cdot 100}{\text{headline inflation}}$$

(Masami K. 2009). This is equivalent to 4.02 percent of nominal GDP of 2007 fiscal year, a midyear in between 2006 and 2008.

However, the subsidy benefitted rural and urban high-income households rather than targeted poor households, and by increasing government expenditures it exacerbated budget deficit, through which the government finances the deficit by borrowing from external as well as domestic sources (NBE, quarterly reports from 2007/08 to 2008/09). In October 2008, therefore, the Council of Ministers decided to eliminate fuel price subsidies, resulting in a price increase of 50 percent for kerosene and 40 percent for diesel (Masami K. 2009).

With regard to subsidy to food price rise, unlike to various measures, it was less effective partly because policy makers often lack sufficient information to gauge the likely causes and effects of food price rise on the economy and to identify, design and implement policy actions that can best avoid risks. The Ethiopian government adopted immediate ad hoc measures to protect urban households. In April 2007, an urban food-rationing program was announced, and from 2008 up to now, households in possession of a ration card could have access to subsidized wheat. However, according to the World Food Program and (UNICEF 2009), a large proportion of urban poor did not have the card. In rural areas, no measures were adopted until 2008. Furthermore, some adjustments in the Productive Safety Nets Program (PSNP), a large-scale program, which started in 2005, were constrained by limited resources. The cash wage paid to public-works participants was raised by one third, but its purchasing power had already declined in May 2008 by 62 per cent (Gilligan et al. 2009).

6. Monetary Policy Response and Transmission Mechanism Analysis

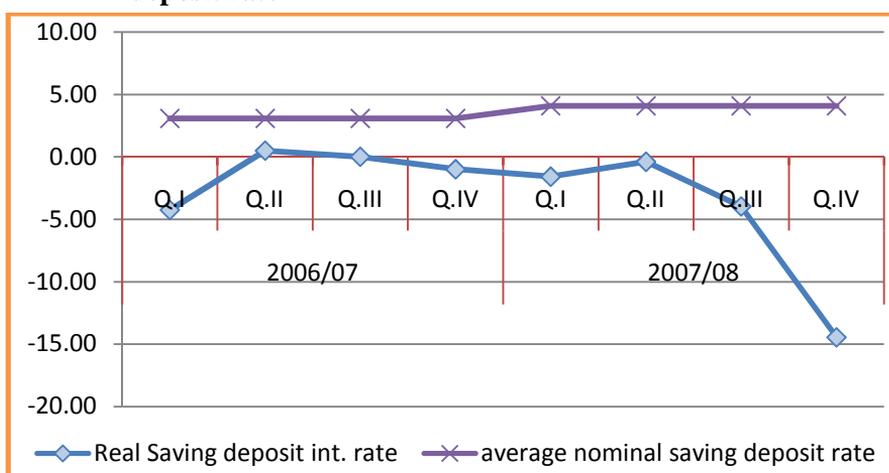
6.1 Monetary Policy Responses

Accommodation

During the shock period, even though the inflationary pressure has remained the most serious concern of the government, the National Bank stayed until July 2007 to take actions on its instruments. The quarterly movement of real

saving deposit interest rate and the vigorous (overheating) of the economic activity explained by the positive output gap⁷ /output above the potential level can infer the accommodative nature of monetary policy(Figure 8 and Figure 9). Given there was no significant increase in the interest rate structure of commercial banks, the real saving deposit rate was negative in real terms, considering the quarterly general inflation that coincides with the expansionary phase in the output gap.

Figure 8: Quarterly real saving deposit rate and nominal average saving deposit rate



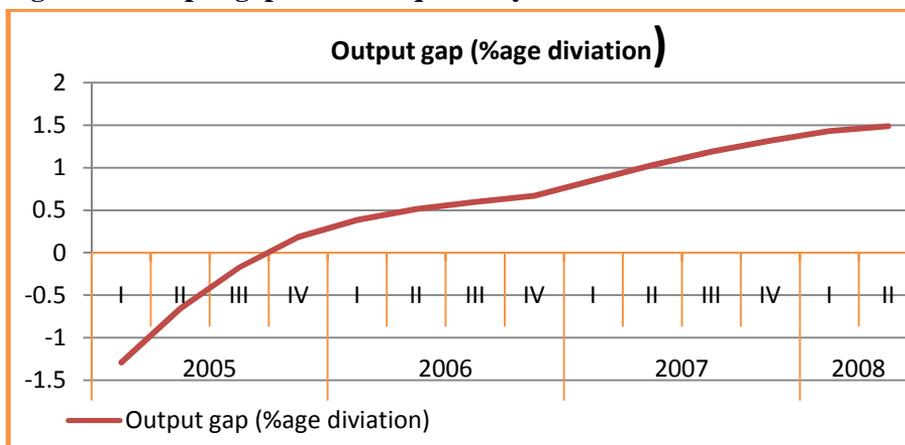
Source: NBE, own computation

However, with regard to monetary aggregates, the growth in broad money is anchored to be in tandem with nominal GDP growth and in line with the objective of price stability. Accordingly, broad money supply grew by 22.2 percent during fiscal year 2006/07 compared with 2005/06 that was lower than the 29.8 percent nominal GDP growth registered in 2006/07 showing prudent monetary policy (Figure 10).

⁷ Output gaps are estimated with a Hodrick-Prescott filter on the quarterly real GDP from IMF IFS (2010=100), Constant Prices.

When the economy is running an output gap, either positive or negative, it is thought to be running at an inefficient rate as the economy is either overworking or under working its resources

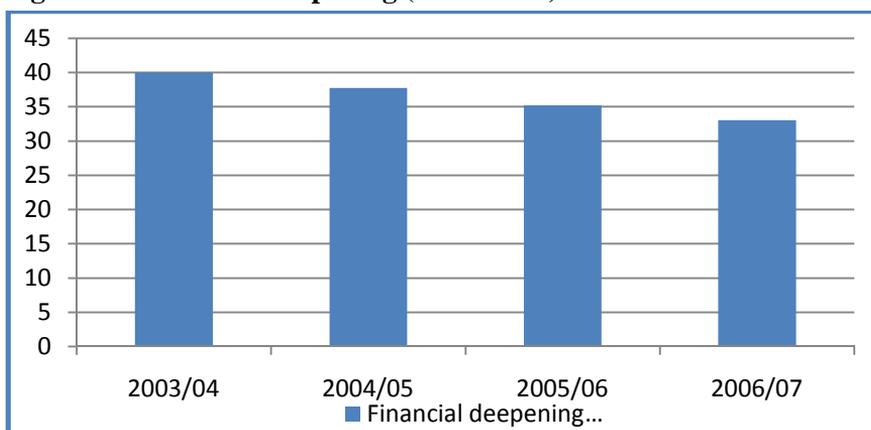
Figure 9: Output gap based on quarterly real GDP



Source: IMF, own computation

The ratio of M2/NGDP, an indicator of financial deepening went down by 5.9 percent to 33.1 against the previous year. It reflects the tight monetary policy measures pursued during the period despite the strong demand for money in line with the expansion of the economy (Figure10).

Figure 10: Financial deepening (M2/NGDP)



Source: NBE, own computation

In spite of the prudent monetary policy pursued by the government, FY 2006/07 witnessed continued build-up in inflationary pressures amidst remarkable economic growth that, reflecting or responsible for an increase in the transaction demand for money. This leads the NBE to raise the reserve requirement from 5

percent to 10 percent and the minimum interest rate on savings and time deposits from 3 percent to 4 percent towards the end of 2006/07.

From Accommodation to Effective Actions

Even if NBE has conducted a tight monetary policy by rising reserve requirement from 5 percent to 10 percent and minimum interest rates from 3percent to 4 percent effective from July 2007, throughout the year 2007/08 however, the problem of inflation has continued daunting challenge in the country where, annual average headline inflation reached 36.4 percent in 2007/08 against 6.1 percent in 2004/05 which was unprecedented in a low inflation country like Ethiopia (Figure 6). It was mainly due to the consequences of continuing rising world commodity prices and internal factors including rapid economic transformation accompanied by structural changes and supply side constraints.

Moreover, in response to NBE's upward revision of the minimum interest rate on savings and time deposits from 3 percent to 4 percent effective from July 4, 2007, commercial banks revised their minimum deposit interest rates on saving and time deposits upward by one percentage point from 3.08 percent to 4.08 percent. However, considering the high headline inflation, all deposit rates and average weighted yields on T-bills were negative in real terms (Figure 7) which can imply ineffectiveness of monetary policy to bring down inflation to a target of single digit, even though it could decrease the pace of inflation.

In addition to those instruments implemented as of July 2007, the NBE further took various policy measures during the fourth quarter of 2007/08 that could help mitigate inflationary pressures, witnessed in recent years. Accordingly, it has further raised the reserve requirement ratio from 10 percent to 15 percent (by 500 basis points) for the second time since July 2007 and liquidity requirement from 15percent to 25percent (by 1000 basis points) effective from April 7, 2008.

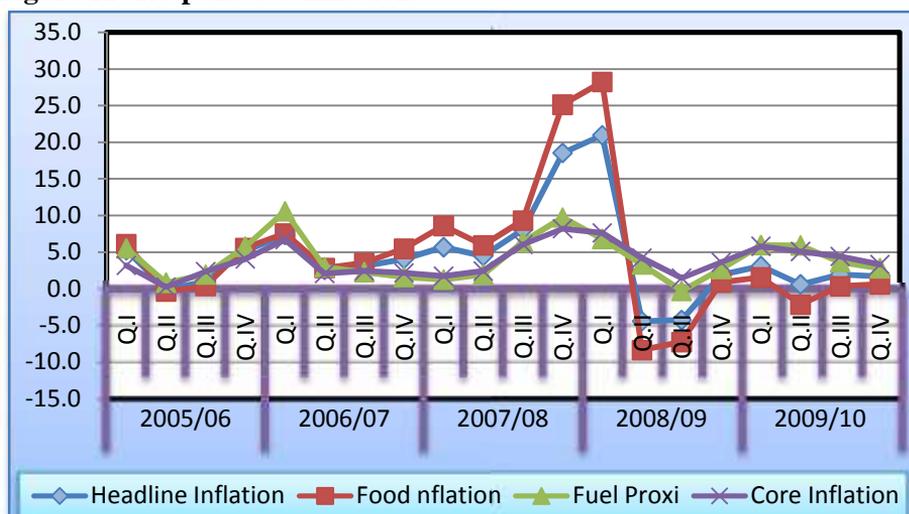
During the same period, there were also various fiscal and administrative actions of the government including subsidizing domestic fuel retail prices despite persistent rise in international market, supplying wheat and edible oil at lower prices to low-income households in Addis Ababa and other towns in the regions and introducing Ethiopian Commodity Exchange (ECX) and

others. The primary objective of those actions was to mitigate the impact of inflation on the low income groups of the society and to contribute towards slowing down the pace of inflation and inflationary expectations.

6.2 Changes to Macroeconomic Indicators

Immediately after implementation of tight monetary policy, (supported by fiscal and administrative policies), nonfood inflation exhibits a decreasing trend until it becomes stable for the next year 2009/10. On the other hand, the tight monetary policy starts to be effective on headline inflation and food inflation starting from the second quarter of 2008/09 where both decreased to reach negative levels of -0.1 % and -8.4 % respectively (Figure: 11). The one-quarter lag in the response of food inflation can be attributed to the ineffectiveness of fiscal and administrative measures of the government concerning food policies, which was unlikely to be the case for fuel prices.

Figure 11: Responses to inflations

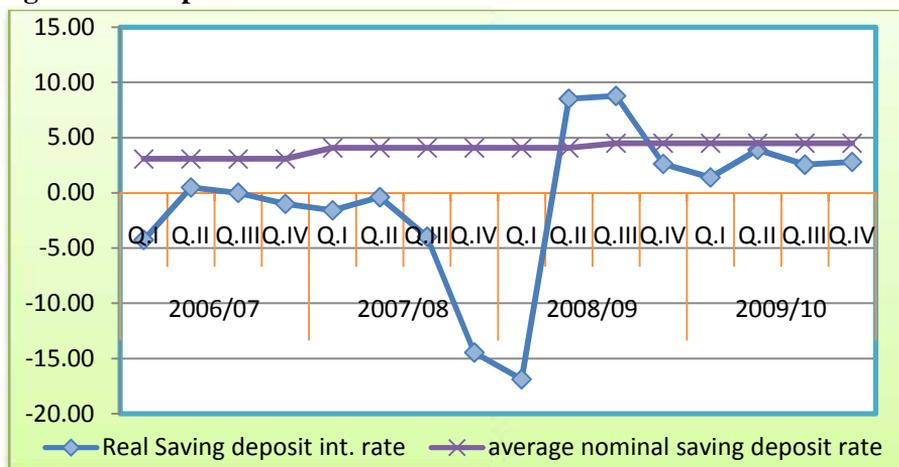


Source: NBE, own computation

Moreover, the tight monetary policy (rising in the RRR and liquidity ratio) has also contributed for the increase in the average saving deposit rate from 4.08 percent in 2007/08 to 4.5 percent in 2008/09. In addition to this, considering the core inflation, the real interest rate rises to be positive starting from the

second quarter of 2008/09 can largely be attributed to the decrease in inflation following the tight monetary policies (Figure: 12).

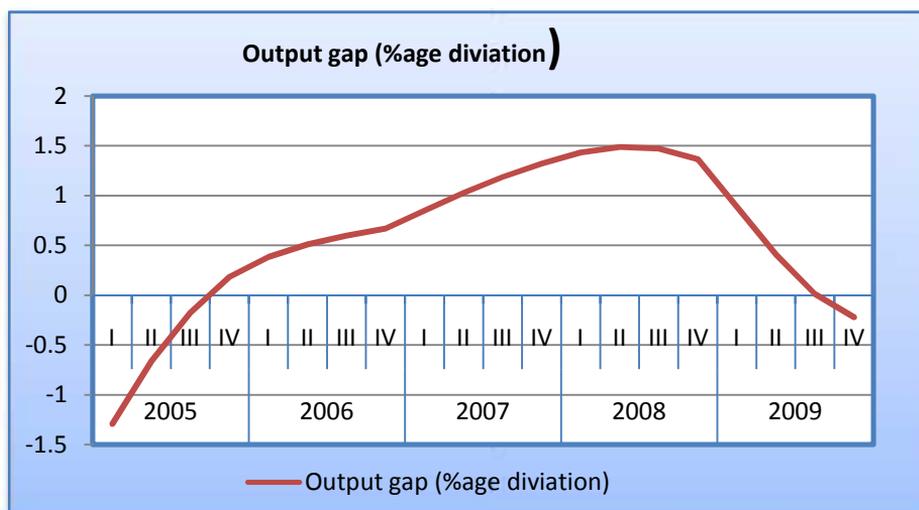
Figure 12: Responses to real interest rate



Source: NBE, own computation

The output gap which is an economic measure of the difference between the actual output of an economy and the potential output (efficient output) of the economy starts to become cold following the tight monetary policy measures (Figure: 13).

Figure: 13 Output gap



Source: IMF, own computation

6.3 Inside the Black Box

6.3.1 Reserve Requirement and Money Supply

Basic Process

The central banks reserve System can use, in theory, reserve requirements as a monetary policy tool for controlling the money supply and interest rates. The process would work like this:

- First, after evaluating the state of the economy, the CB determines whether the money supply needs to increase or decrease and by how much.
- Second, if the CB wants to increase the money supply it lowers reserve requirements and if it wants to decrease the money supply it raises reserve requirements.
- Third, the higher or lower requirements mean commercial banks have to keep fewer or more reserves to back up deposits.
- Fourth, the change in reserves that banks have to keep induces a change lending activity. If reserve requirements are higher, then banks have fewer reserves available for lending. If reserve requirements are lower, then banks have more reserves available for lending.
- Fifth, the change in bank lending affects the creation of checkable deposits, which are an important component of the money supply. More loans mean more deposits and an increase in the money supply. Fewer loans mean fewer deposits and a decrease in the money supply.
- Sixth, the change in bank lending also affects interest rates. If banks are willing to lend more, then interest rates fall. If banks are willing to lend less, then interest rates rise.
- Finally, interest rates, an important variable to link real sector to the financial sector will start work on.

6.3.2 Channels of Monetary Policy

Even though a powerful tool, monetary policy could have unexpected or unwanted consequences. To be successful in conducting monetary policy, the monetary authorities, must have an accurate assessment of the timing and effect of their policies on the economy, thus requiring an understanding of the mechanism through which monetary policy affects the economy. Specific to

developing countries, where the financial sector is not well developed, channels through which monetary policy is transmitted includes money channel, interest rate channel, exchange rate channel and credit channel.

Money Channel: This channel assumes that changes in reserve money are transmitted to broad money via the money multiplier that banks are in the business of creating inside money. When the central bank changes the reserve requirement that banks should keep in it, the amount of money available for banks to lend will be changed. This changes the capacity of banks to create money via lending in the economy. But this argument also assumes a role for individuals holding components of broad money, currency in circulation, and various forms of deposits. It is still a significant channel in countries where financial depth is low and money is still a major asset in people's portfolios as in Ethiopia.

Interest rate channel: This channel works through and assumes the standard Keynesian IS-LM framework, where prices are rigid in the short run. The change in monetary policy stance through the short term nominal interest rate affects real interest rate, which in turn impacts aggregate demand and prices by changing firms and household's investment and consumption decisions. In line with these, a tightening of the monetary policy stance translates into higher interest rates, lower aggregate demand and reduced inflationary pressures. The reverse will be true for expansionary monetary policy stance.

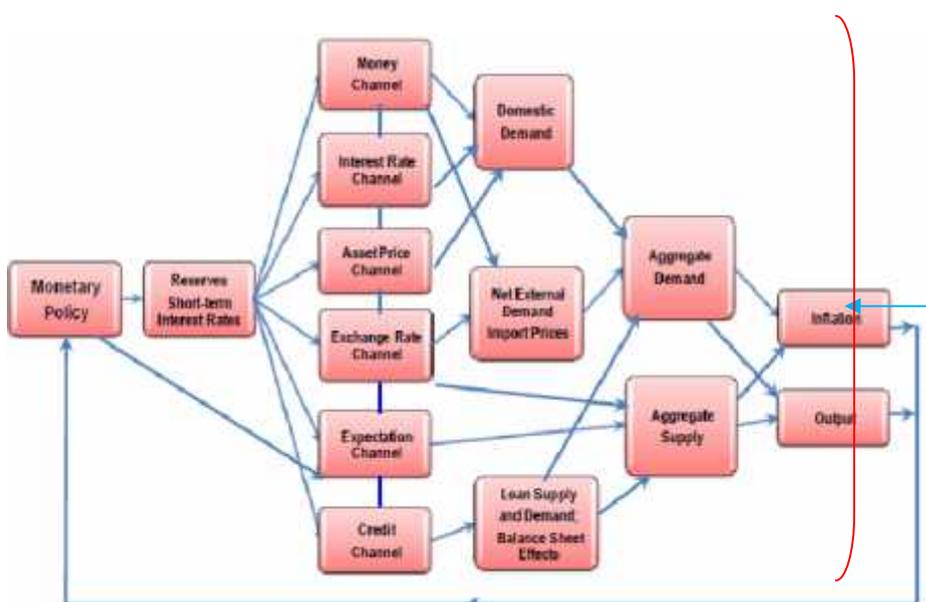
Exchange rate: with the growing internationalization of countries economy, once the monetary policy affects the reserve money and in turn the real interest rate, change in real interest rate can affect the flow of capital to and from a nation. An increase in real interest rate attracts capital investment to the nation and subsequently induces an appreciation of the domestic currency⁸⁸. In the contrary, a decrease in real interest rate leads outflow of capital investment and induces a depreciation of the domestic currency. In turn, movements in the exchange rate will directly affect inflation by changing

⁸⁸ It is by considering the definition of exchange rate as the amount of domestic currency required to purchase a foreign currency.

the cost of imports and will, by moving the real exchange rate, affect net exports and aggregate demand. (Andrew B., 2013).

The credit channel: A restrictive monetary policy can induce banks to use non-price mechanism to limit their supply of credit. It operates via two main channels, which are the bank lending channel and the balance-sheet channel. In bank lending channel, a decrease in money supply leads to a decrease in bank deposits, which further decreases the volume of money that banks have to loan out. This, in turn, decreases investment and, ultimately, aggregate demand. Credit rationing as a byproduct of credit channel may also arise, when borrowers are denied to loans even if they are willing to pay high interest rate that leads to adverse selection and moral hazard problems as loan is curtailed to good quality borrowers,

Figure 14: Channels of monetary policy



Source: Davoodi H., S. Dixit and G. Pinter (February, 2013)

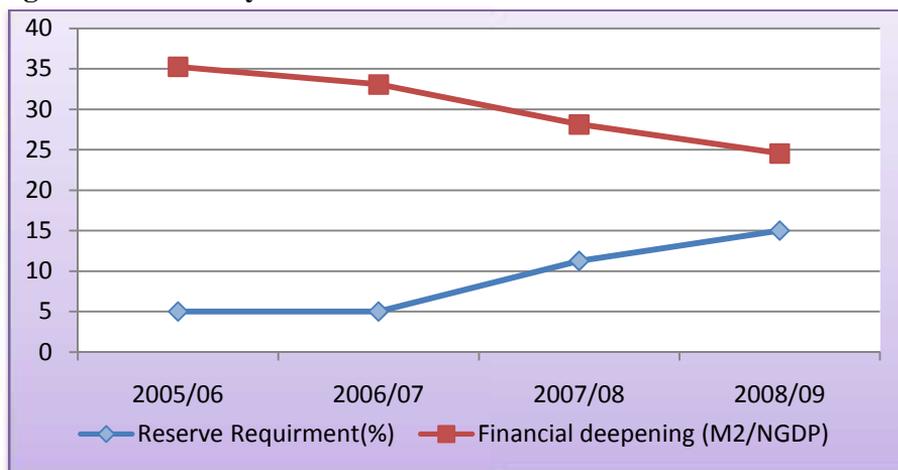
The balance-sheet channel and the cash-flow channel on the other hand, work through changing the value of collaterals held by households and firms that can be pledged to get credit. Accordingly, a restrictive monetary policy raises the interest rate, which in turn decreases the value of collaterals that makes

access to credit tight, and results in lower aggregate demand and inflation. (Andrew B., 2013)

6.3.3 Channels to Monetary Policy Shock in Ethiopia

Monetary channel: The pass-through from the tight monetary policy to the financial deepening is quick and effective. When the RRR increases, it shows the ratio of broad money supply to nominal GDP (financial deepening) continues to decrease immediately. This indicates the effectiveness of the monetary channel, as expected in countries like Ethiopia where financial depth is low and money is the major asset in the people's portfolios.

Figure 15: Monetary channels



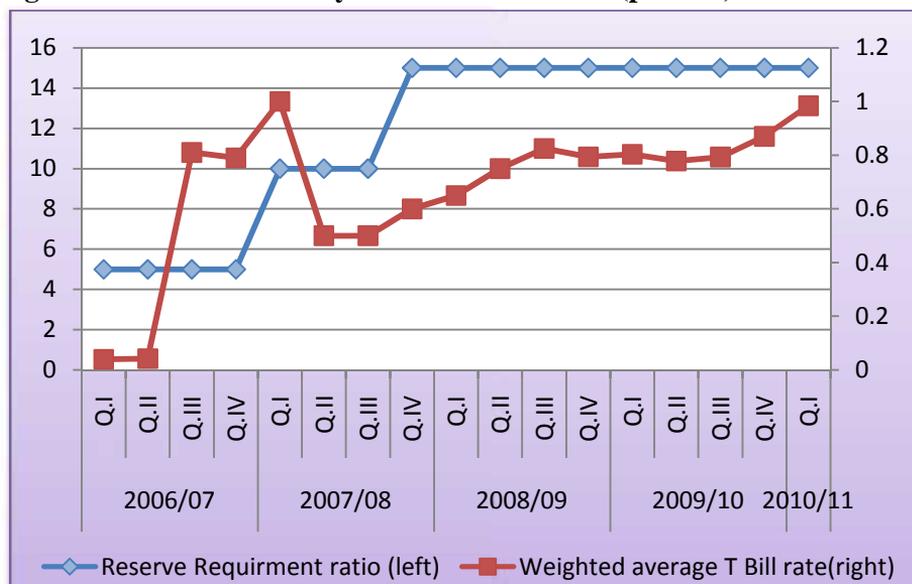
Source: NBE, own computation

Interest rate channel: the policy stance influences interest rates both in the financial market as well as in the intermediaries. Accordingly, the contractionary monetary policy induced by rising RRR and liquidity ratio is expected to have an increasing effect on money market interest rate as well as banking rates.

Money market Rate: Data indicate the pass-through from the policy rates (RRR) to the money market interest rate (using weighted average Treasury

bill rate⁹). It shows the transmission from the policy rate to money market interest rate is quick and consistent (following the second policy shock). The weighted average Treasury bill rate composed of 28 day bill, 91 day bill and 182 day bill responds starting from the first period policy shock and continues to the second policy shock.

Figure 16: RRR and Money market interest rate (percent).



Source: NBE, own computation

Bank rate

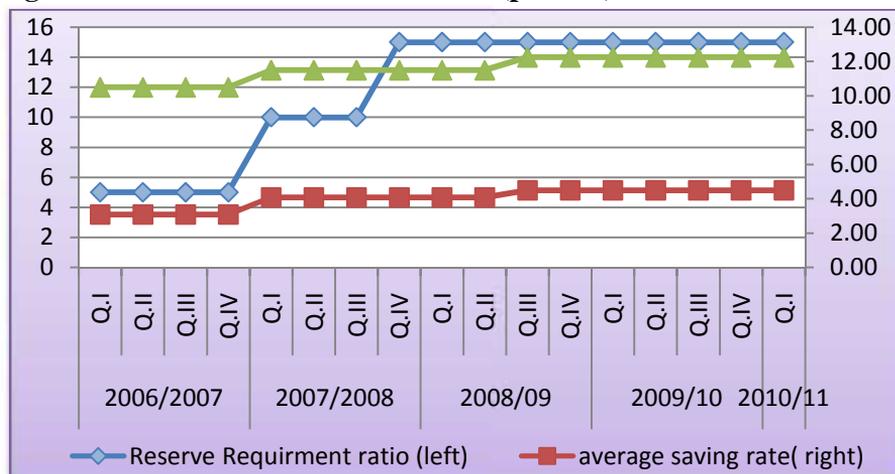
The data also shows, the transmission from the policy rate to the banking rate (comprising average saving rate and average lending rate) is also evident even though it looks slow to transmit. It indicates, banking rate responds to restrictive monetary policy slowly with a lag of between three and four quarters¹⁰.

⁹Due to the absence of inter-bank money market transactions (most periods), no sufficient data is available for Inter- Bank Money Market rate.

Further, weighted average T-bill includes T-bills issued for 28 days, 91 days and & 182 days maturity.

¹⁰The rise in lending and deposit rates during the first quarter of 2007/08 is due to policy shock of rising of minimum deposit and lending rate.

Figure 17: RRR and Bank interest rate (percent).



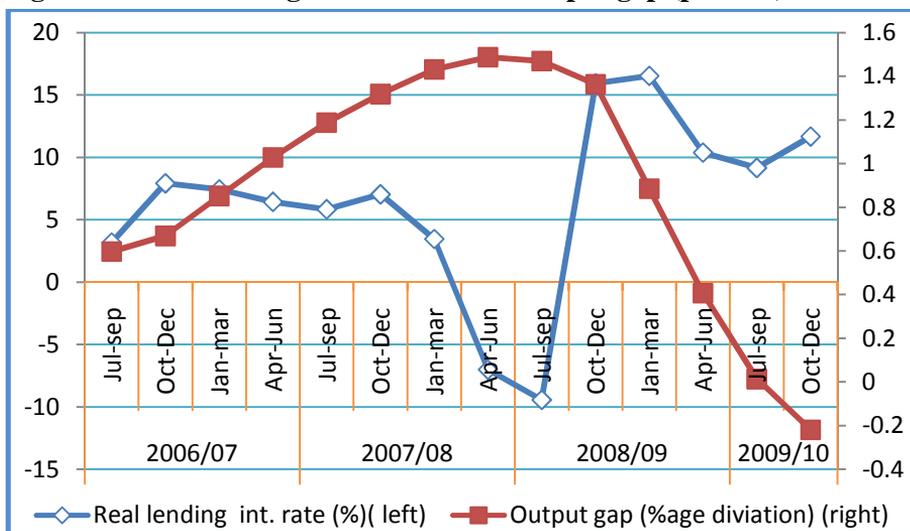
Source: NBE, own computation

Aggregate Economic Activity (output gap)

What matters the most is probably the real interest rate that can determine private consumption decision of households' vis-à-vis its effect on saving decision. It also determines the investment decision of firms' vis-à-vis the cost of capital decision. Those decisions can be captured through interest elasticity of aggregate demand.

In line with this, the study suggests that the tight monetary policy has contractionary effects on aggregate economic activity where the negative real lending interest rates are associated with output above the potential level and positive real lending interest rates are associated with output gap calm down to its potential level (Figure 18). Furthermore, it shows that the transmission goes fast nearly after one-quarter lag.

Figure 18: Real lending interest rate and output gap (percent)¹¹



Source: NBE, IMF, own computation

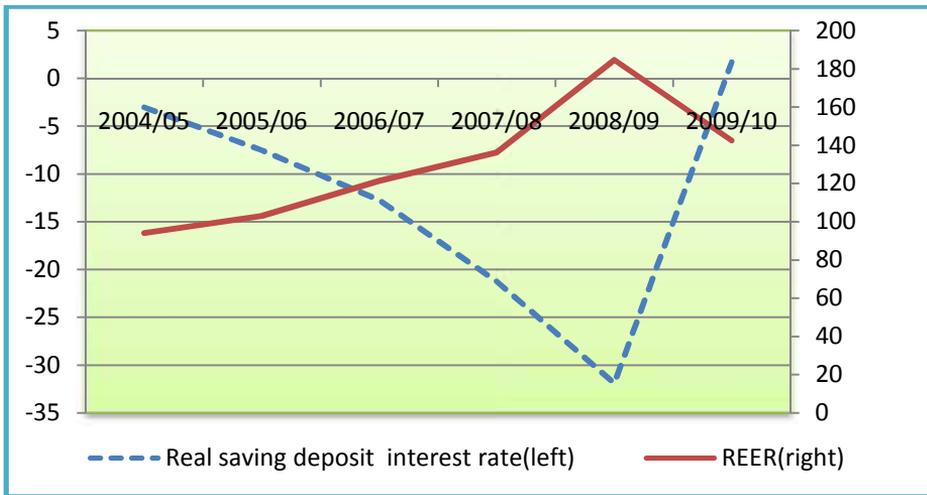
Exchange Rate Channel

The pass-through from real saving deposit rate¹² to appreciation and depreciation of real effective exchange rate looks correlated. The change in real saving rate shows a significant link to the movement of the real effective exchange rate. Also the real effective exchange rate continuously rises with the decrease in the real in interest rate and when the real interest rate increases, the real effective exchange rate show an appreciation (Figure 19). The pass-through from percentage change in exchange rate to inflation (headline) also looks apparent. The evidence suggests the pass through took one quarter lag (Figure 20). Furthermore, across the period the continuous appreciation and depreciation of the real effective exchange rate shows the decrease and increase in the competitiveness of the home economy relative to the main trading partners.

¹¹ Real interest rate is calculated by using real lending interest rate in the World Bank data as well.

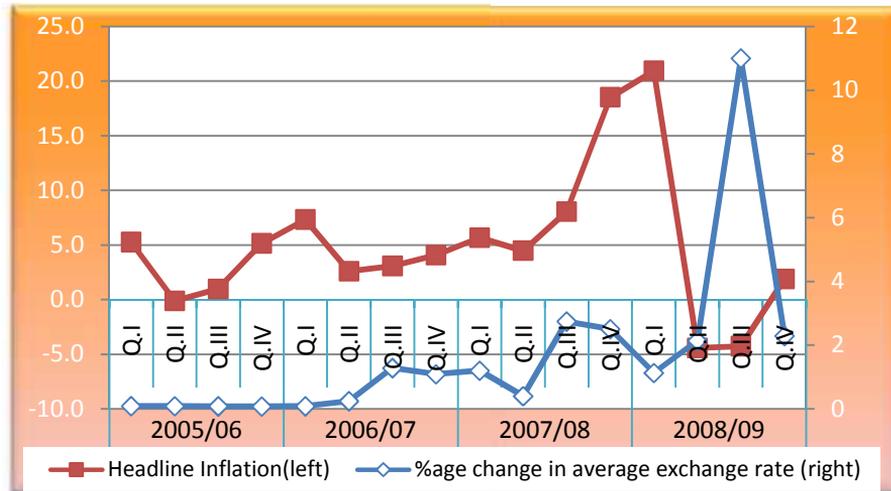
¹² Real saving deposit is selected due to absence of interbank rate and the relative strength of real saving interest rate to capital movement.

Figure 19: Real saving deposit rate and real effective exchange rate (annual)



Source: NBE, own computation

Figure 20: Percentages change in exchange rate and headline inflation

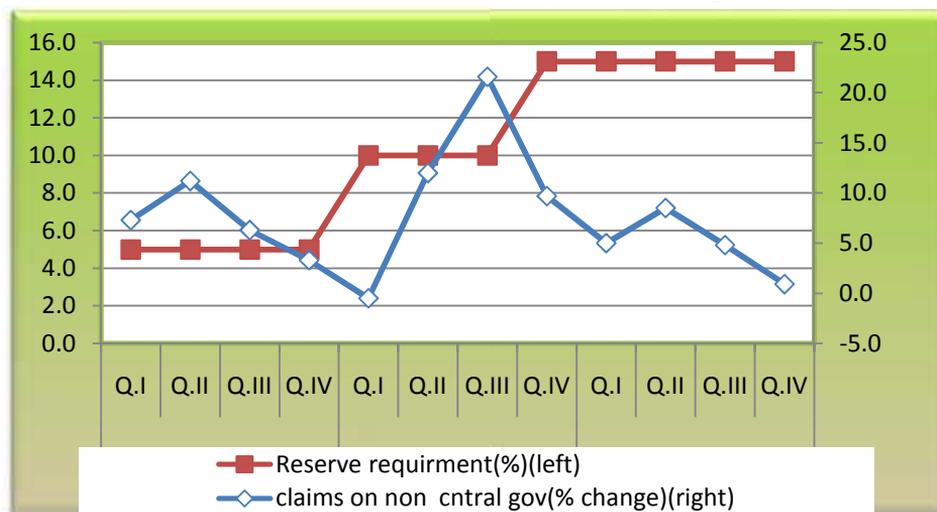


Source: NBE, own computation

Credit Channel

The study also shows the existence of a credit channel which is fast to pass-through from the policy rate to the credit to non-central government. Starting from an increase in the reserve requirement ratio from 10% to 15%, growth in credit to the private sector exhibits decrease in growth rate (Figure 21).

Figure 21: RRR and claims on non-central government (percent)



Source: NBE, own computation

7. Summary and Conclusion

External shocks through the rising of the international oil and food price become a permanent reality, with oil price attaining its climax in 2008, followed by the increase in food price over the same period. Depending on its characteristics, these shocks unless properly managed will have adverse consequences of dislocating the economy of a given nation. Theoretical considerations reveal that the rising of international oil and food prices raises dilemmas to monetary authorities through its adverse supply and demand shocks.

External price shock to the commodities prices of 2007/08 is highly correlated to movements in price of energy and food in Ethiopia. Both consumer price index and pump price for diesel fuel exhibit similar trends with global food price and global energy price indexes. During the period, inflationary pressure has also reached its peak with the headline inflation about 36.4 percent during July 2008. Given the accommodative nature of monetary policy, and vagarious economic activity, output gap has become positive and real saving interest rate exhibits negative rate until effective monetary policy has been conducts as of April 2008.

The monetary policy responses conducted during July 2007 look ineffective as inflation continued to increase; real interest rate exhibit negative value and output gap shows above the potential level. The National Bank of Ethiopia supported by fiscal and administrative strategies, has conducted effective monetary policies by raising the reserve requirement ratio by 500 basis points and the liquidity requirement by 1000 basis points effective April 2008. This has brought significant decrease to inflation; an increase in real interest rates and cool down the vigorous economic activity to its potential level. Clear transmission of monetary policy is found for all monetary, interest rate, exchange rate and credit channels.

8. Policy Suggestion

Pertinent to the responses by the National Bank of Ethiopia, the study has found that monetary policy alone was not effective to curb the impact on inflation and output gap unless supported by administrative and fiscal policies. The study therefore suggests the use monetary policy in compliment with administrative and fiscal policies including subsidizing domestic fuel retail prices and supplying food items at lower prices to low-income households.

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Access to Finance and Barriers to Financial inclusion in Ethiopia

Gebe Yemataw¹ and Gashaw Desalegn²

Abstract

In Ethiopia 78% of adults or 31 million people do not have a formal account. In this study both the supply and demand factors are analyzed to understand the access and barriers financial inclusion in Ethiopia. Thanks to the Ethiopian government and World Bank for their interest in collecting a very rich data set called ESS which includes financial inclusion from demand side for 2015/16 ESS. This study unusually attempts to combine both the supply and demand side analysis to understand access and barriers to financial inclusion in Ethiopia. From the supply side, Ethiopia has been far from the SSA and EAC in performance regarding access to finance. However data show that Ethiopia has a huge untapped potential in mobile and agent banking.

Both the descriptive and probit estimation informs that many socioeconomic factors are associated with reason for not having a formal account among Ethiopian adults. In line with other researchers such as (Demirgüç-Kunt and Levine 2008; Fungá ová and Weill 2015; Zins and Weill 2016) and (Demirgüç-Kunt et al. 2015) our result shows financial capability (income) and education are the most important factor. According to our analysis, both voluntary and involuntary exclusion are the most important barriers in Ethiopia. They are influenced by two types of factors: (1) variables that denote individual vulnerability such as financial capability, gender, age and both financial and general education level: (2) geographic variables such as living in rural areas and different regions, being worried about unexpected expenses (shocks) and religion.

Key words: Financial Inclusion, Barriers, Access to Finance, Ethiopia

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1. Back Ground

Globally 2 billion and in Ethiopia 31 million individual adults have no formal account at financial institutions. Often times, poor and vulnerable people such as women and young are excluded from the financial sector (Findex, 2014). Using the rich ESS data that has a lot of information on barriers to financial inclusion from the demand side, it is of particular interest to deeply investigate what individual's characteristics such as age, gender, income, education and etc are responsible for financial exclusion.

In Ethiopia the level of financial exclusion is intolerably high (78%). Let alone the urban and remote areas close to 40% of the adults in the capital city are excluded from the formal financial sector. Exclusion is very high among vulnerable social groups, 83 percent of females, 60 percent of financially incapable adults, 97 percent of financially illiterate are excluded from the formal financial sector (ESS, 2016).

Unlike many studies before (Beck et al. 2009); (Fungá ová and Weill 2015); (Zins and Weill 2016) and (Demirgüç-Kunt and Klapper 2012) we believe that both the supply and demand side of the financial inclusion and exclusion should be studied together so that a clear picture of the matter can be revealed.

In the supply side we used data that show access of financial institution such as bank and microfinance branch and ratios such as bank branch and ATMs per 100,000 adults from WB, IMF and National Bank of Ethiopia. In this section we have used data that shows mobile penetration and mobile and agent banking level compared to Sub-Saharan and Eastern African Communities (EAC).

In the demand side analysis ESS data is used. Both descriptive and empirical estimation using probit model is used, to understand the perceived physical and institutional barriers to a community and socioeconomic and demographic characteristics of individuals that potentially associated financial exclusion in Ethiopia.

To the knowledge of the researchers there is no study by far that studied barriers to financial inclusion using a big and rich data set such as ESS. Therefore, the objective of this study is threefold, one, it demonstrate the status of financial services from the supply side in Ethiopia, two, it also examine perceived barriers that are responsible for financial exclusion from the demand side, third, it shows the interplay between access to finance and barriers to use it, finally, it gives some policy recommendation that may remove some of the barriers and leads to a better financial inclusion.

The findings from this research are hoped to be useful in many ways. It could be helpful for policy making financial inclusion strategy. Since the study will attempt to reveal the major responsible factors and their relative contribution to exclusions of formal financial sector, the end user governmental and non-governmental organizations could take intervention measures and set appropriate plans to tackle the adult's exclusion from formal financial sector by identifying and giving priority for vulnerable social groups and individuals. This study is expected to contribute its part by filling the information gap concerning financial exclusion in the formal financial sector in the country. Finally, the study could be used as a stepping stone for further studies.

2. Access to Finance: A supply side approach

Both access and its counterpart exclusion are surprisingly hard to measure. For this section, we take the definition: Physical proximity to regulated financial infrastructure such as, bank Branches, Agents, ATM, POS, Internet Banking, Mobile Banking, Card banking etc. (NFIS, 2017) However, from a financial inclusion perspective, greater access does not necessarily imply a higher level of financial inclusion.

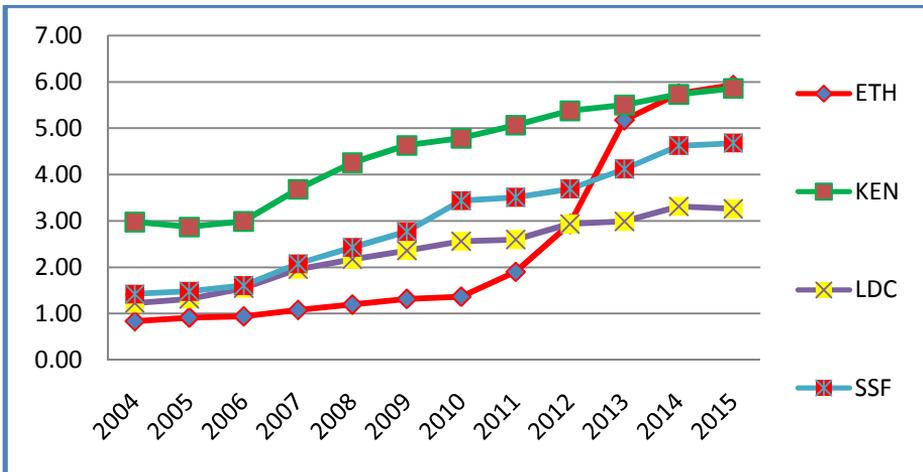
The major financial institutions operating in Ethiopia are banks, micro-finance institutions and insurance companies. As of 2016, there were 2 state owned and 16 private banks. In the same year, the numbers of micro-finance institutions (MFIs) and insurance companies reached 36 and 17³ respectively.

³ Source: NBE

There were less than 500 bank branches all over the country before 2008 for a population of around 80 million at the time. It only needed less than 3 years to approximately double the numbers of bank branches in the subsequent years. Starting in 2011 banks aggressively expand their branches. The biggest bank in Ethiopia the Commercial Bank of Ethiopia alone increased its branch by double in a single fiscal year (in 2011). As of 2016 there were 3282 bank branches in Ethiopia.

The branch expansion by the biggest government owned commercial bank of Ethiopia was a big policy measure. The bank has expanded its branch in all over the country aggressively but the result is twofold. In one hand, the bank has increased the number of its branches on the other hand, the measure taken by the biggest bank has initiated private banks to compete for their own market share and followed the same footstep of Commercial Bank of Ethiopia and expands their branch. The overall effort increases bank branch and hence financial access to Ethiopian adults.

Figure 1: Commercial bank branches (per 100,000 adults)

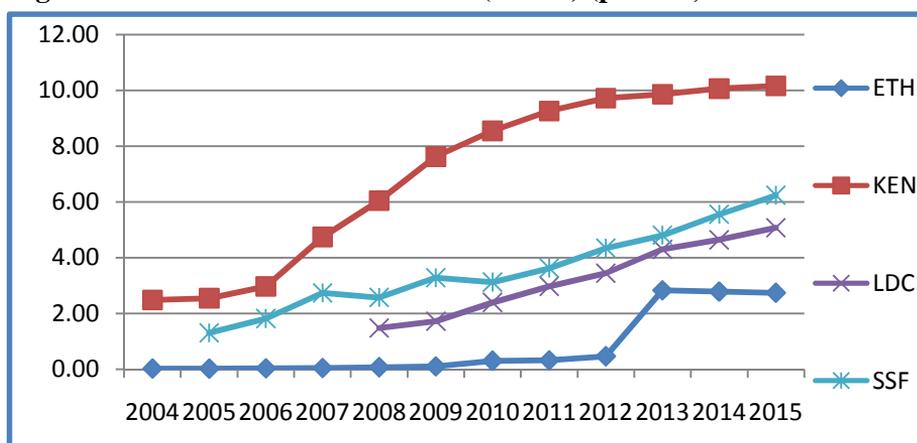


Source: IMF and NBE

Access to formal financial services represents the possibility for individuals to use them. The availability of infrastructure, ATMs and bank branches, captures the extent of accessibility to the formal financial system. Compared to Sub-Saharan and all LDCs Ethiopia have the lowest commercial bank

branches. Even there was no one bank for 100,000 adults in 2006. However, due to a progress made to increase bank branch in recent years, the ratio is now comparable to Sub-Saharan Africa (fig 1). Ethiopia is far from the neighboring Kenya in the ratio of ATMs per 100,000 adult. There was not one ATM for 100,000 Ethiopian adults before 2013. The number of ATM also is increasing in since 2013 (Figure 2).

Figure 2: Automated teller machines (ATMs) (per 100,000 adult



Source: IMF and NBE

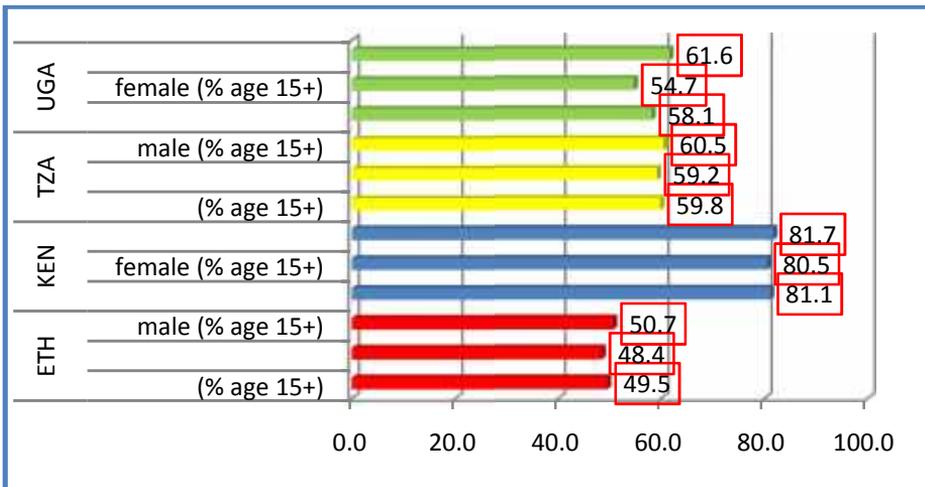
Although bank branch is expanding in many African countries including Ethiopia, a large proportion of its population remains unbanked. Bank accounts are often opened for processing payments (contracts, employment payments) results in dormancy(O’Connell et al. 2015). Lack of proper documentation, complex financial products and services, illiteracy, and inadequate infrastructure combined with the long distances to financial institutions are the main reasons for financial exclusion.

There are many challenges posed by traditional financial intermediations. Many developing countries found it difficult to provide access to financial services and products to all of their citizens using traditional method such as banking and microfinancing. However for many African countries, mobile banking is now a bright spot driven by necessity, innovation and new technologies, which is the advance of mobile banking and mobile money.

Sub-Saharan Africa is the world leader in mobile money accounts with 12% of the adult population now having mobile money accounts versus 2% globally. Only 13 countries in the world have mobile money account penetration of 10% or more and all of them are in Sub-Saharan Africa. Mobile banking and money accounts are particularly widespread in East Africa where 20% of adults have a mobile money account led by Kenya with 58%, and followed by Somalia, Tanzania and Uganda all having over 35%.

As shown in the figure below access to a mobile phone or internet at home for adult in the eastern Africa is at a high level led by Kenya 81%, Tanzania 60% and Uganda 58% respectively. The performance of Ethiopia is also very promising though it is 30 percentage points below the leader (Kenya). In Ethiopia, there are more than 50 million mobile subscribers. In Ethiopia the proportion of adults that have formal financial account is about 11million as of 2016. This figure is much less than the total mobile subscriber and this shows that there is a great potential in Ethiopia for financial inclusion using mobile banking.

Figure 3: Access to a mobile phone or internet at home

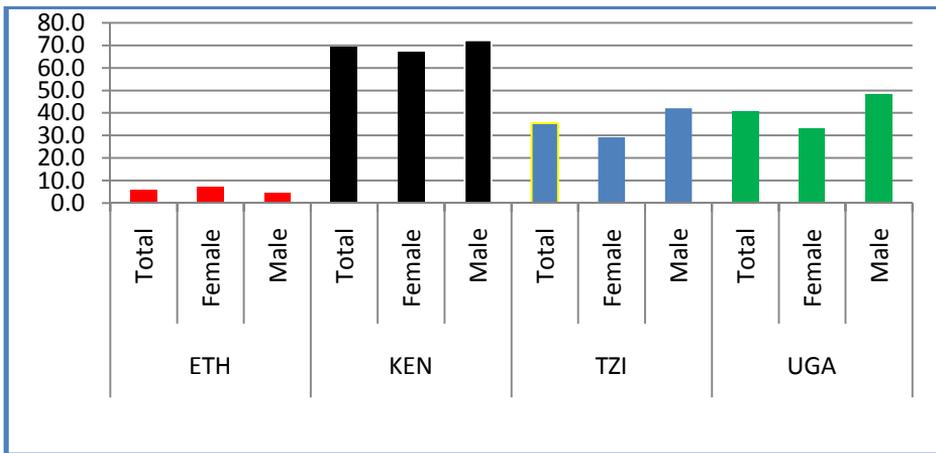


Source: IMF and own computation

In East Africa there are successful mobile financial service providers notably Safaricom's M-PESA in Kenya, Vodacom's M-PESA in Tanzania and MTN's Mobile Money in Uganda. Figure 4 indicates the proportion of adult's

population that made or received digital payments. When almost 70 percent of Kenya’s adult have made or received digital payments only about 6 percent of Ethiopia’s did. Surprisingly, though digital payment is low in Ethiopia, females lead men in this service usage by 2.2 percentage points. Most of the unbanked are females, young people, farmers and the poor, mostly in rural areas in Africa including Ethiopia (Findex, 2014). Digitalization of financial services will help females to be financially included.

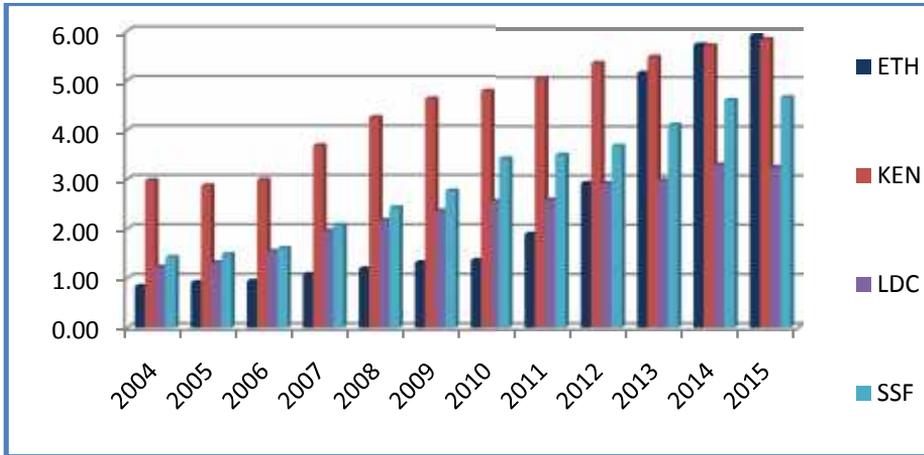
Figure 4: Made or received digital payment



Source: Own computation

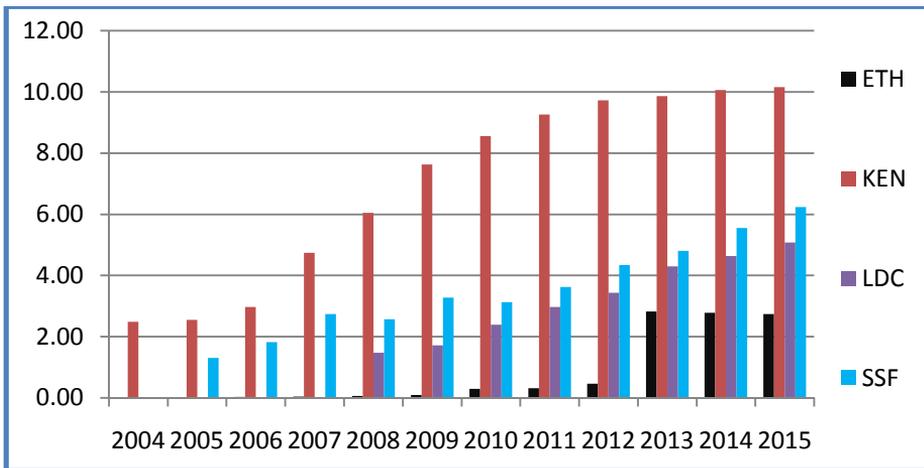
In Ethiopia the main mode of financial services are primarily banks and MFIs. There are 18 banks of which two of them are state owned banks. One state bank dominated the sector owning about 70 percent of the total asset in the sector. Despite, rapid branch expansion (more than four folds since 2010), more than a third of branches are concentrated in the capital Addis Ababa. However, more than 80 percent of the population lives in the rural area. The population per bank branch remains high (35,957 as of March 2015(IMF 2015) thus, the majority of the population is unbanked.

Figure 5: Commercial Bank Branch (per 100,000 adults)



Source: Own computation

Figure 6: Automated teller machines (ATMs) (per 100,000 adults)



Source: Own Computation

3. Barriers to Financial Inclusion: A Demand Side Approach

This section is devoted to analyze the barriers to financial inclusion from the point of view of the excluded themselves. Contrary to financial inclusion, literature on exclusion is scanty. There are some attempts by some researchers such as (Martínez et al. 2013) and (Zins and Weill 2016) among few others to analyzes barriers to financial inclusion from the unbanked point of view.

In Africa (Zins and Weill 2016) has found that people choose not to have an account due to lack of money and cultural reasons. By the same study education and income was found the main drivers against financial exclusion. In China (Fungá ová and Weill 2015) and Mexico the vulnerability or insufficiency of income and voluntary exclusion are the main barriers to financial inclusion (Martínez et al. 2013).

In this section we explore the self-reported reason for financial exclusion in Ethiopia. ESS data asked adults without an account at a formal financial institution why they do not have one, providing insights into where policy makers might be able to remove barriers to financial inclusion.

3.1 Data and Method of Estimation

3.1.1 Data and Sample

We use World Bank 2016 Ethiopian Socioeconomic Survey (ESS) data to realize our analyses. ESS is a collaborative project between the Central Statistics Agency of Ethiopia (CSA) and the World Bank Living Standards Measurement Study- Integrated Surveys of Agriculture (LSMS-ISA) project. ESS began as ERSS (Ethiopia Rural Socioeconomic Survey) in 2011/12. The second wave was conducted in 2013/14 and the third round is carried out in 2015/16.

Though, the ESS data is panel data sets, the earlier two waves did not contain the financial inclusion module. It only contains information on credit at a household level. However, the third wave of ESS contains a financial inclusion module. The survey covers 11,810 individual adults⁴, which are nationally representative samples of 4,958 households'. The target population is around 47 million population aged 18 and above. The survey questionnaire provides a large number of indicators on financial inclusion enabling to assess, the amount of account penetration, the use of financial services, the barriers of formal finance, etc. It also provides micro-level information – gender, age, and

⁴ Individuals whose age are 18 and above are included in the survey. According to Ethiopia's law individuals are allowed to have account if they are 18 or above. This is in contrast to the Findex survey of World Bank which considers individual 15 years of age and above.

marital status, place of residence, education level and etc. that will be used in our analysis.

3.2 Method of Estimation

We have estimated probit models to study the factors that create barriers for accessing financial services on the demand side. This type of econometric analysis is frequently used (Martínez et al. 2013) to determine the probability that an individual or entity with certain characteristics belongs or does not belong to the group that is being studied. Probit models are binary classification models where the dependent variable is dichotomous and takes the value 0 or 1.

In this section we exploit how different individual characteristics are associated with reasons not having an account in Ethiopia.

Our main empirical specifications focus on different barriers having an account in Ethiopia. Adults they respond the reason not having an account were I don't trust banks, Religious reasons Procedure is too complex or has too many, Accounts are too expensive to use, Financial institutions are too far, Prefer informal services, I don't have a reason, I don't understand the benefit, Other like I don't have money and I don't know where or how to open an account.

The dependent variable y_{ij} , the perception of barriers to open formal account (1 if the person perceives the barriers and 0 if not); the unit of the study is the individual. Let us assume that the perception of barriers to access and use formal account depends on a latent variable y_{ij}^* which is determined by a set of exogenous variables, included in vector x_j , so that:

$$y_{ij}^* = \beta_i x_j + \epsilon_{ij} \quad (1)$$

$$y_{ij} = 1 \quad \text{if } y_{ij}^* > 0$$

$$y_{ij} = 0 \quad \text{if } y_{ij}^* \leq 0$$

Where barriers of have a formal account and individuals are indexed by i and j , respectively; y_{ij}^* is a latent variable, x_j is a vector of individual-level characteristics (explanatory variables), β_i is vectors of parameters for each barriers of have formal account, and ϵ_{ij} is a normally distributed error term with zero mean and variance equal to 1. We estimate (1) as a probit model by maximum likelihood.

3.2.1 Variables Included in the Model

Among the individual level characteristics in x_j , we include a number of socioeconomic variables that we consider might associated the barriers to have an account.

Gender indicates whether the respondent is female. Level of financial inclusion for men and women is different. Worldwide the gender gap in account penetration is 7 percent and 9 percent in SSA and Ethiopia. Studies suggest that the female have fewer possibilities for accessing and using financial services (Martinez et al 2013). To the extent that many of the barriers are more paramount for women than men we expect this variable to have a positive relationship with the barriers. For the estimated model, gender is included as a dummy variable for women.

Age According to Modigliani's life-cycle theory people accumulate wealth in their younger or middle age and consume more of their wealth at older age. This would mean financial inclusion is higher among middle-age. Particularly lack of money or income would be barrier among old people. We expect the use of bank accounts to first increase and then decline with age, so in order to capture this we include both age and age squared in years.

Rural takes the value 1 if the respondent lives in a rural area and 0 otherwise. A geographical or location analysis is important particularly in large countries such as Ethiopia. Associated with distance, natural barriers and infrastructures there is differential in accessing and using financial services among rural and urban dwellers. The presence of financial institutions is more limited in rural

areas, so we expect this variable to have a positively related with many of the barriers.

Region indicates that a respondent live in different regional states in Ethiopia. There are six such dummies for Tigray, Amhara, Oromia, SNNP, Addis Ababa and others regions(all other region considered as one category) (excluded categories in the regression). We expect individuals live in Addis Ababa would report less barrier to financial inclusion.

Each respondent falls into one of three *education categories*, represented by three variables: *0-8 Years of Education* corresponds to completion of elementary education or less, *9-12 Years of Education* corresponds to completion of secondary education and some education beyond this as tertiary education. With education any form of barriers would decrease Zins and Weill 2016. We expect a negative association between individual's levels of education and barriers to financial inclusion.

Married indicates whether a respondent is married and unmarried indicates whether a respondent is divorced, separated and didn't marry before.

Religion indicates if the respondent being Muslim and takes the value of 1 and 0 otherwise. We expect individuals being Muslim follower will cite more on religious barrier among other religion.

Financial literacy takes the value 1 if the respondent knows how to open an account in the formal financial sector and zero otherwise, a proxy for financial literacy. As indicated above education and financial literacy have strong association with financial inclusion.

We expect individuals who is financially literate will report less to barriers to financial inclusion i.e. barriers to financial inclusion decreases as financial literacy increases.

Financial capability which is a proxy for income indicates on average the person ability to save 600 Birr at least once in a year. If a person able to save 600 Birr at least once in year considered financially capable, otherwise not.

We expect higher income individual will lower likelihood of citing many of the barriers to financial inclusion except the reason ‘*Lack of Many*’.

Shock takes the value 1 if the respondents worried about being able to cover unexpected expenses and zero otherwise. If the respondents worried being able to cover unexpected expenses will have a positive impact on financial inclusion. Therefore we expect a less likelihood of reporting barriers to financial inclusion relative to those who are not worried about unexpected expenses.

Preferences to save money take the value of one if an individual prefers to save money in formal method and 0 otherwise.

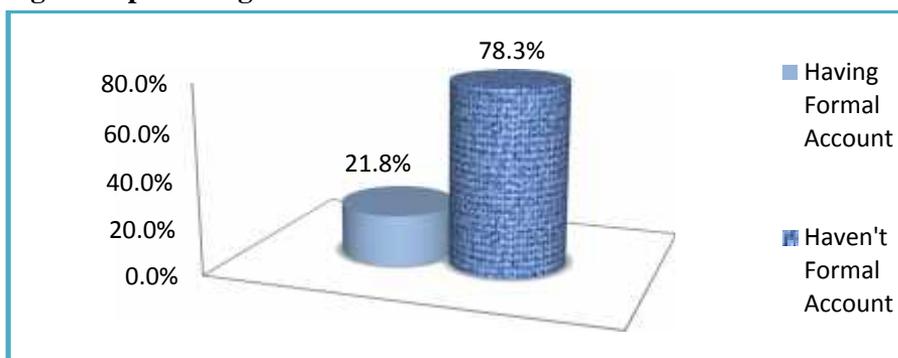
Individuals who perceive there are fewer barriers to financial inclusion will use more of the formal financial channels. Therefore, these people will less likelihood of reporting barriers of financial accounts.

4. Result and Discussion

4.1 Descriptive Discussion

According to the 2015/16 ESS data, 78 percent of adults in Ethiopia aged 18 and above did not have a formal account, only 22 percent did. According to data from 2014 Findex, the percentage of adults excluded from financial sector in Ethiopia is above the World and Sub-Saharan African average.

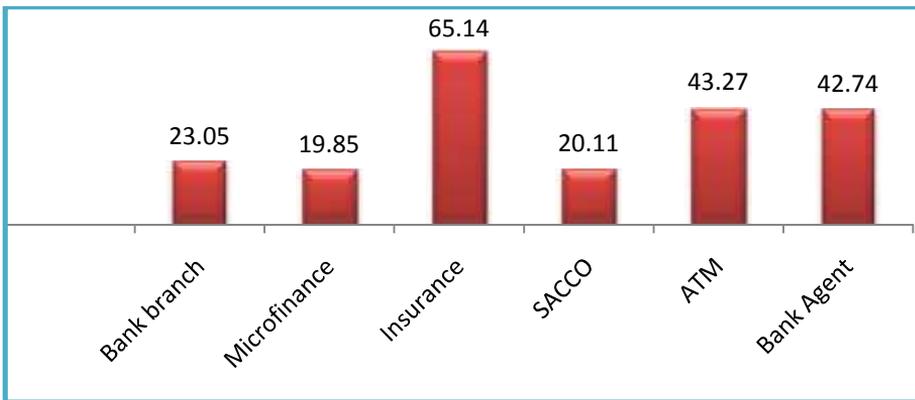
Figure 7: percentage of Excluded adults from formal financial sector



Source: ESS and own computation

ESS data informs Physical proximity to regulated financial infrastructure in Ethiopia. According to the survey community leaders or representatives of the community were asked how close financial infrastructures such as bank branch, MFI, insurance, SACCO, ATM and bank agent are located. In terms of distance MFI and SACCO is the nearest financial institution that can be accessed on average at about 20 kilometers from a given community followed by bank branch, which is accessible to a community on average at 23 kilometers. Insurance is the scarcest and hardly accessible of all financial service in Ethiopia. A person on average travel 65 kilometers to find an insurance office.

Figure 8: Distance of financial service providers from a community



Source: ESS and own computation

Adults perceived reason for not having a formal account in the survey includes: I don't trust banks, Religious reasons, Procedure is too complex or has too many, Accounts are too expensive to use, Financial institutions are too far, Prefer informal services, I don't have a reason, I don't understand the benefit, I don't know where or how to open an account and I don't have money.

As stated before, the survey includes ten possible perceived reasons that individuals are asked to for their decision not to have a formal account. In line with(Allen et al. 2012) we point out that some of these answers can be considered *voluntary exclusion* (“*lack of money*”, “*Prefer informal services*”, “*I don't have a reason*”, “*I don't understand the benefit*” and “*religious*

reasons”, while the others are associated with *involuntary exclusion* (“*too far away*”, “*procedure is too complex or has too many*”, “*too expensive*”, “*I don’t know where or how to open an account*” and “*lack of trust*”). The distinction between voluntary and involuntary exclusion is of prime importance for policy implications, as involuntary exclusion stresses the presence of obstacles to financial inclusion, which can be dismantled by implementing the right policy (Zins and Weill 2016).

Figure 9 summarizes the different barriers to account ownership reported in the survey perceived by individuals. A first look at the data reveals that, *I don’t know where and how to open an account* is the most often cited reasons for not having a formal account in Ethiopia (31%). This reason is part of involuntary exclusions of individuals in the formal financial sector. The second most frequently cited reason for not having an account in Ethiopia is lack of money (29%) and this also a voluntary exclusion. Globally lack of enough money, is most common reason for not having an account (59%) (Demirgüç-Kunt et al. 2015). Individuals without sufficient cash earning don’t to bear the overall cost of having formal account.

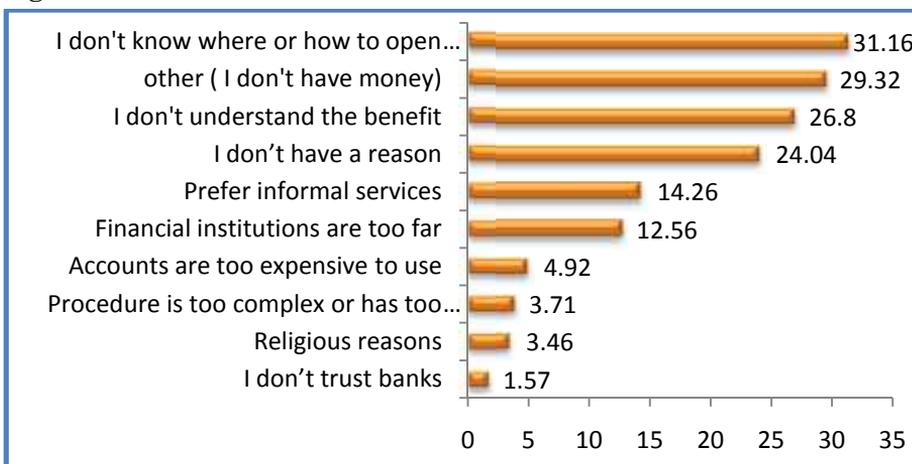
In Ethiopia 26.8 percent individuals reported they don’t understand benefits of opening an account. Followed by I don’t have a reason (24%), prefer informal service (14.3%), financial institutions are too far (12.6%) are important reasons in explaining financial exclusion in survey.

The other reason perceived as a barrier to financially exclusion like *don’t trust financial sector*, *religious reason*, *accounts are too expensive* and *procedures too complex* were less cited reasons (altogether 15% of individuals cited as a barrier).

The above discussions suggest both voluntary and involuntary reasons contribute to the financial exclusions of large proportion of individuals in Ethiopia. The result is similar to BRICS country’s except china. The author in the literature identifies in china relative to the other BRICS financial exclusion is limited and is mainly motivated by voluntary exclusion. However in Ethiopia it is the reverse. Involuntary exclusion due to some obstacles is most

cited in Ethiopia. The result urges policy makers to aim at reducing these barriers and obstacles to reduce involuntary financial exclusion in Ethiopia.

Figure 9: Adult Reasons for Don't Have Formal Account



Source: ESS and own computation

4.2 Discussion of the Estimated Model

In this section we discuss how individual characteristics associated the reason for not having a formal account. As we know account ownership is the one of the most important indicators of financial inclusion. It is thus of particular interests to identify the reason for not having a formal account.

We explain each of the ten barriers to financial inclusion reported in the survey with different socioeconomic characteristics of individuals. Table 1 in the annex displays the probit model estimates of how different individual characteristics associated the likelihood of reporting one of the reason for not having an account (I don't trust banks, Religious reasons, Procedure is too complex and the like)

Except educational⁵ level the other socio economic characteristics of individuals i.e. regional disparity, being female, religion difference, living in rural area, financially capable, preference of formal financial sector,

⁵ Secondary education associated preference of informal education

financially literate and worried being able to cover un expected expenses (shock) have significantly associated reasons for not having an account. In the following paragraphs we document the detail account of the individual characteristics on each and every reason of financial excluded individuals.

The result shows Procedures are too complex is significantly less likely to be cited as barriers to open an account in Tigray region whereas, more likely in SNNP than the reference region (Other regions⁶). The individuals living in SNNP has higher marginal effect which is 4 percent and followed by Tigray region 2percent in. In addition individuals with higher income are less probably to cite procedures are too complex as a barrier to financial inclusion.

As expected distance is one of the main barriers to rural residents and Muslims are more likely to perceive distance is a barrier to financial inclusion than Christians. Significant proportion of Muslims lives in remote areas where both financial and other infrastructure is in short supply. This might be the reason for Muslims significantly perceive distance as a barrier than Christians. Conversely, being female, living in Oromia, Tigray and Addis Ababa and financially capable (income) less likely to cite distance as a barrier in account ownership. In rural 13 percent of the population reports distance as a barrier and 14% of individual adults living in Addis Ababa report distance is not a barrier to open an account. An interesting finding is observed relative to men; women perceive distance is not a barrier for account opening. This may indicate that women perceive other reasons other than distance for account opening. From the regression result we found that women have cited no reason for not opening an account and it is statistically significant. This implies voluntary exclusion is widespread among Ethiopian women than men.

Account opening is too expensive (costly) is significantly more likely to be cited as a barrier by individuals living in SNNP and Oromia region and less likely by individuals living in Addis Ababa compared to the individuals living in other regional states.

⁶Other regional states represents Afar, Somalia, Harari, Gambella and Dire Dawa

Being Muslim, living in rural area, Amhara, Oromia and SNNP regions and Addis Ababa are more likely to report that they do not understand the benefits to use an account. The marginal effects of rural residence is very high (19.2 percent) not having an account because of they didn't know the benefits of account ownership. Whereas, individuals who prefer formal financial institution and financially literate are less likely to report that they didn't know the benefit of opening an account as a barrier. This indicate that a lot of awareness creation using both financial and general education is needed in rural and other part of the country, so that individuals would understand the advantage of using a formal financial institution.

Have no knowledge where and how to open an account is significantly more likely to be reported as a barrier by young age, rural residence and SNNP region and less likely by old age, married, Addis Ababa residences and financial educated individuals. As expected, the marginal effects of Addis Ababa resident and financial educated individuals are higher which is 14percent and 20 percent respectively to report no knowledge where and how to open an account as not a reason for not having an account.

Individual characteristics like being married, Muslim, secondary education level and financial literate is significant and more likely to report preference of informal financial sector as a barrier to have a formal account. While, worried about unexpected expenses, prefer formal financial service, higher income, living in Tigray, Oromia and Addis Ababa significantly but less likely to report preference of informal financial sector as a barrier to have a formal account. Surprisingly, a financially literate and secondary level educated individual cited informal financial services as a barrier to financial inclusion. This is an indication that the formal financial services have no enough product and services that suits the demands of those individuals rather the informal sector fills the gap.

Muslims reported religion as a reason a barrier to open an account. Actually 3.5percent of the population cited religion as a barrier to open an account. Muslims with a probability of 6.6 percent cite religion as a reason for not having a formal account. This indicates that the formal financial sector is not providing services and products such as interest free banking that are

compliant with Islamic teaching. Of course the actual demand for such products needs further studied.

Individuals being female, living in the four big regions (Tigray, Amhara, Oromia and SNNP), Addis Ababa and who worried about unexpected expenses (shock) less likely mentioned religion as a barrier to financial inclusion.

Individuals who are living in Amhara, Oromia and SNNP more likely mentioned lack of trust for formal financial institutions as a barrier to open an account. However, rural residents and individuals who worried about unexpected expense less likely cited lack of trust as a barrier to have a formal account.

Lack of money as a barrier to having an account is significantly associated by individual characteristics of young and old age, being Muslim, rural residence, Tigray, Amhara, Oromia, shock, preference and financial capability. Young age, Muslim and rural residents less likely reported lack of money as a barrier to open an account. Financial education for young ages and increasing access to financial services and education both general and financial are the proper intervention in the rural Ethiopia.

Old age, living in Tigray, Amhara, Oromia, who worried about unexpected expenses and financially capable and literate individuals, are more likely to report lack of money as a barrier to have a formal account. In compliance with lifecycle hypothesis old age individuals lacks money in to participate in the financial sector. However, surprisingly enough individuals who are financially capable also more likely cite lack of money as a barrier. This might indicate there is lack of awareness and financial illiteracy among capable individuals that should be addressed through financial education. That is many individuals with financial capability are excluded due to other reasons. This implies if a proper intervention is taken there is a big potential for many individuals to be financially included in Ethiopia at least from the point of view of financial capability.

Finally, individual characteristics such as being female, preference of informal financial service and financially literate individuals more likely associated with no reason as a barrier to have an account and less likely with individuals living in Amhara regions. This implies voluntary exclusion is significant in women and financially literate individuals.

5. Conclusion and Recommendations

Data from WB, IMF and NBE is used for the analysis of the supply side of access to finance. In this issue a detail analysis on access of financial institution and infrastructure and their development over time and a comparative analysis with other economies such as SSA and East African Community particularly with overachiever in terms of financial inclusion (Kenya) are provided. In general financial inclusion in terms of all indicators or proxy measures is low in Ethiopia compared to SSA. However, recently Ethiopia has made a progress in access to mobile and other infrastructures. For the demand side analysis we used ESS data. In general, the demand side data shows that financial exclusion in Ethiopia is very high and a number of barriers are responsible for this. We believe that involuntary exclusion can be reduced putting the right policy in place. Accordingly we have forwarded some policy suggestion in the subsequent section.

Expanding financial access points and exploiting untapped potential of mobile banking and internet penetration. The availability of infrastructure such as ATMs, bank branches and others capture the extent of accessibility to the formal financial system. Compared to SSA and East African Community Ethiopia is far behind in access to finance indicators such as bank branch and ATMs per 100, 000 adults. However, Ethiopia has made a progress in access to mobile and internet penetration which is nearly comparable to Eastern African communities' average. However, mobile and internet banking is in its infant stage compared to those economies. Increasing access to financial services via increasing bank branch, Microfinance, SSACO, insurance, ATMs, POS machine, agent banking and non-financial infrastructure should be a priority of policy makers. Moreover, Ethiopia should use the untapped mobile and internet infrastructure potential in reducing financial exclusion.

Removing physical, bureaucratic, and financial barriers could expand the use of formal accounts. Many of the perceived barriers to open an account have significant correlation with many of the individual characteristics. Particularly as it is pointed out earlier involuntary exclusion such as *I don't know where or how to open an account distance, procedure is too complex, too expensive to open an account and lack of trust* can be reduced given the right policy is in place.

Promoting both financial and general education among young's and rural residents. Both the descriptive and empirical result indicates that education correlate with many of the barriers negatively. Lack of education and financial illiteracy is the main barrier to financial inclusion in Ethiopia among young's and rural inhabitants. Therefore, efforts in promoting and expanding both financial and education could lead to a lower exclusion by reducing many of the barriers.

Issuing National ID. Significant adults have picked procedures is too complex to open an account. One of the documents required to open an account is an ID card. Young and migrants struggle to get one easily. This result in financial exclusion of those groups. Therefore, issuing a national ID will reduce the problem of opening an account.

Developing suitable products and services for Muslims and vulnerable social group such as young, women and poor. Providing service and products that are compliant with Islam teaching is necessary because religion is one of the barriers for financial inclusion. Further survey can be conducted to identify such demand. Agent and mobile banking will help vulnerable social groups particularly young and women.

Promoting and expanding non-traditional financial services and products such as agent banking and mobile banking in rural Ethiopia. More than 85% Ethiopians live in rural areas and distance from financial service providers is a major barrier for financial inclusion. Therefore, along increasing traditional services such as bank, microfinance branches and other, it will be better to promote mobile and agent banking.

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Annex

Table 1: Determinants of Barriers of Financial Inclusion

Variables	Complex process	Too far away	Too Expensive	No Benefit	No knowledge	Prefer informal	Prefer informal	Lack of Trust	Lack of Money	No reason
female	-0.007 (0.008)	-0.0261* (0.0146)	0.00786 (0.0102)	-0.0243 (0.0197)	-0.0135 (0.0198)	0.00836 (0.0157)	-0.0168** (0.00729)	-0.00226 (0.00402)	-0.0184 (0.0220)	0.0479** (0.0209)
Age	-0.002 (0.002)	0.00123 (0.00326)	-0.000337 (0.00201)	0.00026 (0.0040)	0.00859* (0.00439)	0.00088 (0.0031)	0.00197 (0.00162)	0.00164 (0.00103)	-0.0104** (0.00455)	-0.000467 (0.00459)
Age square	2.54e-0 (2.57e-)	-9.77e-06 (3.93e-05)	4.71e-07 (2.46e-05)	7.33e-6 (4.81e-05)	-0.000106** (5.36e-05)	5.96e-0 (3.94e-05)	-1.56e-05 (2.08e-05)	-2.10e-05 (1.37e-05)	0.000124** (5.52e-05)	-8.29e-06 (5.56e-0)
Marital status	0.0043 (0.013)	0.0236 (0.0198)	-0.00264 (0.0129)	0.0102 (0.0253)	-0.0490* (0.0259)	0.0545*** (0.0187)	-0.00917 (0.00826)	0.000604 (0.00540)	0.00462 (0.0263)	0.00396 (0.0265)
Religion	-0.002 (0.009)	0.0394** (0.0155)	-0.00967 (0.0130)	0.0593*** (0.0204)	0.0180 (0.0208)	0.0295* (0.0164)	0.0655*** (0.00823)	0.00286 (0.00455)	-0.0633*** (0.0235)	-0.0214 (0.0250)
Secondary	0.0062 (0.011)	-0.00220 (0.0174)	-0.00281 (0.0125)	-0.00398 (0.0245)	-0.0413 (0.0265)	0.0451** (0.0201)	0.0126 (0.00829)	0.00488 (0.00509)	0.00579 (0.0262)	0.0268 (0.0236)
Tertiary	0.0167 (0.018)	0.0118 (0.0404)	-0.0122 (0.0234)	0.0503 (0.0467)	-0.0502 (0.0522)	-0.0213 (0.0337)	0.00674 (0.0174)	-0.00608 (0.00813)	0.0346 (0.0502)	0.0153 (0.0418)
Rural	0.0082 (0.011)	0.132*** (0.0195)	0.0133 (0.0118)	0.192*** (0.0242)	0.0811*** (0.0260)	0.0227 (0.0181)	0.00214 (0.00787)	-0.0113** (0.00468)	-0.136*** (0.0241)	0.00407 (0.0230)
Tigray	-0.03** (0.0166)	-0.0526** (0.0253)	-0.0542 (0.0401)	-0.0488 (0.0387)	-0.0558 (0.0369)	-0.0923*** (0.0309)	-0.0209 (0.0132)	0.00465 (0.00791)	0.0822** (0.0394)	0.0202 (0.0383)
Amhara	-0.014 (0.015)	-0.0320 (0.0214)	0.0195 (0.0209)	0.0851*** (0.0323)	0.0330 (0.0317)	0.0173 (0.0234)	-0.0358*** (0.0124)	0.0240** (0.00991)	0.0986*** (0.0368)	-0.0741** (0.0344)
Oromia	-0.007 (0.012)	-0.129*** (0.0175)	0.0355* (0.0185)	0.0554** (0.0270)	-0.00549 (0.0271)	-0.0518*** (0.0194)	-0.0143** (0.00676)	0.0187** (0.00853)	0.160*** (0.0321)	0.0101 (0.0283)
SNNP	0.0366*** (0.013)	-0.00420 (0.0197)	0.150*** (0.0194)	0.0693** (0.0292)	0.0680** (0.0288)	-0.0127 (0.0216)	-0.0633*** (0.0134)	0.0196** (0.00775)	0.0590 (0.0362)	-0.0401 (0.0329)

Cont'd from Table 1

Variables	Complex process	Too far away	Too Expensive	No Benefit	No knowledge	Prefer informal	Prefer informal	Lack of Trust	Lack of Money	No reason
Addis Ababa	-0.023 (0.0220)	-0.142*** (0.0528)	0.121*** (0.0260)	0.0766* (0.0458)	-0.187*** (0.0607)	-0.131*** (0.0404)	-0.0372* (0.0195)	0.00147 (0.0116)	-0.0125 (0.0444)	0.0727* (0.0412)
Shock	-0.00745 (0.00864)	-0.00972 (0.0138)	0.00987 (0.0100)	0.0222 (0.0196)	0.0134 (0.0203)	-0.0530*** (0.0165)	-0.0190*** (0.00716)	-0.00651* (0.00522)	0.0667*** (0.0239)	-0.0344 (0.0230)
Finliteracy capability	-0.00415 (0.00976)	-0.00726 (0.0152)	-0.00653 (0.0102)	-0.0844*** (0.0213)	-0.213*** (0.0224)	0.0299* (0.0173)	-0.00701 (0.00743)	-0.000785 (0.00463)	0.0396* (0.0239)	0.139*** (0.0218)
	-0.0151* (0.00866)	-0.064*** (0.0156)	0.0107 (0.0133)	0.00166 (0.0232)	-0.0345 (0.0239)	-0.0343** (0.0174)	0.0112 (0.00783)	-0.00240 (0.00465)	0.0689*** (0.0259)	-0.0192 (0.0249)
Observations	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810	3,810

Financial Inclusion in Ethiopia: Using ESS Data

Gashaw Desalegn¹ and Gebe Yemataw²

Abstract

Only less than a quarter of Ethiopian adults have a formal account. In this study the status and level of financial inclusion in Ethiopia is documented. We find better education, financial literacy, being a man, being younger, being residence of urban, living in capital city and preference for formal financial services are associated with greater level of financial inclusion in Ethiopia. We recommend policies that will narrow down gender, religious, urban and rural gap and foster financial inclusion in Ethiopia.

Key words: Financial Inclusion; Financial Institution; Ethiopia

1. Background

Financial inclusion is gaining a momentum worldwide (Oji, 2015). In the developed nation, the concern grows after the 2008 financial crisis. In the developing regions, such as Africa, financial inclusion is one of the discourses in development agenda. The G-20 summit in Seoul in 2010 has decided that financial inclusion must be a global development agenda. Even 11 out of 17 SDGS are supported by financial inclusion (UNSGSA, 2016). Many African countries including Ethiopia are adopting financial inclusion as one of their national strategy. Many of them are exerting a tremendous effort in generating evidences by collecting data and employing big surveys supported by both national and international organizations such as World Bank.

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Many authors struggle to compare their result worldwide (Cámara & Tuesta, 2014). One of the challenges, in measuring FI is the absence of universally accepted way of measuring it. In general, there are two set of financial inclusion indicators- account ownership (penetration) and account use.

Account penetration indicator measures individual ownership of formal accounts at formal financial institution, whereas, account use indicator focuses on saving behaviour, source and purpose of borrowing, use of insurance product and other financial products and services.

In this study, we have used three indicators for financial inclusion. Account ownership, saving and the uses of financial products and services including ATM, mobile banking, internet banking and agent banking (Allen, Demirgüç-Kunt, Klapper, & Peria, 2012); (Zins & Weill, 2016).

According to Findex data, 2 billion adults are unbanked Worldwide as of 2014. Since 2011, adult population account ownership has risen from 51percent to 62. Similarly developing countries are making a substantial progress towards financial inclusion. Account ownership on average has increased from 41percent to 54percent in the same period. In Africa the average account ownership (35%) is low when compared to both the world and developing countries. Only 22 percent of Ethiopian adults have accounts as of 2016. This is very low compared to the Sub-Saharan average (34%). In addition, the use of financial products and services such as saving, ATM, mobile banking, internet banking and agent banking is in its infancy level. For example, mobile banking in the neighbouring Kenya is 75percent compared to 1percent in Ethiopia.

(Zins & Weill, 2016) and (Demirgüç-Kunt & Klapper, 2012a) investigated the reason for low level of financial inclusion in Africa where Ethiopia is one of the sample. However, to the knowledge of the researchers, there is no specific study that is conducted to examine the status and factors for low level of financial inclusion using nationally representative data.

Therefore, the main motivation of this study is to find the factors that explain the low level financial inclusion in Ethiopia. The main contribution of this

study is it highlights the status and level of financial inclusion in Ethiopia. Specifically it investigates the associations between different socioeconomic and demographic characteristics, such as financial education, financial capability, gender, age, residence of individuals and etc. with financial inclusion indicators measured by account ownership, use of saving and financial products and services to understand financial inclusion in Ethiopia. Finally, we recommended policies that will foster financial inclusion in Ethiopia. The study is organized as follows: chapter two reviewed related literature, chapter three presents method of study and sampling issues, both the descriptive and empirical analysis is given in chapter four and finally we concluded the study with specific policy recommendation in the last chapter.

Literature Review

This section reviews some findings mostly from Africa and other world case studies. Though there are improvements towards financial inclusiveness in Africa in the recent years, the gap between the developed and developing region remains big. According to (Demirgüç-Kunt & Klapper, 2012b), there is a disparity among countries in Africa in the level of financial inclusion ranging from 51% in Southern Africa to 11% in Central Africa. In some countries 95percent of their adult population have no formal financial accounts in 2012. Only 1 individual out of 4 has a formal account. According to same study, men, rich and educated are more likely to have a formal financial account.

Using World Bank's Global Findex database (Zins & Weill, 2016) concluded that being a man, richer, more educated and older favour financial inclusion in Africa with higher influence of education and income. As (Mlachila et al., 2016) pointed out gaps in financial inclusion, particularly those related to economic status and gender have been compensated to some extent by novel financial services, such as mobile payment system and mobile banking particularly in Eastern Africa.

(Oji, 2015) identifies both supply and demand side constraints responsible for low level of financial inclusion in Africa. Demand constraints, such as low levels of financial literacy; and supply constraints, such as the limited capacity

of many African financial institutions are the main impediments for financial inclusion.

A study by (Adeola & Evans, 2017) reported macroeconomic determinants of financial inclusion in Africa are per capita income, broad money (% of GDP), literacy, internet access and Islamic banking presence and activity are significant factors explaining the level of financial inclusion in Africa.

A research by (Fungá ová & Weill, 2015) using Findex data base finds that financial inclusion measured by account ownership is not much of a problem in China. Income and education contribute to greater financial inclusion. The study concludes that a major concern in the short run is the limited use of formal credit. In the long run obstacles related to gender, income and education would hamper financial inclusion in China.

In another study on use of credit in China, (Chen & Jin, 2017) finds that formal credit use is very low. Individuals often times use informal credit. Formal credit is more accessible to socially and economically advantageous individual. The Poor and the disadvantages have low access and use of formal credits. The main impediments are insufficient supply of bank credit in financial markets and households' low financial literacy, particularly low levels of knowledge about formal borrowing.

3. Data and Method of Estimations

3.1 Data and Sample

We use World Bank's 2016 Ethiopian Socioeconomic Survey (ESS) data to realize our analyses. ESS is a collaborative project between the Central Statistics Agency of Ethiopia (CSA) and the World Bank Living Standards Measurement Study- Integrated Surveys of Agriculture (LSMS-ISA) project. ESS³ began as ERSS (Ethiopia Rural Socioeconomic Survey) in

³ For detailed information on LSMS - Data: Ethiopia
<http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTRESEARCH/EXTLSMS/0,,contentMDK:23635542~pagePK:64168445~piPK:64168309~theSitePK:3358997,00.html>

2011/12. The second and third wave was conducted in 2013/14 and 2015/16 respectively.

ESS data is panel data sets; however, the earlier two waves do not contain the financial inclusion module. It only contains information on credit at a household level. The survey covers 11,810 individual adults⁴, which are nationally representative samples of 4,958 households'. The target population is around 45 million population aged 18 and above. The survey questionnaire provides a large number of indicators on financial inclusion that enables to assess, the amount of account penetration, the use of financial services, the barriers of formal finance, etc. It also provides micro-level information on gender, age, marital status, place of residence, education level and etc.

3.2 Method of Estimation

In this section we exploit how the different individual characteristics are associated with financial inclusion in Ethiopia using probit model estimation.

Our main empirical specifications focus on three dimensions of the financial inclusion: (a) owning a formal financial account (account holding), (b) using formal financial account to save, and (c) using of financial product and service such as ATM, Agent banking, Mobile banking and Internet banking).

The dependent variable y_{ij} , stands for owning a formal account, use of formal account to save and use of financial product and service is a binary variable. Therefore, we use the following model specification to investigate its determinants:

$$y_{ij}^* = \beta_i x_{ij} + \epsilon_{ij} \quad (1)$$
$$y_{ij} = 1 \quad \text{if } y_{ij}^* > 0$$

⁴ Individuals age 18 and above are included in the survey. According to Ethiopia's law individuals are allowed to have account if they are 18 or above. This is in contrast to the Findex survey of World Bank which considers individual 15 years of age and above.

$$y_{ij} = 0 \quad \text{if } y_{ij}^* \leq 0$$

Where financial inclusion indicators and individuals are indexed by i and j , respectively; y_{ij}^* is a latent variable, x_j is a vector of individual-level characteristics (explanatory variables), β_i is vectors of parameters for each financial inclusion indicators, and ϵ_{ij} is a normally distributed error term with zero mean and variance equal to 1. We estimate (1) as a probit model by maximum likelihood.

3.3 Variables included in the Model

Among the individual level characteristics in x_j , we include a number of socioeconomic and demographic variables that would affect the account ownership and use of formal financial accounts.

Female indicates whether the respondent is female. To the extent that it is harder for females to have bank accounts, we expect this variable to have a negative relationship.

Age and **Age Squared** are both in years. We expect the use of bank accounts to first increase and then decline with age, so in order to capture this we also include age squared.

Rural takes the value 1 if the respondent lives in a rural area and 0 otherwise. The presence of financial institutions is more limited in rural areas, so we expect this variable to have a negative impact.

Regional indicates that a respondent lives in different regional states in Ethiopia. There are six such dummies for Tigray, Amhara, Oromia, SNNP, Addis Ababa and others regions (all other region considered as one category) (excluded categories in the regression). We expect individuals live in Addis Ababa have a better chance to be financially included.

Each respondent falls into one of the three **education categories**, represented by three variables: *0-8 Years of Education* corresponds to completion of elementary education or less, *9-12 Years of Education* corresponds to completion of secondary education and some education beyond this as tertiary

education. We expect the likelihood of account ownership to increase with the individual's level of education.

Married indicates whether the respondent is married or unmarried. Unmarried indicates whether a respondent is divorced, separated or never been married.

Religion indicates if the respondent is a Muslim or Christians. It takes the value 1 if a respondent is Muslim and 0 otherwise. We expect being Muslim follower negatively affect financial inclusion.

Financial literacy takes the value 1 if the respondent knows how to open an account in the formal financial sector and 0 otherwise, a proxy for financial literacy. We expect financially literacy positively impact financial inclusion.

Financial capability, which is a proxy for income indicates on average the person's ability to save 600 birr at least once in a year, is considered financially capable, otherwise not. We expect the higher the income of an individual the higher the likelihood of financial inclusion. **Shock** takes the value 1 if the respondent is worried about being able to cover unexpected expenses and 0 otherwise. If the respondents worried being able to cover unexpected expenses will have a positive impact on financial inclusion.

Preferences takes the value of 1 if an individual prefers to save money both in formal and informal method and 0 otherwise. If an individual prefers to use formal financial method to save tier money, this will increase financial inclusion.

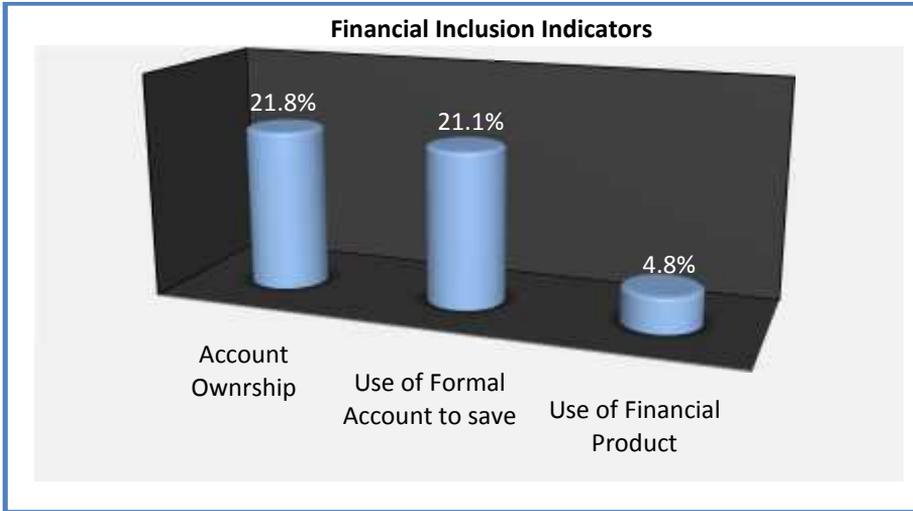
4. Result and Analysis

4.1 Descriptive analysis

In line with related literature, we focus on three main indicators of financial inclusion. Formal account refers to the fact that the individual has an account at a formal financial institution, use of formal account to save⁵ and use of financial services like ATM, Agent banking, online baking, mobile banking and other financial product.

⁵ It could have been possible to include use of formal credit as one indicator. However, in the data set credit is in household level but this study uses individual level analysis.

Figure 10: Percentage of Adults on Financial Inclusion Indicators



The bar graph in the Figure1 presents the three financial inclusion indicators account ownership, use of formal account to save and use of financial product or service in the formal financial sector. The result shows that 22 percent of adult age 18 years old and above have formal account and the remaining 78 percent are exclude from the formal financial sector. The figure also explores out of the total adult, 21 percent of individual adults use the formal account to save and 4.8 percent of adults use financial product or services like mobile banking, ATM, Agent banking, online banking and other financial product and services. The financial inclusion indicators of account ownership in Ethiopia is lower compared to African average (35 percent) and world average (61.5 percent). Furthermore, adult’s use of formal account to save is also higher in Africa (15 percent) and lower world (27 percent) as indicated by 2014 Global Findex data.

Table 1: Descriptive Statistics Result Financial Inclusion Indicators with Socio-economic and Demographic Variable

Socio-economic and Demographic Characteristics		Account Ownership	Use an account to save	Use of Financial Product
Gender	Male	26.0	26.1	6.4
	Female	17.0	16.5	3.2
Region	Tigray	28.0	27.2	4.4
	Amhara	28.0	24.8	2.7
	Oromia	15.0	14.9	4.0
	SNNP	15.0	14.4	3.8
	Addis Ababa	61.0	61.0	23.4
Residence	Others	17.0	16.9	4.3
	Rural	12.0	10.7	1.2
Religion	urban	50.0	50.0	14.7
	Christian & other	25.0	23.4	3.6
Marital Status	Muslim	13.0	12.1	2.2
	Married	23.0	21.7	4.5
Education level	unmarried	19.0	18.0	5.3
	Elementary & below	19.0	18.7	2.4
	Secondary	36.0	35.9	11.1
Financial Literacy	tertiary	79.0	79.0	37.5
	Yes	54.0	52.6	12.7
Financial capability	No	3.0	0.9	2.6
	Capability to save 600 in 12 month	14.0	12.1	2.4
Shock	Not capable	40.0	39.6	10.2
	worried to cover unexpected expense	21	20	4.6
Preference	Not worried	22	20.5	4.9
	formal	37.0	35.0	8.3
	Informal	2.0	1.5	0.1

Table 1 presents the descriptive statistics of the three financial inclusion indicators with demographic, social and economic characteristics of individual adults. The result demonstrates there is a gender gap in the three financial

inclusion indicators. 17percent of female and 26percent of male adults are account holder, whereas, 26.1percent males and 16.5percent females use their account to save and 22percent male, and 3.2percent females and 6.4percent of males uses financial products and services in the formal financial sector. Thus, there is 9percent gender gap in account opening, 6percent in the usage of an account for saving and 3percent in use of financial product and services. The gap in account ownership and use to save in formal account is wider than use of financial product. The result is consistence with the study of (Demirgüç-Kunt, Klapper, Singer, & Van Oudheusden, 2015). The gender gap in Ethiopia in account penetration is highest among developing countries. The global gender gap is 7percent and it is 9percent in SSA (30percent for females compared to 39percent for men).

We observe only 12, 10.7 and 1.2 percent of individuals who live in rural areas are account holder, use formal account to save and financial services and products respectively. While, for individuals who live in urban areas the three indicators for financial inclusion are 50, 50.4and 14.7 percent respectively. Financial inclusion indicators are higher in urban than rural because most formal financial services in Ethiopia concentrate in large towns and capital cities. By region, Addis Ababa has the highest percentage of adults with all financial inclusion indicators; account ownership and use of formal account to save ((61 %) each, and use of financial product and service (23.4percent). Only 28 percent of Tigary and Amhara and 15 percent of Oromia and SNNP adults have an account. The use of financial products and services in all regions is below 5 percent Except Addis Ababa which is 23.4percent.

We demonstrate the religious disparity on financial inclusion indicators, approximately 25percent, 16.1percent and 3.6percent of Christians have an account, use formal account to save and use of financial product and services respectively. While, 13, 9.3 and 2.2percent of Muslim have an account, use formal account to save and use financial product and services respectively. Hence, financial inclusions indicators are higher among Christian than Muslim religions.

Financial inclusion is also higher among adults with tertiary level of education 79.0percent of them have an account and use their account to save and 37.5

and 37.5 percent of them use financial product and services followed 36 for both account holding and use to save and 11 percent in use of financial products and services by secondary education level. The indicators show that a lower level of financial inclusion for Primary and uneducated individuals. Thus, increase in level of education of adult associated with a lower financial exclusion.

As expected, financial inclusion indicators are higher in financially literate adults who are aware of how to open an account in the formal financial sector. A 54 percent, 52.6 percent and 12.7 percent of financially literate adults have an account, save in the formal account and use financial product and services respectively. Whereas, only 3 percent, 1 percent and 2.6 percent financially illiterate adults have an account, save in the formal account and use financial product and services respectively.

Paradoxically, account ownership (14%), use of account to save (12.1%) and use of financial product and services (12.1%) were lower for individuals who are able to save 600 birr at least once in a year or financially capable adults than financially not capable adults. Adults who worried or not worried about being able to cover unexpected expenses proxy of shock have a 1 percentage point difference on account ownership (21% worried and 22 % not worried).

As expected adults who prefer formal financial sector is higher in account ownership and use of formal account to save which are 37 and 35 percent and lower proportion of adults prefer informal financial sector (2 and 1.5%) for each indicator respectively. The use of financial product and service is also higher among adults who prefers formal financial sector (8.3%).

4.2 Model Estimations and Analysis

This section discusses the estimated probit models of the three financial inclusion indicators i.e. account ownership, use of formal account to save and use of financial product and services. Interpretation of the model focuses more on the significant socio-economic characteristics of individual adults. As observed in column 1 of Table 2 (account ownership result), most of these variables are significant at conventional levels and all of them have the expected sign. The likelihood of owning an account is lower for older age group and rural dwellers and higher for the younger age group, having tertiary education, living in Tigray, Amhara regional state and Addis Ababa city administration, financially literate, financially capable and individual's

preference of formal financial institutions and being married. These results are in line with those of (Allen et al., 2012).

Table 2: Determinants of Financial Inclusion

Variables	(1) account older	(2) Account use	(3) Account use to save
female	-0.00997 (0.0112)	-0.0810*** (0.0230)	-0.00960 (0.00815)
age	0.0149*** (0.00255)	0.0119** (0.00570)	0.000462 (0.00194)
Age square	-0.000140*** (3.00e-05)	-0.000180** (7.05e-05)	-3.62e-06 (2.13e-05)
Marital status	0.0443*** (0.0140)	-0.0250 (0.0270)	0.00178 (0.00999)
religion	-0.0223 (0.0144)	0.00219 (0.0285)	-0.00468 (0.00984)
secondary	0.0209 (0.0132)	0.151*** (0.0299)	0.0134 (0.0102)
tertiary	0.154*** (0.0157)	0.270*** (0.0260)	0.0320*** (0.0117)
rural	-0.0927*** (0.0121)	0.000406 (0.0332)	0.0263** (0.0113)
Tigray	0.0473** (0.0206)	-0.0378 (0.0414)	0.0171 (0.0159)
Amhara	0.0758*** (0.0184)	-0.113*** (0.0389)	-0.0173 (0.0148)
Oromia	-0.0209 (0.0174)	0.0315 (0.0370)	-0.0143 (0.0140)
SNNP	-0.00451 (0.0198)	-0.0152 (0.0390)	-0.000204 (0.0168)
Addis Ababa	0.0397** (0.0192)	0.0721* (0.0373)	0.00500 (0.0148)
shock	0.0130 (0.0117)	-0.0196 (0.0222)	-0.00922 (0.00879)
preference	0.201*** (0.0211)	0.0273 (0.0986)	0.0950*** (0.0188)
Financial literacy	0.254*** (0.0136)	0.102 (0.0873)	-0.0244 (0.0193)
Capability	-0.124*** (0.0113)	-0.0302 (0.0224)	-0.0189** (0.00840)
Observations	6,103	2,293	2,078

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Having tertiary education, living in rural area and preference for formal financial institution have similar impacts on the usage of formal financial

account for saving as it has impacted probability of owing an account. Individual's characteristics, financial capability of using a formal account to save have reverse effect to the likelihood of owning a formal account.

The last column in the Table 2 shows that the likelihood of use of financial product and service is lower for being female, older and living in Amhara region and higher for being younger , having educated in secondary and tertiary level and living in Addis Ababa.

Both the descriptive and empirical result informs that the gender gap is very wide. Our econometric analysis shows that being a woman reduces the likelihoods of using financial products and services, even after controlling for individual characteristics suggesting the existence of gender biases in the country. As reported in Table 2 in column 1 and 2 being female does not have an effect on account ownership and use of formal account to save. However, use of financial product and service i.e. online, agent, mobile and internet banking have significantly and negatively affect which implies the females have a lower chance of use of financial product service. In other words, being female reduces the probability of using formal financial product and service by 8.3percent compared to male.

Married people are found to have greater chance (6% more) to open an account in the formal financial service while no similar effect is observed for those who are single or divorced. The fact that marriage increases the chance of account ownership may be explained on the ground that married people have increased financial responsibility that leads to a higher demand for financial services.

Tertiary level education is positively associated with ownership of a formal account. Individuals with tertiary education have a higher chance (26.5percent) to open formal account than with individuals with primary education. Similarly, tertiary education is positively associated with use formal account. Individuals with tertiary education have a chance of 2.1 percent more chance to use formal account to save than with individuals with primary or no education.

Positive evidence between education and financial inclusion is also obtained. Considering use of financial product and service secondary and tertiary education has positive and significant effect. It increases the likelihood of using financial product and services by 17.4 percent and 30.9 percent respectively compared to no or primary education.

Financial inclusion also determined by Place of residence i.e. whether an individual lives in urban or rural and regional disparity is also observed. Living in a rural area reduces the likelihood of account ownership in the formal financial sector by 13% compared to an individual living in an urban area. Regionally, Adults living in Tigray, Amhara and Addis Ababa have more chance to have a formal account; the marginalities are 7%, 11% and 6% compared to individuals living in other regional state. Being a rural residence increases the likelihood of using formal account for saving than being urban resident by 1.6%. However regional difference has no significant impact use of formal account to save in the formal financial sector. Living in Addis Ababa increases the likelihood of using financial products and services by 8 percent, while, living in Amhara region reduces the probability by 11 percent.

Person's ability to save 600 birr, a proxy for income, is one of the determinants of financial inclusion. The result indicates that income significantly affect individual adults opening a formal account and use of formal account to save. Ability to save 600 birr at least once in a year increases the probability of opening an account by 18.5 percent and reduced usage of formal account to saving by 1.6 %.

Individual who knows how to open an account in the formal financial sector is considered as a proxy for financial literacy. The result shows that being financially educated increases the probability of account ownership in the formal financial sector by 32% than financially uneducated. On the other hand, being financially literate reduces the likelihoods of use of formal account to save by 1.3 % than financially illiterate.

The preference for formal and informal financial sector is the other significant factor on financial inclusion. As expected preference for formal financial sector increases the likelihood of both account ownership and use of formal

account to save by 22% and 31 % respectively compared to those who have preference for informal financial sector.

6. Conclusion and Recommendation

In this study a detail account of financial inclusion in Ethiopia from the demand side is documented. In general financial inclusion in terms of all indicators or proxy measures is low in Ethiopia compared to SSA. The survey covers 11,810 individual adults and the analysis is at individual level; targeting a total of 48 million adults. The survey questionnaire provides a large number of indicators on financial inclusion that enables to assess, the proportion of account penetration and the use of financial product and services. It also provides micro-level information on gender, age, marital status, place of residence, education level and etc.

The descriptive analysis shows the following results. While, the majority of Ethiopians rural residents only 12percent of them have formal account, 10.7percent use their account to save and usage of financial products and services is almost negligible among rural residents. Regionally as it is expected financial inclusion is higher in Addis Ababa and lower in both Oromia and SNNP. As expected there is a gender gap in financial inclusion indicators in Ethiopia. Educated and financially literate adults are exceedingly included in the formal financial sector. Financially capable adults are less included than incapable adults. Those who prefer formal financial services are more included than those who prefer informal financial services. The percentage of population who are worried about unexpected shocks and not worried are almost similarly included.

Our main empirical specifications focus on three dimensions of the financial indicators: owning a formal financial account, using formal financial account to save, and using of financial product and service. Unusually rural residents in Ethiopia have more probability to use their account to save than urban. There is also significant gender gap in financial inclusion in Ethiopia. Though it is not confirmed using the econometric estimation there is also a religious gap between Muslims and Christians. Furthermore, both the general and financial literacy positively correlated with financial inclusion indicators. Old

age lowers the probability whereas young's have a higher probability of financial inclusion. Preference for formal financial institution and being married also increases the probability of financial inclusion. Finally financially capable individual have lower probability of financial inclusion in Ethiopia. We have not found a significant association between financial inclusion and Shock and religion respectively. According to both the descriptive and empirical results the following policy recommendations are forwarded for a better financial inclusion in Ethiopia.

Government to people transfer and vice versa can be made digitalized, like utility bills, school fees, both urban and rural PSNP, tax (lower tax payer), transportation fees, etc. In Ethiopia as of 2015/16 there are close to 8 million Productive Safety Net program (PSNP) beneficiaries in rural Ethiopia. As of 2017, the figure is 10 million due to the recent recurrent drought (MOFAC). Most of the beneficiaries live in remote area and are food insecure household with low income. The transfer is mostly made mostly in cash. Therefore, government can consider this as a good channel to intervene and make the payment via formal account either by bank or microfinance whichever is convenient.

Promoting both financial and general education: Both general and financial literacy have found to increase financial inclusion in Ethiopia. Ethiopia has made a progress in general education in the last decade; this should be strengthening for it also increases financial inclusion. Incorporating financial education into a curriculum and increasing awareness using other method of channels such as mass media can be considered for better financial inclusion.

Addressing disparity between urban and rural residents and regional difference: Both financial and other Infrastructure development, such as electric power, telecommunication, mobile and agent banking, increasing number and branch of microfinance, banks shall expanded in the rural areas. Tigray and Amhara regions have a better microfinance institution that helps them more financially included than the rest of the regions. In Oromia and SSNP a special policy intervention particularly expanding access point and use of microfinance are worth considering. The experience of Tigray and Amhara regions can be used as a benchmark.

Developing suitable products and services for Muslims and vulnerable social group such as young, women and poor. The descriptive result reveals that financial inclusion varies between Muslim and Christian, though it is not confirmed by the econometric results. Products and services compliant with Islamic banking shall be developed and expanded. Of course further survey can be made to know the actual demand for such products and demands. Vulnerable social groups such as women and young should be address by developing products and services suitable for them. However, the econometric results do not confirm the same.

Financial education programs targeting females will enable them to develop a reasonable understanding of owning a formal account, and how to use financial products and services. Ethiopian females are among the most excluded from the formal financial sector in the world. Products and services that are suitable for females shall be creatively designed. Most females live in rural area and with low level of both general and financial education. Introducing agent banking in rural Ethiopia will help females excluded from owning a bank account due to remoteness of formal financial services. Both the descriptive and empirical result show that financial inclusion is highly linked to income generating capability. It is also noteworthy to address the issue of gender equality in economic activities.

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Residential Pricing in Ethiopia: Do Urban Green Amenities Influence House Buyers' Decision?

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Abstract

Urban green amenities are vital infrastructures to realize sustainable urban development and healthy life in cities. However, direct economic value of green amenities is seldom measured in monetary terms. Moreover, studies on urban green amenities' valuation in developing countries are scanty and are limited in Ethiopia. To fill the gap, this study aims to investigate impacts of urban green amenities on residential pricing using hedonic pricing method. The impact of green amenities in residential house pricing is analysed using the data collected from 391 residents of Addis Ababa. Results from the log-linear regression model indicated that buyers of residential house attach positive and significant value to urban green amenities. Specifically availability of green spaces increases the average price of house by 32%. Views for landscapes, nature areas and water-bodies increase average house price by 38%. However, result shows no statistical evidence for the impact of park availability on house price. Other house characteristics such as number of total rooms, bedrooms, and size of house have positive relationship with the average price buyers assign. Therefore, designing urban residential areas and real estate's that incorporate green spaces and nature landscapes can yield significant benefits for the developers and help building resilient and green cities in Ethiopia.

Keywords: Urban green amenities, residential pricing, environmental valuation, hedonic pricing model, Addis Ababa, Ethiopia

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1. Introduction

More proportion of the world population currently live in urban areas than rural areas. In 2014, people residing in urban areas has reached 53% and this figure is expected to grow further to 66% by 2050 (UNDESA, 2014). Furthermore, the rate of urbanization is higher in developing countries including those in Africa despite their low level of current urban population. According to UNDESA (2014), Africa is urbanizing faster and projected to be 56% by 2050 from the 40% in 2014. As the world continues to urbanize, sustainable development challenges will be increasingly concentrated in cities, particularly in the lower-middle-income countries where the pace of urbanization is fastest. In this case, it needs formulating integrated policies to improve the lives of urban dwellers and sustain healthy environment.

In Ethiopia, the current rate of urbanization is high. According to World Bank (2015), urbanization in Ethiopia increases by 5.4% per a year which put the country among the top 10 fast urbanizing countries in the world. The main drivers for current rapid rate of urbanization in Ethiopia include the expansion of existing cities, rural-urban migration and transformation of small rural villages to towns. However, rapid urbanization demand balanced investment in basic infrastructure such as health, education, roads, water and sewerage, housing and recreational facilities (AfDB, 2016). The provision of such facilities is challenging in urban areas of Ethiopia including the capital city, Addis Ababa.

Addis Ababa is largest urban area in Ethiopia serving as a capital for the country as well as the headquarters for the African Union and other international institutions including UNECA. The city is expanding at the fastest rate with unbalanced expansion of infrastructure and services. These create burden on the provision of housing and green amenities. In view of this, the city government has designed a structural plan that designates around 22,000 hectares of land, which is 41% of the total land, for green area development. The successful implementation of the plan and protection of green amenities in Addis Ababa require support from the private sector including real estate developers, individual house builders and buyers. But the support from private sector depends on their attitude towards and value they

assign to urban green amenities such as green spaces, parks, street trees and other related urban ecosystem services. Therefore, understanding residents' value for urban green amenities can provide important insight for urban planners and decision-makers to develop green infrastructures in cities.

However, studies on the impacts of urban green amenities on residential pricing are very limited in developing countries particularly in Africa. To mention some, Jim and Chen (2006), Chen and Jim (2010) and He et al (2010) examined on environmental amenities on house prices in different cities in China. Chaudhry et al. (2013) assessed the impact of environmental attributes on the market price rates of residential plots in the city of Chandigarh, India. In Ethiopia, to the best of our knowledge, there is no study on the impacts of urban green amenities on house pricing or value. Most valuation studies in Ethiopia focused on estimating the economic value of parks and forests, urban waste management and river water quality improvement. For instance Juhar (2013) examined valuation of forests in rural area whereas Teshager (2014) investigated residents' willingness to pay for the improvement of urban river quality. On the other hand, Sema (2010) assessed the location differences in prices of houses in Addis Ababa although the reasons for those deviations in residential price are not well-studied. Furthermore, research on the environmental valuation and the role of green amenities in house prices in Ethiopia are scanty. Given the key research and knowledge gap, this study aims to investigate impacts of urban green amenities on residential pricing focusing on the demand side of the housing market.

2. Literature Review

The indirect values of environmental amenities are commonly measured through their effect in the value of properties like house. The typical empirical approach for estimating green amenities value in house price is Hedonic Pricing (HP) method. As noted by Monson (2009), hedonic pricing model can help measuring effects of both tangible and intangible characteristics of the house including outside influencing factors on its price.

In this regard, several studies in different countries have employed hedonic pricing method and find out the positive value green amenities on the price of

urban house in case of middle income countries. For example, Chaudhry et al. (2013) examined the impact of key environmental attributes like proximity to urban lake, having good water quality, parks/gardens, clean air and traffic noise attenuation on the market rates of residential plots in the city of Chandigarh in India using hedonic pricing method. The study indicated that proximity to lake and leisure valley chain of green spaces raised housing prices by about 10% and 2% respectively. The study demonstrated that a possibility for increasing the rate of urban residential property in areas near to the lake. Jim and Chen (2006) assessed the impacts of key environmental features on residential housing value in Guangzhou, China. The study indicated that view to green spaces and proximity to water bodies increased housing price by 7.1% and 13.2%, respectively. Similarly, Chen and Jim (2010) analysed the amenity and dis-amenity effects arising from the heterogeneous urban landscape in a Chinese city of Shenzhen that indicated residential gardens were the most attractive landscape resulting in an average increase of housing price by 17.2%.

In developed countries, several studies found positive effect of urban green amenities in residential prices. In Netherlands, Luttik (2000) investigated the effect of various environmental factors on the price of houses using hedonic pricing method. The results indicated that 28% increases in house price with a garden facing water connected to a lake and revealed that house price varies by landscape types. Other similar studies also reported an increase in the value of properties with greater proximity to green areas. For example, a study by Tyrvainen and Miettinen (2000) in Finland revealed that one Kilometer increase in the distance to the nearest forested area lead to a decrease in the market price of house nearly by 6% and houses with a view to forest are on average more expensive than houses comparable with respect to other characteristics nearly by 5%. Similarly, Legget and Blockstael (2000) studied the effect of nearby water quality on residential land prices and found waterside house owners' higher willingness to pay for reductions in pollution.

However, some studies did not find positive association between the prices of residential house and environmental amenities. For instance, He et al. (2010) did not find positive impact of accessibility of recreational facilities and parks on house price in Beijing. Instead, showed the main determinants of house

purchase price were the price of land, ratio of area of building to total area, and the distance to city downtown place. In addition to the quantitative studies, some other research use qualitative approach and report that people do not consider green amenities in their choice of residential places. For example, róbek et al. (2015) qualitatively surveyed residents' choice of residential locations in Poland and results indicated that the quality of the environment was not the main criterion in determining choice of residential location despite high levels of environmental awareness among the respondents. A quiet neighborhood and scenic value were regarded as the most important determinants.

Some studies applied a Contingent Valuation Method (CVM) to estimate the value of urban green amenities. Lo and Jim (2010) investigated residents' recreational use of urban green spaces and assessed their monetary value using CVM in Hong Kong. The result indicated over 80% of the respondents willing to pay to recover a hypothetical reduction of urban green spaces area by 20% due to urban development. This implied that residents place significant monetary value to the non-marketed services of the urban green spaces that could provide pluralistic view to green space planning and nature conservation as the part of city planning and management. Similarly, Adekunle et al. (2008) assessed an economic valuation of the environmental service functions of forest trees in urban area of Nigeria using CVM. The study found the mean monthly WTP values ranged from 70 to 154 Nigerian Naira with corresponding aggregate values of 23450 and 51724 Naira (1USD=129 Naira), as well some socioeconomic variables such as age, monthly income, and length of service significantly influenced the respondents' WTP for urban environmental service.

Tameko et al. (2011) analysed the preferences, attitudes and motives of urban park visitors for a policy that aims at endowing the park with more amenities using CVM. The study revealed 78% of respondents are willing to pay an entrance fee that is higher than the current one if the park was endowed with more amenities. Moreover, the study found the mean willingness to pay 370.35 CFA and 351 CFA francs per person for the Logit model and Turnbull lower bound estimator, respectively. Moreover, the result also

indicated improved urban park will result in increased welfare gains for the visitors and improve the environmental quality.

Another line of studies applied choice experiment method to solicit the non-market value of environmental goods. In Burkina Faso, Traore and Salles (undated) evaluated the value of recreational and conservation benefits of the Bangr-Weoogo urban parks using choice experiment approach. The study targeted to observe if visitors' preferences shared between recreation and biodiversity of urban park can be reconcilable by identifying trade-offs between the different characteristics of the park. The study result showed current situation of park is preferred and increase of biodiversity is the feature able to improve the visitors' well-being. Besides, visitors reported that they prefer current recreational restrictions and against the increase of relaxing areas. In Poland, Giergiczny and Kronenberg (2014) estimated the value of street trees in the city center of Lodz using choice experiment approach. They developed a set of hypothetical programs which put varying emphasis on the different ways to increase the numbers of trees to indicate how valuation results helped to improve governance of urban ecosystem services. The study indicated that residents were willing to pay the highest price for greening streets where there were few or no trees and confirmed the general importance of planting trees.

Another study by Abildtrup et al. (undated) estimated the non-market value of urban green spaces around the in Nancy city, France using choice experiment method. The study created choice alternatives by changing the attributes of actual residential location and analyzed data using mixed logit model to account for preference heterogeneity. They measured the willingness to pay applying both "preference-spaces" and "willingness-to-pay-spaces" methods results of which showed that parks and forests have both direct use value (recreation) and indirect use value (scenic view). The study result indicated that no substitutability between parks/public gardens and urban forest and there is a significant variance in the preferences for location attributes and scale heterogeneity which should be considered when analyzing preferences for urban green space.

In Ethiopia, studies on the value of green urban amenities particularly on residential pricing are lacking. Most of the valuation studies in Ethiopia focused on estimating economic value of parks and forests, urban waste management and river water quality improvement. For instance, Juhar (2013) applied CVM to measure the value of forest in Ethiopia taking the case of 'Wof- Washa' natural forest in Amhara region. The finding indicated that respondents mean willingness to pay is Birr 19.75 per year and the presence of community plantation and the type of contribution were significant factors that affect willingness to pay. Teshager (2014) estimated households' willingness to pay for protection of river water pollution in Addis Ababa using choice experiment method. The study result indicated that respondents are willing to pay per year the average amount of Birr 90.34, 12.89 and 27.87 for additional level and 1.48 for extra meter for river water quality, river water volume, recreational facilities and riparian buffer zone, respectively. This shows that residents prefer the improvement of the quality of urban river water.

On the other hand, Sema (2010) indicated that location has a substantial influence on housing price in Addis Ababa. The study result revealed that a 10% rise in plot area increases housing price by 5.5% and 4.5% in CMC and Alemgena areas respectively. Still the empirical studies concerning the valuation of urban ecosystem services in Ethiopian context are limited. This hampers supporting urban planning and decisions with research works about urban ecosystems and greening activities. In view of this and the absence of studies on urban green amenities valuation, this study attempt to examine the urban green amenities effect on residential house pricing by taking Addis Ababa as a case study.

3. Methodology

3.1 Data

The data used in this study is obtained from the household survey conducted as a part of multi- country research project Ecosystem Service Accounting for Development (ESAfD). For the purpose of gathering required data, we used comprehensive questionnaire developed by the collaboration of different experts in all case study countries. However, we modify the questionnaire

based the local context and feedback obtained during the pre-survey pilot testing on 20 households in Addis Ababa. The questionnaire includes various questions related with socioeconomic characteristics of the respondents, urban green amenities and choice exercises on urban ecosystem services and nature restoration programs. The survey covered five sub-cities and twenty one Woreda³ located in major river basins of Addis Ababa.

The first stage of sample selection, out of the 700 primary sampling units consisting of Enumeration Areas (EAs) in the sub-cities that was drawn from Addis Ababa sampling frame database of the 2007 Population and Housing Census of Ethiopia covering the five sub-cities, 237 EAs were identified around and within the buffer area of these major rivers and river lines. To conduct our survey, forty EAs were randomly selected out of the 237. EAs on average contain a range of 150-200 households. The sampling units in each sampling domains were drawn with a probability proportional to size. On the other hand, we draw households using an inverse probability such that the sample is self-weighted within a domain. We conduct a design effect (DEFF) to estimate the minimum sample size required prior to determining the number of sample households. Accordingly, the minimum sample size found to be 633 households. We determined that the sample size of 640 households and distributed it equally among the 40 EAs.

At second stage, we used an equal probability systematic sampling procedure to select 16 households from each EAs. For this purpose, we select a central sample starting point in each EA from which we identify four quadrants to ensure sufficient representation of sample from all directions. The identification of the sample starting point on the enumeration area undertaken by using GPS coordinate points around the central part of the enumeration area and visualizing the X and Y coordinates to plot a point on the map. Then, 4 households are selected using a random walk pattern approach.

³ Woreda is the administrative unit equivalent to sub-district under sub-cities in Addis Ababa.

After the selection of a random coordinate within the enumeration area, then field staffs identify the nearest landmark to the randomly selected coordinate, clearly marked on the enumeration area map. Then, four enumerators assigned in each EA to gather the data by selecting the households in such a way that one enumerator walk north, the second to the south, the third to the east and fourth to the west with the help of eligibility screening questionnaire used to select the households. The selection procedure of individual household in the walk pattern is that select every 15th household for densely populated enumeration areas 175 households. For enumeration areas 175 households, we select every 10th household for the interview. In case the selected household is not available, the survey team revisited twice and substitute next household on the random route walk (n+1) if they could not get the head of household during all the revisit time. Otherwise, the selected households were not replaced or changed to avoid sampling biases.

However, this particular study used the data obtained from 391 households for the empirical analysis. It is because of the two practical reasons: the first reason is that we focused only on the demand side of the housing market and estimate buyers' value of urban green amenities. Therefore, we excluded the observations of the households who own the house they are living in. The second reason is that some of the key variables in the survey found to have missing value and 'I Don't Know' responses. Hence we drop households with missing value and no response from the analysis.

3.2 The Hedonic Pricing Model

This study applied a hedonic modeling approach to measure the value of urban green amenities in residential pricing in Addis Ababa, Ethiopia. As proximity to green amenities are intangible, its value is not commonly reflected in direct transaction price. Therefore, it is important to measure its indirect value through revealed preference using hedonic pricing model. According to Monson (2009), hedonic pricing model can help to measure the effect of intangible characteristics on the overall transaction price of a house.

Hedonic model explain observed behavior when there are many and different personal preferences. Specifically, it help to assess economic behaviour considering many personal preference factors in housing market. As indicated in Johnson Gardner (2007) and Monson (2009), commonly included factors are wide array of locational features, physical features, environmental features, economic factors, and preferences of individual households and their unique needs. As a result, the relationship between purchase price of house (observed behaviour) and factors that affect buyer’s willingness to pay that price is expressed as:

Price of house = f (house characteristics, location, environmental factors, others) (1)

Here, ‘other’ factors include those factors difficult to observe, specifically the unique tastes and residential requirements of individual households. Equation (1) can be expressed statistically as:

$$P = + 1X1 + 2X2+ 3X3 + ... + nXn + \quad (2)$$

Where P = Price which buyers attach to the house; = a fixed monetary value independent of the value consumers place on the factors. In other word, is the minimum price a buyer will pay for a home before even considering all of the qualities and amenities; = The monetary value that a buyer places on a specific house feature, X = An individual feature of a house that has a unique monetary value; n = The total number of house features that factor into the house price paid; = Unpredictable determinants of house value, or random error term.

By rewriting the Equation (2), we can form a vector of locational, physical, economic and other factors together (V), and environmental variables (U) as expressed below.

$$P = + \sqrt{V} + \sqrt{U} + \quad (3)$$

Where P = vector of average prices that respondent assign for the house; = vector of fixed monetary value independent of the value a house buyer places on other variable factors; V= vector of monetary value that correspond to all

non-urban green amenity features of a house that affected the price willingly paid by the buyer; V = Vector of specific features of a home, not including nearby urban amenities, that in part determined the price a buyer was willing to pay for a home; U = Vector of monetary value that correspond to all urban amenity features of a home that affected the price willingly paid by the buyer; U = Vector of specific urban green amenity that in part determined the price a buyer was willing to pay for a home, and ϵ = Vector of random error standing for unpredictable determinants of house price.

Finally, we specified a hedonic price model to investigate the value of urban green amenities in residential pricing in Addis Ababa. In our model, house buyer's subjective price of house is determined as the function of house location, materials by which a house is built, characteristics of house itself, nature of surrounding environment and green amenities. Put in functional form:

HP = f (location, house characteristics, neighborhood facilities, environmental amenities)

Where, HP is the average price respondents willing to pay for the house; location is defined in terms of the sub-city in which the house is located; house characteristics includes house construction material, size of the compound in which the house is located, size of the house area, house renovation, total number of rooms and bedrooms of the house, type of toilet and roof. On the other hand, neighborhood facilities include the access and quality of primary school, secondary school and healthcare facility, quality of streets and safety and crime condition. Environmental amenities comprise the view to attractive landscapes, nature and water-bodies, availability-and access of parks and green spaces.

4. Results and discussion

4.1 Descriptive analysis

Out of total sample of 640 households, only 30.2% owned the house whereas about 64.5% rented and about 5.3% are using the house they are living in without payment. For the purpose of empirical analysis, this study focused on

the demand side of house market and chooses 413 households who do not own the house and want to buy it. After that, about 19 observations are dropped due to the missing values and ‘I Don’t Know’ responses for the some variables. Finally, the empirical analysis has been done based on the 391 households.

Table 1: Nature and descriptive statistics of house characteristics variables

Variables	Nature of variable	Mean	SD*	Min	Max
House price	<i>Continuous</i>	473352	824820	11500	6,750,000
Type of house	Categorical	4	2.3	1	6
House renovation	Dummy (1 = Yes, 0 = No)	1.4	0.5	1	2
Total rooms	Continuous	2.26	1.28	1	17
Bedrooms	Continuous	0.93	0.66	0	3
Compound size	Continuous	65.55	202.2	6	3500
House area size	Continuous	30.14	23.52	2	240

Source: Authors’ computation based on the survey data*Standard deviation

As can be seen from Table 1, the mean price of a house is 473, 352 Birr with the maximum price being 6,750,000 Birr. The number of total rooms, bedrooms, size of house area and compound area are considered as important housing characteristics. The average number of the rooms houses have was two with the minimum of one and the maximum being seventeen. This indicated that a higher deviation in the number of rooms, where the majority of houses have small number of rooms. On the other hand, the average number of bedroom was one where there are house with no specifically standalone bed rooms but with maximum number of bedrooms was found to be only three.

In addition, the size of area of the compound and the house itself has been shown high variation. The mean area of the compound in which houses found was about 65.5 meter square where the minimum and maximum being 6 and 3500 square meters, respectively. The high variation in the size of compound areas is reflected in the high standard deviation which is 202 square meter. Similarly, there is a noticeable deviation in the size of house area, the mean

size of house area was found to be about 30 square meter with the minimum and maximum of 2 and 240 square meters, respectively.

Table 2: Description of access and availability of urban green amenities and other facilities

Variable	Description	Nature	Percentag
Bathroom	Availability of separate bathrooms	Dummy (1 = Yes, 0 = No)	7.2
Skeptic tanker	Availability of separate skeptic tanker for liquid & solid wastes	Dummy (1 = Yes, 0 = No)	5.88
Air conditioning	Availability of air conditioning in a house	Dummy (1 = Yes, 0 = No)	4.4
Piped water	Access to piped water for a house	Dummy (1 = Yes, 0 = No)	90.0
Electricity	Access to electricity for a house	Dummy (1 = Yes, 0 = No)	98.7
Landscape, nature and water view	View to attractive landscapes, nature areas and water bodies	Dummy (1 = Yes, 0 = No)	21.5
Attractive street view	View to attractive streets with trees & other features	Dummy (1 = Yes, 0 = No)	25.6
Other attractive view	View to other attractive features different from landscapes, nature areas, water bodies & streets	Dummy (1 = Yes, 0 = No)	6.9
Green space availability	Availability of green spaces or areas covered with trees, grasses & others	Dummy (1 = Yes, 0 = No)	37.6
Parks availability	Availability of parks around the living area	Dummy (1 = Yes, 0 = No)	48.1

Source: Authors' computation based on the survey data

Furthermore, about 7% of the respondents have separate bathrooms and about 6% have separate skeptic-tanker for liquid and solid wastes disposal. These indicated that the majority of house lack basic facilities for sewage and

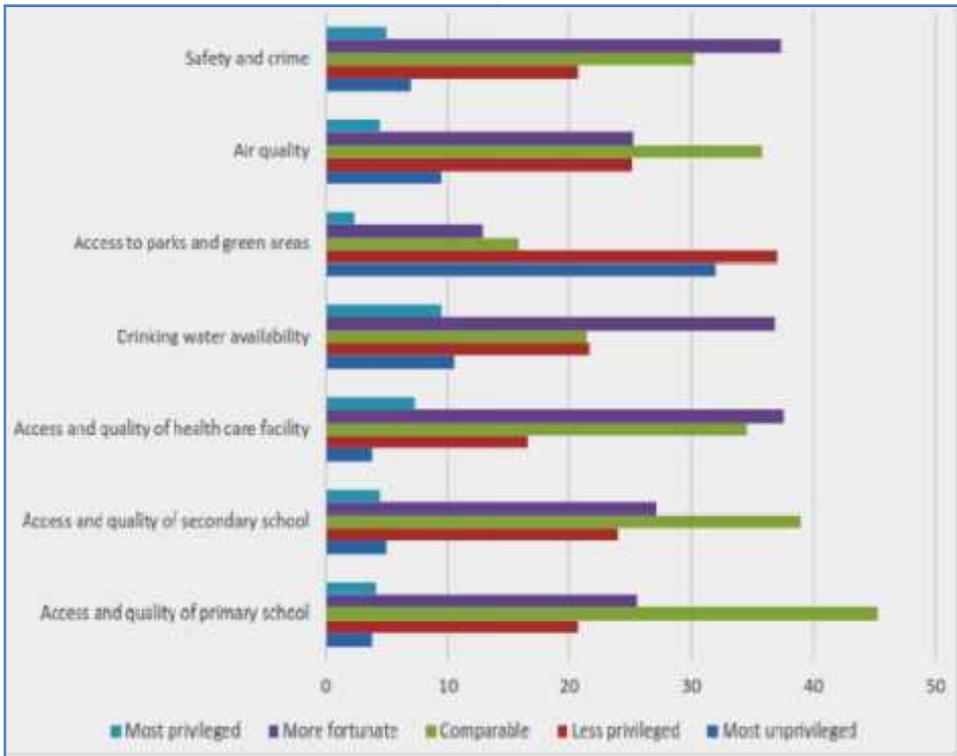
sanitation services. In addition, about 4.5% of houses have air conditioning (i.e. access to have fresh air through window).

Other important facilities for residential houses in cities are access to reliable piped water and electricity. About 90% has access to piped water whereas the remaining 10% do not have piped water for their house. Although it seems small proportion, lack of reliable and potable water supply is critical given its implication for the health and sanitation of the family living in the house. About 22% of the residents believed that their neighborhood or area is less privileged concerning the availability of drinking water while 37% think their area is more fortunate as compare to other most areas (see Figure 1). On the other hand, access to electricity among the sample houses is found to be 98.7% (Table 2) which is pretty much better as compared to piped water access. Given the fact that electricity in Ethiopia is generated mainly hydropower and wind energy, increased access to electricity in Addis Ababa and appreciable move towards realizing green economy in the city. However, the key question rests on its reliability as power outage is frequent in the countries.

Houses located in an area with the eyesight to attractive landscape, nature areas and water- bodies are attractive for residents. About 21% have a view to attractive landscapes, nature areas and water-bodies. Landscape and nature area includes any environmental features including mountains, forests, valleys and others. About 25% of the houses have street views

Furthermore, availability of green spaces and parks nearby the residential areas also determine attractiveness of the location. About 37% of the respondents agree that there are green spaces covered by trees, grasses and other features around the location of their house. About 48% of the residents indicated that their house is located near to park (see Table 2). The nature of park can be any size, level of development and meant for any purpose. As compared to access to green spaces, larger proportions of house have access to parks in their locality. However, 37% of the respondents indicated that their village or neighborhood have access to parks and green areas as shown in Figure 1. The deviation between the availability and access to parks are due to the reason that some parks in Addis Ababa are currently not made open to the public visitation.

Figure 1: Conditions of neighborhood infrastructural and environmental facilities



Source: Authors' computation based on the survey data

In addition to green amenities, the relative access and quality of education and health infrastructure and facilities can determine residents' location choice. About 45% of respondents rate the access and quality of primary school found in their village as comparable to other areas in the city. About 21% of the respondents rate their neighborhood less privileged while about 4% rank it as most unprivileged concerning primary education access and quality. As far as secondary education is concerned, slightly lower proportion of respondents (about 4%) agree that their village is most unprivileged as compared to other areas in the city. By the same token, about 39% of the residents believe that their neighborhood is comparable to other villages in the city regarding the quality and access to the primary education. Unlike the access and quality of education, more proportion of respondent report that their village is more fortunate than other areas in the city concerning the access and quality of

health care facilities (see Figure 1). Putting in specific terms, about 38% of the respondents believe that their neighborhood is more fortunate as compared to other areas. On the other hand, only 25% and 27% of respondent believe their neighborhood is more fortunate regarding the access and quality of primary and secondary education. Similarly, about 7% of the residents rate the access and quality of health care facilities in their village most privileged than other areas in the city. However, only about 4% of the residents believe their neighborhood is most privileged concerning the access and quality of primary as well as secondary education in comparison with other villages in the city.

Safety and crime condition in a given area is also an important factor for the location preference of residents. The respondents are also asked to rate the safety and crime condition in their neighborhood as compared to other places. Results indicate that 37% of the residents believe that their village is more fortunate concerning the safety and crime conditions as compared to other places in the city. About 30% and 21% of the respondents rate their neighborhood as comparable and less privileged, respectively, as compared to other villages in the city. It is worth noting that the ratings are only based on the respondents' perceptions and belief about their neighborhood relative to other villages they know or experienced in the city.

The residents are also asked to rate the air quality in their neighborhood in terms of smoke, smog, particles, dust and smell. As can be seen from Figure 1, about 39% of the respondents rate the air quality in their neighborhood as comparable to other places in the city. However, 9.5% believe the quality of air in their village is most unprivileged as compared to other areas. Moreover, the contradiction in responses about the air quality is that similar proportions of respondents (about 25%) rate their neighborhood as less privileged and more fortunate than other villages in the city.

4.2 Empirical results

In the regression analysis, we have tried both linear and log-linear hedonic pricing model specifications, while in this study we report the results from log-linear regression model. Log-linear model includes the natural logarithm

of average price of house. The results from Log-linear model yield a better goodness of fit indicating that non-linear model is more appropriate in explaining our data about the relationship between price of house and other different factors the buyers consider when assigning a value to a house.

Locational factors affecting the price of house

One of the factors that affect the residential prices is the location of the house. As presented in Table 3, house buyers are willing to pay high price for houses located in Lideta sub-city as compared to Gulele sub-city. This might be because of residents preferred center locations in the city and it is easily convenient for traveling around the city. Lideta is the center for businesses and residential apartments with relatively better infrastructure including connectivity to the new Light Railway Transit in Addis Ababa. Our results shown that no statistical evidence for the residents' willingness to pay higher price for houses that are located in other sub-cities namely Addis Ketema, Arada, and Kirkos as compared to Gulele.

Apart from the physical location of particular house, buyers care about the facilities available associated with location of the house. These include access and quality of economic and social infrastructures such as schools, health facilities, and others. In the regression, we included variables representing access and quality of neighborhood infrastructures as dummies taking 1 for most privileged and more fortunate responses as compared to other neighborhood, 0 otherwise. The regression result shown that access and quality of primary school has positive and statistically significant impact on the price buyers assign to a given house. As compared to houses in most unprivileged areas, buyers are willing to pay 14.7% higher price for houses in most privileged areas in terms of access and quality of primary schools. However, the results show no statistical evidence for the impact of the access and quality of secondary school and health care facilities on the price of house, as the coefficients were found to be statistically insignificant. This might be due to buyers care more for the distance of school for their young children and as their children grow they can manage going to schools by their own as long as they can get quality education.

Another key factor for the residents' decision to value the house is the streets, safety and crime condition in a given area. The buyers assign 20% higher price for the houses located in the most privileged areas in terms of safety and crime condition as compared to most unprivileged areas. Residents prefer living in more secured and safe areas instead of areas with frequent crimes and other social safety problems. On the other hand, buyers willing to pay about 30% more for the house with better view to attractive streets, while the quality of streets was statistically insignificant.

Effects of house characteristics on the price

In addition to location, the type of materials which the house is constructed can determine the price of a house. This is because the material by which the house built can affect the strength and durability of the house. To examine this effect, we incorporate the categorical variable of the main materials for house construction namely brick, wood with mud and cement, wood with mud, and metal sheet & stones. For this purpose, we keep concrete as a base variable. Regression results indicated that buyers pay 205% lower price for house whose walls are constructed by metal sheet and stones as compared to concrete, it is statistically significant (Table 3). However, results indicated that no statistical evidence for differences in prices of house built with concrete over those constructed by wood mud and cement, and wood and mud. Majority of the houses are built by wood with mud and wood with mud and cement. Most houses in sample sub- cities are old and built during modern construction materials were not common in the country. Another thing worth mentioning is that the coefficient for type of houses is statistically insignificant.

The size of house area, total number of rooms and bedrooms are also found to be important factors that affect the average house value buyers assign. An increase in the area of house size increase the price of house buyers willing to pay by 1.2%, keeping other things constant and significant at 1%. The positive relationship between house size and price is not surprising that larger house area is key factors for choosing a house in Addis Ababa, and as the size increases costs of house construction also increases. The price of a house residents willing to pay also increase by about 15% and 22% as the

number of total room and bedroom of the house increases, respectively. Although its coefficient is smaller, number of total rooms better explain the price of house which is reflected in 1 percent statistical significance as compared to the number of bedrooms which is statistically significant at 10%. The probable reason for this is that people adjust any rooms in their house for different purposes. Another factor that theoretically affects the price of house is the house renovation, but our results indicated that it has a positive coefficient but not statistically significant evidence for the impact of house renovation on the price of house.

Other factors that can determine the price of house are the type of facilities and the nature of house components. Residents assign lower prices for houses with the toilet type of private pit latrine, shared pit latrine and containers and other outlets as compared to the houses with flush toilet facility. Result indicated that price of a house with shared pit latrine decrease by 80% as compared to a house having flush toilets, significant at 5%. Similarly, residents assign 167% lower price for a house with containers and other toilet outlets which is statistically significant at 1 percent while it is insignificant for private pit latrine. These indicate that the type of facility for toilet outlets can affect house buyers' preference and decision in setting the value of a house.

Buyers of house also take the type of house component facilities into consideration during the determination of house price. The house component facilities include the type of house floor, roof and others. The result indicated that buyers prefer houses made of concrete and concrete related over corrugated iron, roof tile and clay. Houses that have roof made of corrugated iron and clay worth about 158% and 220% lower prices as compared to houses with roofs made of concrete, significant at 1 percent. This is because concrete roofs are more strong and durable than other forms of roofs.

Table 3: Regression results from the hedonic price model

Variables	Coefficients	Standard error	P-value
<i>Sub-city (Base: Gulele)</i>			
<i>Lideta</i>	0.956	0.2284	0.000
<i>Kirkos</i>	0.335	0.2843	0.238
<i>Arada</i>	0.203	0.1859	0.274
<i>Addis-Ketema</i>	0.239	0.2348	0.309
<i>House construction material(Base: Concrete)</i>			
<i>Brick</i>	-0.382	0.5063	0.451
<i>Wood with mud and cement</i>	-0.478	0.3202	0.139
<i>Wood with mud</i>	-0.03	0.3308	0.933
<i>Metal sheet & stones</i>	-2.051	0.4810	0.000
<i>Compound size</i>	0.0001	0.0002	0.438
<i>House area size</i>	0.012	0.0037	0.003
<i>House renovation</i>	0.085	0.1462	0.559
<i>Total rooms</i>	0.1482	0.0491	0.003
<i>Bedrooms</i>	0.2234	0.1233	0.071
<i>Toilet type(Base: Flush toilet)</i>			
<i>Private pit latrine</i>	-0.394	0.3581	0.271
<i>Shared pit latrine</i>	-0.802	0.3476	0.022
<i>Containers/some others</i>	-1.671	0.4361	0.000
<i>Roof type(Base: Corrugated iron)</i>			
<i>Roof tile</i>	-0.270	0.4625	0.559
<i>Corrugated iron</i>	-1.583	0.4819	0.001
<i>Clay</i>	-2.189	0.3026	0.000
<i>Access/quality primary school</i>	0.147	0.9420	0.100
<i>Access/quality secondary school</i>	-0.108	0.0870	0.212
<i>Access/quality health care facility</i>	-0.016	0.0784	0.838
<i>Quality streets</i>	-0.016	0.0750	0.829
<i>Street view</i>	0.308	0.1589	0.053
<i>Safety/crime</i>	0.203	0.0684	0.003
<i>Landscape/nature/water view</i>	0.378	0.1735	0.030
<i>Park availability</i>	-0.239	0.1529	0.125
<i>Green spaces availability</i>	0.324	0.1461	0.027
<i>Constant</i>	10.927	0.8651	0.000
Dependent variable: Natural logarithm of average price of house R-squared = 0.32			

Source: Authors' regression analysis based on the survey data

Impacts of urban green amenities on house price

Buyers not only account the house characteristics but also considered location issues in their decision to pay for a house. Environmental and other factors can affect the buyers' preferences and hence determine the willingness to pay for house or to value. As indicated in Table 3, there is positive and statistically significant relationship between the landscapes, nature and water view and the price of house. In specific terms, the availability of view to landscapes, nature and water body increase the price of house by about 38%, which is significant at 5 percent. The result of positive and statistically significant effect of nature and water-bodies on the house price is partly consistent with Jim and Chen (2006) and Chaudhry et al. (2013) which found positive relationship between proximity to urban water bodies and house price in China. Here, it should be noted that the quality of water can determine the people's preference although our analysis does not control for the quality of water.

Similarly, availability of green spaces around the area of house location significantly determines the price buyers pay for the house. Keeping other locational and house characteristics constant, result indicated that availability of green spaces increase the price of house by about 32.5%, it is statistically significant at 5 percent. The positive impact of green spaces on residential price is consistent with the finding of Chen and Jim (2010) showed an increase in house price as availability of garden area increases. Our results did not shown statistically significant evidence for the effect of park availability on the price of house buyer will pay. This result is in line with the finding of He et al. (2010) who reported no positive influence of accessibility of parks on the price of house in Beijing.

5. Conclusion

The study examined the effluence of green amenities on the buyers' choice and willingness to pay for residential house in Addis Ababa, Ethiopia. For this purpose, it employed hedonic pricing model with a focus on the demand side of housing market. Empirical results revealed that green urban amenities influence house buyers' decision about price. Other characteristics being

constant, green spaces, and attractive landscape, nature and water-body has significant positive impact on price of the house. Apart from the green amenities, some house characteristics and neighborhood infrastructure also influence the value or price of a house. Results show that location, type on construction materials, roof and toilet type, size of the compound and house matter in determination of house prices by buyers. Buyers are willing to pay more prices for house located in the area where there is access to quality primary school. More importantly, the safety and crime condition also affect the price of house. House located in areas with more safety and less crime is found to have 20% more price.

Availability and access to green space increase the price of the house by 32%. Houses which have a view to attractive landscape, nature and water-bodies has about 38% higher price. In addition, a view to attractive streets which has trees and other eye-catching features increase the price of house by 30%. This result indicated that residents attach positive value on the urban green amenities. Residents have strong preference for the urban green amenities. This is reflected in the positive impact of the availability and access to green spaces, and view to the attractive landscapes, nature and streets on the price respondents assign to the house. Therefore, the study findings highlighted that improving the availability of and access to the green amenities in urban areas are important in designing urban residential places and in real estate's development. Considering resident's preference for urban green amenities in their decision to value houses can provide useful information both for the developers and decision-makers to build resilient and green cities.

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Intergenerational Transmission of Poverty and Child Well - Being in Ethiopia: Early Childhood Health, Nutrition and Cognitive Development

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Abstract

The primary objective of this paper is to trace the initial childhood poverty (wellbeing) trajectories in Ethiopia in the light of Intergenerational Transmission of poverty (IGT). Childhood poverty as part of the overall intergenerational poverty or wellbeing is assessed using the first life cycle covering the preschool period which covers children's age from conception to their fifth birthday and the second life cycle which covers children's' years of primary school.

In the first cycle children's health and nutritional status is considered as a summary outcome variable to capture their wellbeing for the period. In order to identify the major factors which affect preschool child health and nutritional status in Ethiopia we have employed 2SLS Instrumental Variable regression using panel data obtained from the first two rounds of the Young Lives survey in 2002 and 2006. Our result shows that the summary outcome variable for preschool child health and nutritional status – Height for Age Z score (HAZ) is found to be significantly associated with educational level of the household head, housing quality index, consumer durables index, access to toilet facilities and electricity in the surrounding community, the number of male and female children aged 1 -5 years other than the index child, sex of the child, mothers education and fathers education.

In the second life cycle stage children's wellbeing is captured by their cognitive development measured using PPVT RAW score. In order to obtain the major factors associated with children's educational attainment and thus their cognitive development we have employed IV estimation strategy. The Young Lives data for the same younger cohort children administered in the last round in 2010 is used for the analysis in this part. Accordingly, we find that variations in the children's cognitive ability in the beginning of the second life cycle stage is attributed to

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children's time allocation, paternal and care giver's educational status, household wealth, household composition and birth order. Finally, the link variable between the two life cycle stages (One period Lagged value of HAZ) is found to be weakly significant to determine subsequent educational attainment and thus children's cognitive development. Based on these results we suggest some policy implications such as adult education schemes for parents; infant nutritious food supply programs and school feeding programs; enacting a more modest child labor law and strengthening its enforcement; and infrastructural development especially power supply and sanitation facilities.

Key Words: Intergenerational Transmission of Poverty (IGT), Life cycle Framework, HAZ, PPVT, Childhood Poverty, Cognitive Development, Positive Deviance

1. Introduction

The process of intergenerational transmission (IGT) of poverty from parents to a child shows the likelihood that a child born in to poor or non-poor parents becomes a poor or non-poor adult. Two broad stages in the life-cycle can capture the complete IGT process (a complete poverty cycle). The first stage captures the likelihood that a child born into a poor family will be a poor child which depends partly on the extent to which poor or a non-poor parents transfer poverty-related capital to their children and partly on the extent to which the child is vulnerable, resistant or resilient to poverty. The second stage, on the other hand, captures the likelihood that a poor (or non-poor) child will become a poor (or non-poor) adult (starting the cycle anew), which depends on individual (resilience) and structural factors (such as availability of safety net). It is intuitively clear that these stages are highly interrelated to each other (K. Moore, 2001).

Empirical investigations so far indicated that being a poor child increases the chances of being a poor adult but this is not always the case, and other factors can operate independently to affect well-being over the life-course. In other words, poverty is not simply transferred as a 'package' from one generation to the next. Instead a complex set of factors contribute to the likelihood of a person being poor at some point in their life, and influence the likelihood of that they will become chronically poor, or experience 'irreversibility'.

Although highly context specific, household characteristics and initial endowments have been found to be important factors determining an individual's asset bundle, their capabilities and characteristics, and their power to exercise agency. Individuals' assets, capabilities and agency come together to shape family histories. The interaction between these factors alongside the key moments and decision making points in a life course affect the likelihood that an individual moves into poverty in the future, lives in poverty for the rest of their life or escapes poverty (K. Bird, 2007; Aubery (2012); Brooke Laura Krause (2013)).

Particularly, well-established empirical evidence on the decisive role of early child health, nutrition and education on its wellbeing coupled with the fact that children are particularly vulnerable to exploitation and abuse; make childhood a critical stage of development in the life³ cycle. Thus, in such respect, the concept of childhood poverty focuses on the major deprivations which children face in childhood, especially in terms of health, nutrition, and education. As a result, since the negative effects of deprivation on human development tend to cumulate, individuals with greater exposure to poverty during childhood are likely to have more difficulty escaping poverty as adults (Victoria et. al, 2008; Behrman et. al, 2009; Maluccio et. al, 2009). Therefore, in the face of the life cycle framework, childhood Poverty and the mechanisms that lead to a transmission of poverty over a life course and between generations assume special significance in low income countries where a large number of families continue to live in chronic poverty situations.

Proper nutrition, for instance, contributes significantly to declines in under-five mortality rates and therefore, improving nutritional status is essential for achieving the Millennium Development Goals (MDGs). Globally, an estimated 165 million children under-five years of age, or 26%, were stunted (i.e., height-for-age below -2 SD) in 2011 — a 35% decrease from an estimated 253 million in 1990. High prevalence levels of stunting among children under-five years of age in Africa (36% in 2011) and Asia (27% in

³ This is mainly because they are still growing physically, are naturally dependent on adults, and are often powerless for their wellbeing and security.

2011) remain a public health problem, one which often goes unrecognized. More than 90% of the world's stunted children live in Africa and Asia (UNICEF-WHO-World Bank, 2012).

The 2011 Ethiopian Demographic and Health Survey estimated the national prevalence of stunting among children at 44.4 percent, the prevalence of underweight at 28.7 percent and wasting at 9.7 percent. The survey also revealed that the level of chronic malnutrition among women in Ethiopia is relatively high, with 27 percent of women either thin or undernourished—that is, having a body mass index (BMI) of less than 18.5 kg/m². Similarly, the prevalence of anemia among women in the reproductive age group (15–49) was found to be 17 percent (CSA, 2012).

From policy perspectives, cognizant of the indispensable role played by early childhood health, nutrition and education on human capital development, the Ethiopian government has begun to adopt strategies targeted towards improving child wellbeing. The Government of Ethiopia has demonstrated its policy commitment to nutrition by developing a standalone National Nutrition Strategy (NNS) and a National Nutrition Program (NNP), along with a set of guidelines. The government has also incorporated nutrition, in particular stunting, into its 5-year Growth and Transformation Plan (GTP). Sectoral strategies and programs also provide a good opportunity to mainstream nutrition into other NNP implementing sectors and to enact legislation or establish legal frameworks to enforce key nutrition interventions (NNP, 2013).

Such efforts of the government were not fruitless. In this respect, UNICEF report (2013), using DHS, shows that under-five mortality fell from an estimated 139 deaths per 1,000 live births to 77 per 1,000, between 2000 and 2011 in Ethiopia, which is close to the MDG 4 target of 66 per 1,000. Moreover, stunting among children under 5 also decreased during this period, from an estimated 57 % to 44 %. Moreover, primary school and children's early childhood academic achievement has relatively better statistical figures than health and nutrition in Ethiopia in recent years. As per the Ministry of Education report in 2012, the Net Enrolment Rate (NER) in primary education increased from 22.5 % in 1992 to 85.3 % in 2010/11.

However, Ethiopia ranked 7th among 14 countries hosting 80% of the world's most stunted children. There are still more than 5 million children in the country (44%) who were stunted in 2011, which is as equivalent as saying that 3% of the world's stunted children live in the country. More surprisingly, the economy's leap in GNP per capita growth in the last decade from US\$130 in 2000 to US\$400 in 2011 seems to be insufficient by its own to reduce under-nutrition in the country (UNICEF report, 2013). On the other hand, although there have been significant recent successes in improving access to basic education, there remain significant challenges in ensuring that education is of adequate quality. Lower performance in primary school as explained by higher dropout rates (19.1% for boys and 17.6% for girls, in 2008/09) and thus lower gross intake in the last grade of primary school (52 % in 2008/9) can partly explain some aspects of these challenges, (MoE report, 2012).

Collectively speaking, despite the recent efforts by authorities and corresponding success stories, early childhood health and nutritional status, and schooling attainment in Ethiopia are at their very critical stage which could trigger potential damages to the country's human capital development⁴. According to the child development report in 2012 Ethiopia ranked 138th between 2000 and 2004, and ranked 136th between 2005 and 2010, having child development index (CDI) score of 49.35 and 32.53 respectively.

As a result, in the quest to fill the knowledge gap between the process of IGT poverty in Ethiopia and the prevalence of the problem itself, as manifested by the facts explained above, the motivation of this paper is driven by the necessity of investigating the nature and reversibility of child well-being in the process of intergenerational transmission of poverty during childhood in Ethiopia. Therefore, using the life-cycle framework the paper will identify the range of individual child, household and community level factors that increase

⁴ Countries are ranked according to their scores in terms of a child's chances of dying before her or his fifth birthday, of not enrolling in school and of being underweight. These three indicators are aggregated by simply calculating the average score between them for each period under review, meaning that they each have equal weighting in the index scores. Countries are then ranked according to their CDI scores. The lower the country's score the better.

the likelihood that poverty is passed from parents to their children during pre-school and schooling years of childhood in the country.

The paper will contribute to the existing literature in several ways. First, the paper uses the life-cycle framework to solve various problems in making empirical inferences about the impact of parental characteristics on child characteristics in Ethiopia in the presence of unobserved factors such as inter-generationally-correlated genetic endowments, capital market constraints and purposive placement of different public-sector infrastructure and programs. This is unlike all previous research efforts that studied some section of childhood poverty only on some section of childhood in the life cycle perspective. As a result, the paper will use the life-cycle framework to examine the relative role of the household and the community in improving child health, nutrition and education. Second, the paper captured the independent effect of family characteristics on child health, nutrition, and educational status by controlling for community level unobservables - that are likely to confound the parameter estimate on both household level covariates as well as community level covariates (Rosenzweig and Wolpin, 1986; Ghuman et. al, 2005). This is mainly to capture the partial tendency of parental commitment towards inheriting poverty related capital and thus see the trend of positive deviance in the intergenerational framework. Third, the paper, using the Young Lives panel data in the life-cycle perspective, will examine the relationship between parental background and child wellbeing (as a summary outcome of early childhood health, nutrition, and subsequent child schooling) as part of the IGT poverty in Ethiopia.

Objectives

The main goal of the paper is to assess factors responsible for childhood poverty or wellbeing (captured using pre-school health & nutrition, and subsequent cognitive development) as part of the intergenerational transmission of poverty in Ethiopia as observed in the initial stages of the life cycle.

The specific objectives are:

- to identify the individual, household, and community level determinants of early child health and nutrition outcomes during pre-school childhood.
- to analyze the broader parental and community related factors that determine child academic attainment or cognitive development in children's years of primary school
- to assess the causal relationship between preschool health and nutrition outcomes and the subsequent knowledge acquisition or cognitive development of the child

2. Review of Related Literature

In the pursuit of identifying the gaps in stock of knowledge between the intergenerational transmission (IGT) of poverty and the problem itself, a wealth of empirical research endeavors have been conducted with a multitude of sub themes. In this section, we have tried to briefly summarize previous empirical literature, which we thought are relevant to the issue.

Health, Nutrition and Irreversibilities in Child Development:

Rich empirical literature is available on the separate long-term consequences of early childhood health and nutritional status on future wellbeing. Most literature cites child and maternal nutrition and health status along with the timing of shocks and interventions as the critical factors in determining the irreversibility of poverty transfers. Some of the key texts, which discuss these links and processes, and the implications for interventions in relation to the irreversibilities of such transfers, are summarized below.

Alderman and Hoogeveen (2008) examined the degree to which malnutrition leads to reduced lifetime earning capacity in Tanzania, due to both delays in schooling and declines in total schooling. The repercussions of malnutrition in childhood on subsequent learning and school performance are analyzed by using a unique longitudinal dataset. Similarly, Harper et.al (2004) highlighted the 'crisis in childhood poverty of staggering proportions which has significant long-term implications'. Their work demonstrated the importance of child, adolescent and maternal nutrition in determining health across a

lifetime, and thus one of the key drivers of chronic poverty at the individual and household level. Furthermore, they have showed that missed or poor education have long term effects on other efforts to escape poverty, and childhood nurturing on aspirations and welfare.

Moore (2004) draws evidence from six South-East Asian countries to explore these linkages. He suggested that poverty experienced by youth is often linked to childhood deprivation and parental poverty, and, like poverty in childhood or in old age, it can have implications across an individual's life-course and that of her or his household. Krause (2013) analyzed the impact of childhood malnutrition on educational achievement of Peruvian children. The paper tried to identify which type of nutritional status, and at what stage of childhood, is most critical for educational achievement. While, Averett and Stifel (2006), suggested that malnourished children tend to have lower cognitive abilities when compared to well-nourished children, Aubrey (2012), found that both short term and long term malnutrition have a detrimental effect on knowledge acquisition and rainfall shocks have a long-lasting effect on children development in Madagascar. According to Sanchez (2009), compared to well-nourished children, children that became malnourished early in life are in cognitive disadvantage before school enrolment. By comparing the anthropometric measures of a Tanzanian preschooler with those of a child in a wealthy reference country, Luzi (2010) showed that malnutrition and poor health experienced during early childhood have long term effects on her human capital growth.

Luna and Michael (2013) examined the causal channels in the European Union, through which being born poor affects the individual's economic outcomes as an adult, assessing the role of both parental and child human capital. They have found that being poor in childhood significantly decreases the level of income in adulthood (of around 3,000 euro on average), increasing the probability of being poor by 3%. Wagmiller et.al (2009) studied the long-term consequences of growing up poor in the United States. They have found that individuals who grow up in poor families are much more likely to be poor in early adulthood. Moreover, the chances of being poor in early adulthood increase sharply as the time spent living in poverty during childhood

increases. At all levels of poverty during childhood, African-Americans are more likely to be poor than whites in early and middle adulthood.

Education, Training and Reversals in Poverty Trajectories:

Education is demonstrated to be a significant pathway for breaking the IGT poverty cycles and, potentially, for the “catching-up” of bad starts in life due to poverty. Maternal education is identified as particularly significant, especially in terms of nutrition information, for the well-being of children. Moreover, early enrolment in schools and sustained education are shown to influence adult income-earning potential K. Moore (2004).

Glewwe, et.al. (2001) have found that better nourished children perform significantly better in school, partly because they enter school earlier and thus have more time to learn but mostly because of greater learning productivity per year of schooling. They further suggested that a dollar invested in an early childhood nutrition program in a developing country could potentially return at least three dollar worth of gains in academic achievement, and perhaps much more. Moreover, Alderman et.al (2004) examines the impact of preschool malnutrition on subsequent human capital formation in rural Zimbabwe using maternal fixed effects – instrumental variables (MFE-IV) estimator with a long-term panel data set. Case et.al (2004) also used longitudinal data from a demographic surveillance area (DSA) in KwaZulu-Natal, South Africa, to examine the impact of parental death on children’s outcomes. They have found significant differences in the impact of mothers’ and fathers’ deaths and loss of a child’s mother is a strong predictor of poor schooling outcomes. In Bangladesh women receive less schooling, land and inherited assets than men, and also give up their inheritance to their brothers in exchange for economic and social support. While inter-generationally transferred assets, mostly controlled by the husband, increase levels of current assets and consumption, only husbands’ schooling and inherited land, as well as women’s social networks, are protective against chronic poverty according to Quisumbing (2011).

Using a unique data set from Ghana with comprehensive information on individual, family, community, school quality characteristics and a direct measure of intelligence together with test scores, K. Samuel et.al (2012),

examined the long-term cognitive effects of the 1983 famine on survivors. They showed that differences in intelligence test scores can be robustly explained by the differential impact of the famine in different parts of the country and the impacts are most severe for children under two years of age during the famine. On the other hand, Glewwe and Miguel (2008) found that poor health and nutrition among children reduces their time in school and their learning during that time in Tanzania. They implied that programs or policies that increase children's health status could improve their education outcomes.

Likewise, Behrman et.al (2010) researched the impact of mothers' intellectual human capital and long-run nutritional status on children's human capital in Guatemala. In connection with this, they have found that; maternal human capital is more important than suggested by the standard estimates; maternal cognitive skills have a greater impact than maternal schooling attainment on children's biological human capital; and for some important indicators of children's human capital, maternal biological capital has larger effect sizes than maternal intellectual capital (schooling and cognitive skills).

Health, nutrition, education and child development in Ethiopia

In Ethiopia, there is no, comprehensive and exhaustive literature on inter-generational transmission of poverty and wellbeing. Yet, there are many separate studies focusing on some aspects of poverty dynamics.

Yisak Tafere (2012) analyzed children's experiences and perceptions of poverty in Ethiopia. In his paper, Yisak argues that children's lived experiences of poverty provide us with strong evidence to advance our knowledge of childhood poverty and develop apt policies to reduce it. Children's poverty experiences suggest the multidimensional, contextualized and intergenerational nature of child poverty. Moreover, Yisak and Tassew (2012) analyzed child wellbeing in connection with the incidence of shocks and the way to transform the Productive Safety Net Program beyond food security in Ethiopia. They argued that, amid limited resources and contexts of vulnerability to protracted shocks, there is a need for child-focused social protection.

Using data from Young Lives longitudinal survey the impact of idiosyncratic and covariate economic shocks and the resulting work burden on children on the likelihood of children completing primary education or dropping out of primary school in Ethiopia was investigated by Tassew and Adiam (2012). Their results indicated that both idiosyncratic shocks and covariate shocks have a statistically significant effect on the risk of children dropping out of primary school. Moreover, they have also found that the amount of time children allocate to domestic activities, unpaid activities and paid labor were each found to have a positive effect on the probability of children dropping out of school.

Tassew (2010) examined the existence of permanent consequences of early childhood malnutrition and recovery of children from their early childhood malnutrition. Accordingly, he showed that the existence of permanent consequences of early childhood malnutrition and also the potential for the strong recovery of children from their initial early malnutrition and found significant effects on Z score of height-for-age and log of height, not only for post-natal economic shock but also the pre-natal economic shocks, implying the long-term consequence of shocks on children's height.

Tassew and Liyousew (2012), examined the effects of pre-school attendance on the cognitive development of urban children at the ages of 5 and 8 (measured by the Peabody Picture Vocabulary Test (PPVT) and the Cognitive Development Assessment – Quantitative test (CDA-Q)) using data from Young Lives longitudinal survey in Ethiopia. They have found that pre-school attendance has a statistically significant positive impact on the cognitive development of children at the ages of both 5 and 8 years, with the bigger impact at the latter age. Moreover, they showed pre-school attendance has also a positive and statistically significant effect on primary school enrolment and progression through grades.

Using a mixed-method approach, Keetie and Laura (2012), developed a hybrid taxonomy of child poverty and well-being that can be used for a dynamic analysis in the Ethiopian context. Accordingly, they argued that education is an area in which a child will only make progress once they are of school-going age, with educational indicators being unable to capture any

aspect of children's well-being before or after they leave school. Similarly, they argued under-nutrition indicators are particularly pertinent during infancy and are less able to capture the level of well-being of older children, although lack of food was clearly an important issue for children aged 13–14. Neha and Quisumbing (2011) found some implications of perceptions of unequal divorce allocations on child schooling in Ethiopia. They showed that, not only do children in households where divorce allocations favor the husband do worse compared to children of the same age, but girls fare even worse than boys in these households.

3. Data And Methodology

Data

To analyze the early age intergenerational transfers process of wellbeing from parents to a child, the paper used data from Young Lives longitudinal study⁵ in Ethiopia. As part of the young lives study, three rounds of quantitative surveys of households, children and communities have been conducted between 2002 and 2010 in Ethiopia. In 2002, 2,000 (Younger Cohort) children aged 6 to 18 months and 1,000 (Older Cohort) children aged 7.5 to 8.5 years were selected using the Sentinel Site Surveillance System. Twenty sentinel sites were selected from five main regions of the country from which samples of 100 and 50 children were selected in each site corresponding to the Younger and Older Cohorts, respectively. Purposive sampling strategy⁶ is used to select the sentinel sites while households in each site are selected randomly. Therefore, the participants in this study are those Young Lives sample children of the Younger Cohort in Ethiopia who were surveyed at three points in their lives, each corresponding to a round of survey collection.

⁵ The Young Lives project is a long-term international research project investigating the changing nature of childhood poverty in four developing countries (Ethiopia, India (in Andhra Pradesh), Peru and Vietnam) over 15 years. The study is tracking the development of 12,000 children (3000 children from each survey country), using longitudinal quantitative and qualitative research over a 15-year period.

⁶ Severity of food deficit, representativeness, and costs of tracking respondents in the future (and thus manage sample attrition) were the major purposes while selecting the sites.

The Ethiopian Young Lives dataset is characterized by some peculiar features which make it ideal for poverty analysis. First of all, the sample attrition in the succeeding waves of the survey was extremely low and is thus less likely to cause estimation problems. The total attrition rate is 1.33% and 2.13% for the second round and third round respectively. Secondly, Young Lives dataset collected from all the three waves provides sufficient variables essential for childhood poverty analysis. Finally, the young lives sample is found to be characteristic for the Ethiopian population.

Methodology

The analytical framework binding the empirical analyses in the paper is drawn from different but complimentary sources. The household production model (HPM), as presented in Becker (1965, 1981), is considered as the standard economic framework to analyze children's health, nutrition and educational attainment. In line with Becker's HPM, the generic analytic framework for analyzing individual and familial decisions related to the intergenerational transmission of well-being developed by Chronic Poverty Research Centre (CPRC) (Behrman, 2006), is used as specification guide for econometric models used for analysis in this paper. Moreover, consistently with the generic framework, separate developments by Behrman and Deolalikar (1988) and Thomas and Strauss (1992) alongside Glewwe and Miguel (2007), are used to ease empirical modeling and estimation.

The generic framework developed by Behrman, (2006) helps to solve various problems in making empirical inferences about the impact of parental characteristics on child characteristics in the presence of unobserved factors. Accordingly, a life-cycle framework with three life-cycle stages is developed to illustrate the causal effects of parental background on the capabilities of their adult children. The three-consecutive life-cycle stages represent; pre-schooling (from conception through to about age five or six); schooling and adolescence (from age six or seven); and adulthood to the time of the data respectively. Individual capability is determined by a production function in which the inputs are all previous life-cycle experiences, genetic and other unobserved endowments. The framework uses the production function of

adult intellectual abilities observed during adulthood (third period) to measure inter-generationally transmitted wellbeing in the three-life cycle setup.

However, there is no single standard measure for child wellbeing like adult intellectual ability; we could not estimate the parental production of child wellbeing for the two life cycle stages using the reduced demand equations all together. Instead, two separate estimations are held for two stages of the child's life cycle that it accomplished so far. Therefore, instead of a single production function like that of intellectual functioning in the three-stage life cycle framework, there are two production functions for both child health and educational experiences. Parent's utility maximization, constrained partly by these production functions at the respective life cycle, provides the conditional demand relations for child health and schooling. The conditional demand relations obtained are thus used as a specification guide for the econometric models to follow.

Consistent with the three stages lifecycle framework, we have specified a two-period empirical model to analyze the process of inter-generational transfers of wellbeing in Ethiopia. Accordingly, the production function of adult intellectual abilities now represents child wellbeing which is determined by parental production of child health and nutritional status in the first stage of life cycle (preschool), and parental production child primary schooling achievement which is represented by child's cognitive development in the second stage of life cycle. The summary measure of pre-school experience (life cycle stage 1) is child health and nutritional status which is represented by anthropometric measures; and the summary measure of primary school experience (life cycle stage 2), is child academic achievement which is represented by test scores of child cognitive development. This is where we consistently brought Jere R. Behrman's generic framework and the two separate analytic frameworks developed by, Behrman and Deolalikar (1988), and Thomas and Strauss (1992); and Glewwe and Miguel (2007) together without losing generality.

In the first life cycle stage, following Behrman and Deolalikar (1988), and Thomas and Strauss (1992), the static conditional demand function for child health and nutrition status is used as a specification guide to model the

empirical model parental demand for ore school child health and nutrition. The next task is thus to choose for a suitable indicator for the dependent variable-child health and nutritional status. The most widely used indicators of child health are height-for-age z-score (HAZ), weight for-height z-score (WHZ) and weight-for-age z-score (WAZ). The Young Lives dataset included weighing the sample children and measuring their height. Of all the three indicators, Stunting (HAZ) is identified as a long-run measure of health as it captures the entire stock of nutrition accumulated since birth (Waterlow, 1988). It reflects chronic under nutrition during the most critical periods of growth and development in early life.⁷Therefore, HAZ is used as dependent variable for the first objective of analyzing the child, household and community level factors attributing major changes in pre-school child health outcomes. Accordingly, the empirical model is defined as follows:

$$HAZ_{it}^1 = \beta_0 + \sum_{j=1}^P \beta_j^X X_{jit}^1 + \sum_{j=1}^Q \beta_j^Z Z_{ji}^1 + \epsilon_c^1 + \epsilon_{it}^1 \quad (1)$$

Where, HAZ_{it} , is the child's height-for-age z-score at time t , the subscripts i and t refer to the individual and time respectively. The Xs capture time-varying regressors and the Zs capture the inclusion of time-invariant regressors. The choice of the right-hand side variables will be guided by the conditional health demand function in Behrman and Deolalikar (1988), and Thomas and Strauss (1992). There are two sources of unobservables in this empirical specification, ϵ_{it} and ϵ_c where, ϵ_{it} is the time-varying disturbance term which is identically, independently and normally distributed. The term ϵ_c captures the time-invariant community specific unobservable that affects child health.

Panel data obtained only from the first two rounds of the survey are used in this section. In order to break the correlations between the observed right-side variables of the empirical model and the corresponding compound disturbance terms that include unobserved determinants in addition to stochastic terms, instrumental variables (IV) or two-stage least squares (2SLS) estimation

⁷HAZ is defined as the percentage of children aged 0 to 59 months whose height for age is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards.

strategy is used. The IV or 2SLS estimation procedure basically consists of making first-stage estimates in which endogenous right-side variables in the relation of interest are regressed on the instrument set and then making second-stage estimates of the relation of interest that uses the predicted values of the endogenous right-side variables instead of the actual values Wooldridge (2006).

Nevertheless, the robustness of the IV estimation procedure is conditional on the identification of good, valid and relevant instruments. Finding good instruments for all endogenous regressors in the models is often not easy, which is another estimation problem by itself. Instruments are expected to be good in the two senses, that is, the predicted values of the right-side endogenous variables well represent the variation in the right-side variable (the first characteristic of good instruments) but are not correlated with the disturbance term in the second stage (the second characteristics of good instruments). Good IV estimates, thus, can eliminate problems which arise due to omitted (unobserved) variables, endogeneity and random measurement error. Diagnostic tests for good instruments to identify the extent of bias due to “weak instruments” that do not satisfy the first condition for good instruments are conducted.

In the second life cycle stage, considering the timing and realization of some factors like previous period child nutritional status along with other level inputs, a dynamic empirical model for child schooling achievement is specified following the framework developed by Glewwe and Miguel (2007), using the simple two period knowledge production function. The evolution of child knowledge acquisition is expressed as household’s production process which is determined by current and past child, household, and community level factors. These factors coupled with child genetic and innate ability (including unobserved intelligence and learning motivation) influence children’s schooling achievement and thus their cognitive development.

$$S_{2i} = \alpha + \beta HAZ_{1i} + \delta X_{2i} + \gamma P_{2h} + \lambda Z_{2c} + \varepsilon_{2i} \quad (2)$$

Where S is child schooling achievement outcome measured by the above child cognitive test scores. These cognitive test scores depend on different factors. First of all, it depends on previous round child nutritional status, HAZ_{1t} which are represented by (stunting) Height-for-Age z-scores. Accordingly, Height-for-Age as observed in the previous wave of data collection is used to measure children nutritional history. In addition child cognitive development depends on; X_t is vector of household characteristics (including, among others, income, mother's education and father's education), P_t is a vector of prices, Z_t is a vector of community characteristics, which might have an effect on child school enrollment. ϵ_{2jt} is a Gaussian disturbance term which is assumed to be distributed independently identically. Numbers in subscript indicate period of realization for each variable. And, the subscripts i, h and c , each indicate individual, household or community level variables.

Unlike the first life cycle stage, the analysis in this part is cross sectional because of data limitations. This is mainly because data on cognitive test scores for the younger cohort child is first administered in the last round (Round 3). Child's learning productivity is partially determined by parental investments in early childhood education, health and nutrition. In addition to previous period child's health and nutritional status and current community level factors, parental inputs in the model can be broadly classified as inputs that are endogenous and reflect parental choices or preferences, and inputs that are exogenous and not subject to parental choice in the child cognitive development acquiring process according to Todd and Wolpin (2004). Moreover, nutrition and parent's inputs are functions of, among other things, child learning efficiency or 'endowment' which represents factors, such as ability and motivation, that are out of parents' control but are influenced by home environment as well as by genetics.

The presence of endogeneity of such regressors because of unobservable heterogeneity in the model implies violation of the basic assumptions of OLS estimates - which is source of the common estimation problem in the production function approach to studying child outcomes. Such violations can generally lead to omitted variable or simultaneity bias. Estimating the model using OLS, with the presence of endogenous regressors such as unobserved

time invariant child innate ability as well as parent preferences toward child academic achievement, is therefore likely to produce biased parameter estimates of these regressors.

As a result, a set of control variables are introduced to reduce the omitted variable bias and improve the robustness of the estimation results. Finding a valid, strong instrument to deal with endogeneity due to these violations is challenging. The strategy through which the above challenges are accounted for is the standard approach which has been to follow a two-prong strategy, whereby as many household as child controls, together with IV, is jointly implemented (Glewwe et.al. 2001; Alderman et.al. 2006).

4. Study Variables

Child well-being summarized by preschool health nutrition and later cognitive development is conventionally known to be determined by various factors at individual child, household and community level under different socio economic and environmental setup. Backed by indications from well-established empirical evidence and the empirical model specified earlier, this section presents description and justification of variables (both dependent and independent) used for the analysis in the paper.

Dependent variables

Height for Age Z – Score (HAZ)

According to the WHO, stunting (HAZ) is the percentage of children aged 0 to 59 months whose height for age is below minus two standard deviations (moderate and severe stunting) and minus three standard deviations (severe stunting) from the median of the WHO Child Growth Standards. HAZ is identified as a long-run measure of health as it captures the entire stock of nutrition accumulated since birth (Waterlow, 1988). It reflects chronic under nutrition during the most critical periods of growth and development in early life. Therefore, HAZ is used as dependent variable to achieve the first objective of analyzing the child, household and community level factors attributing major changes in pre-school child health outcomes.

The Young Lives dataset contains information on the weight and height of the sampled children. Child height was measured to the nearest 0.1 cm using height boards made for the purpose. These measures coupled with the age of the child, measured in days based on the birth and interview date is used to obtain HAZ. Table 4.1 below provides the anthropometric measures for the younger cohort children in 2002 and 2006.

Table 4.1: Description of anthropometric measures for the younger cohort children

Younger Cohort Children	2002	% age	2006	% age
Stunted	830	41.5	599	31.32
Severely Stunted	425	21.26	157	8.21
Thinness	305	15.25	163	8.5
Severely Thinness	127	6.35	42	2.19
Under Weight	634	31.71	455	23.79
Severely Underweight	284	14.2	77	4.02

Source: UK Data Archive, 2014

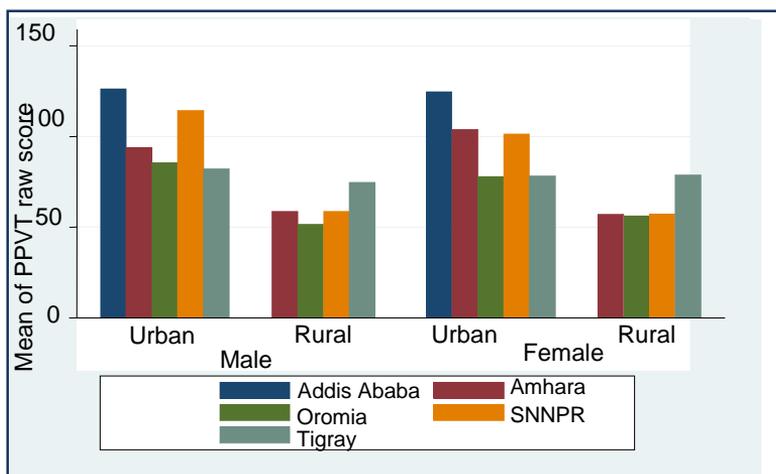
The Z score for height for age (HAZ) ranges from -8.24 to 8.7 with mean of -1.2. The regional mean value of HAZ ranges from -1.37 in SNNP to -0.77 in Addis Ababa, whereas it is -1.3, -1.21, and -1.17 for Amhara, Tigray, and Oromia regional states respectively. Moreover, the mean value of HAZ is -1.27 and -1.2 for male and female children of the younger cohort sample respectively. And finally, the mean value of HAZ is -0.96 for children who live in urban areas and -1.35 for those who live rural areas.

Generally, as shown in the table above, from the sample of 1999 children interviewed in the first round, 830 children i. e. 41.5% are stunted; 425 (21%) are severely stunted. Moreover, in round two, 599 children (31%) from 1912 children are found to be stunted and 8% i. e. 157 children are found to be severely stunted. Likewise, 15 % and 8% of children are found to be wasted in the first and second rounds respectively. In addition, in the first and second rounds only 6% and 2% of the sample children are found to be severely wasted. In addition, 32% and 14% of children in round one and 24% and 4% of children in round two among the younger cohort children are found to be underweight and severely underweight respectively.

Peabody Picture Vocabulary Test (PPVT)

The PPVT is a test of vocabulary recognition that has been widely used as a general measure of cognitive development (Cueto et.al 2009). Its main objective is to measure vocabulary acquisition in persons from 2.5 years old to adulthood. The test is individually administered, untimed, norm-referenced and orally delivered. PPVT raw score⁸ recorded in 2010 (round 3) of the Young lives data is used as dependent variable to analyze parent’s demand for child knowledge acquisition and thus their cognitive development. The raw scores of the PPVT ranged from 0-204 and the exam was administered in local languages in Ethiopia spoken by the child and by the field worker who administered the exam. It consists of 17 sets of 12 words each. Children start the test at a particular set depending on their age. They then move up or down depending on their responses.

Figure 1: Summary for variable: PPVT raw score by of region, sex and sentinel sites



Source: UK Data Archive, 2014

For the younger cohort sample, the mean value of PPVT raw Score is distributed evenly among male and female children for the whole sample. Similarly, the mean value is also relatively the same for children living in rural areas in all regions of the country except Addis Ababa. On the other hand, mean PPVT value is higher in urban areas than in rural areas.

⁸ The PPVT offers raw scores as well as standard scores. Raw scores are calculated by subtracting the total number of errors from the ceiling item.

Regionally, children from Addis Ababa have higher mean value of PPVT followed by SNNPR.

Moreover, from the data the mean PPVT value is 125.4 for Addis Ababa; 77.3 for SNNPR; 77.43 for Tigray; and 68 and 62 for Amhara and Oromia regional states, respectively. For the total sample the mean PPVT value is 79.15.

Explanatory Variables

A set of individual child, household and community level variables administered for the younger cohort children in the Young Lives dataset are used as regressors for the empirical analysis in this paper. At the household level variables amplifying information on parental demographics and background, household composition, household education, livelihoods and socioeconomic status are used as regressors in the econometric analysis. At individual child level, child activities including their time spending, their background and demographic characteristics and endowments are used for analysis. Moreover, we have used community level infrastructure variables that characterize the environment where the child lives such as availability of water and sanitation facility, availability of immunization and electricity and school characteristics.

Well established empirical literature supports that household characteristics have a significant role to play in determining child wellbeing. In connection with this, paternal involvement has been associated with children having greater self-esteem, higher education achievement and more secure gender identification in developed countries. Moreover, the effect of parental (and in particular maternal) education on children health and education outcomes has been researched extensively and less is known about the influence that sibling's education can have on a child's educational outcomes. In addition to this, the effect of parental (and in particular maternal) education on children education outcomes has been researched extensively. Less is known about the influence sibling's education can have on a child's educational outcomes.

Furthermore, asset base is critical to enhance opportunities and reduce the vulnerability of poor peoples' livelihoods. Besides, the household was a

source of social capital for the children when they were younger, but may become less important as the children grow older and establish networks independent of the household. It is important to find out about the household's influence on the child through the direct affects of intra-household dynamics as well as the indirect effects of the social capital of the household on the children.

Components of wealth index as the main instrument used in Young Lives to measure the socioeconomic status of the household is used in the analysis. Wealth index (wi) is composed of three sub-indexes, i.e, household quality index (hq), access to service index (sv), and ownership of consumer durables or simply consumer durables index (cd). These indexes were estimated consistently across the three rounds, and only those variables consistent across the three rounds are considered. Wealth index is thus defined as a simple average of these three sub-indexes as follows;

$$W_{it} = \frac{[hq_{it} + sv_{it} + cd_{it}]}{3}$$

Household quality index is a simple average of dummy variables constructed for crowding (scaled sleeping rooms per person), main material of walls, main material of roof, and main material of floor. Similarly, access to service index is computed as a simple average of dummies for accesses to electricity, safe drinking water, sanitation and fuel for cooking. Moreover, the index for ownership of consumer durables is constructed as a simple average of a set of dummies for a list of consumer durables that take the value 1 if the household owns at least one for each commodity. The list of these consumer durables is country specific in the Young Lives dataset. For Ethiopia, the list is a basket of ten commodities - radio, television, bicycle, motorbike, automobile, landline phone, mobile phone, table and chair, sofa, and bedstead.

Conventionally acknowledged empirical literature also supports that child and community level characteristics have a significant role to play in determining child wellbeing. Poverty affects the roles and responsibilities assumed by children and the ways in which they use their time. While the information about school and work is collected over the previous 12 months, the previous

day's activities are used to give an idea of the balance of time spent on different activities by the child. Further, domestic work and chores often have significant impacts on the lives and well-being of children, in particular, on their school attendance, and on the time they are able to spend studying. Finally, community level infrastructure variables that characterize the environment where the child lives such as availability of water and sanitation facility, availability of immunization and electricity, school characteristics are used as regressors in the empirical analysis in this paper.

Table 4.2: Descriptive statistics of some explanatory variables

Variable	Mean	Std. Dev.
Household Size	5.98	2.08
Household Quality Index	0.28	0.20
Consumer Durables Index	0.19	0.19
Service Quality Index	0.35	0.26
Wealth Index	0.27	0.18
Number of Milk Animals	1.33	1.84
Number of Males Aged 0-5 Years	0.38	0.57
Number of Females Aged 0-5 Years	0.37	0.57
Hours Per Day Spent Caring HH Members	0.69	1.25
Hours Per Day Spent on Household Chores	1.23	1.39
Hours Per Day Spent on Family Activities	1.11	2.01
Hours Per Day Spent for Working	0.01	0.25
Hours Per Day Spent for School	3.68	3.18
Hours Per Day Spent for Studying	0.69	0.85
Hours Per Day Spent for Playing	6.31	3.66

Source: UK Data Archive, 2014

Table 4.2 shows descriptive statistics of some explanatory variables used in the paper. Generally, household level variables used in the paper include; household size, care giver's education, age of the household head, sex of the household head, education of household head, household quality index, service quality index, consumer durables index, number of milk animals number of males aged 0-5 years number of females aged 0-5yrs. Moreover, at individual child level we have used variables such as child sex, father's age,

father's education, mother's age, mother's education, hours per day spent on household chores, hours per day spent on family activities, hours per day spent for working, hours per day spent for studying, hours per day spent for playing, previous period height for age z score. And, at community level we have used access to electricity, access to toilet, access to drinking water, price of cooking oil, school type, and distance from the school.

5. Main Findings

Determinants of Pre-School Child Health and Nutrition

Panel data obtained only from the first two rounds of the Young Lives survey are used to analyze the factors that determine children's preschool health and nutrition status. With the aim of breaking the correlations between the observed right-side variables of the empirical models and the corresponding compound disturbance terms that include unobserved determinants in addition to stochastic terms, we have used instrumental variables (IV) or two stage least squares 2SLS estimation strategy.

The 2SLS regression result presented in Table 5.1 shows that the summary outcome variable for preschool child health and nutritional status – HAZ score - is found to be significantly influenced by child, household and community level factors. Sex of the index child (male dummy), mother's education and father's education are individual child level factors that are found to have significant effect on children's preschool health and nutrition. At the household level children's preschool health and nutritional status is found to be significantly determined by educational level of the household head, household quality index, consumer durables index and the number of male and female children aged 1 -5 years other than the index child living in the household. Moreover, access to public toilet and electricity in the surrounding community are the community level factors which are found to have detrimental effect on children's preschool height for age z-score.

The regression result in Table 5.1 also shows that boys are more likely to be stunted than girls. This is consistent with results from earlier studies in Ethiopia and in other African countries, and is largely attributable to possible genetic differences between male and female children. Moreover, this

differential is perhaps attributed to the fact that girls are genetically more robust than boys in nutrition absorption and that the energy requirement is higher for boys than girls.

The 2SLS regression result also reveals that preschool child health and nutrition in the first life cycle stage is found to have a strong positive relationship with parental and head education level. As it is true for many research findings our paper also come up with the fact that parent's as well as head's education level has a significant role to play in determining children's preschool child health and nutritional status.

Table 5.1: 2SLS Estimation Results for Height for Age Z Score

Explanatory Variables	Dependent Variable: Height for Age Z Score	
	Coefficient	Std. Err
Care Giver's Education	-0.12	0.08
Age of the Household Head	-0.01	0.01
Sex of the Household Head	-0.18	0.16
Education of HH Head	0.03*	0.01
Household Quality Index	0.84*	0.17
Consumer Durables Index	0.81*	0.28
Access to Electricity	0.23*	0.08
Access to Toilet	0.11	0.05
Access to Drinking Water	-0.05	0.05
Price of Cooking Oil	0.07	0.12
No. of Milk Animals	0.02	0.01
No. of Males Aged 0-5 years	-0.10*	0.05
No. of Females Aged 0-5years	-0.07*	0.04
Household Size	-0.00	0.02
Child Sex	0.28*	0.06
Father's Age	0.00	0.01
Father's Education	0.03*	0.01
Mother's Age	0.01	0.01
Mother's Education	0.06*	0.03
Constant	-1.79	0.33

Variables with association significant at 0.05

This is not surprising as parental education (especially maternal education) is known to play a significant role in preschool child health and nutritional achievement in developing countries. This may be because of the fact that parents specially heads have a dominant role in intra household bargaining in addition to the derived role that parental health and nutrition knowledge would play in determining children's preschool health and nutrition performance. Well educated parents combine both indigenous health and nutritional knowledge and practices with modern scientific health-seeking behavior for the betterment of their children's health and their nutritional intake. In addition to this, well-educated household heads and parents tend to give quality care and nurture for their children by choosing for better health and nutritional inputs.

Two components of household wealth index i.e, consumer durables index and household quality index are found to be positively related with height for age Z score of children below 5 years of age. This is mainly attributed to the fact that children growing up in well-built and well-furnished houses are nurtured well and have better health and nutritional status. Households which possess TV and Radio, for instance, have updated information about nutritional knowledge and household which have refrigerator can provide well preserved and healthy food for their children which are manifestations of quality health care and nurture. Households with higher consumer durables index and higher household quality index, therefore, possess quality houses and child friendly home which reduce children's malnourishment.

In addition, the empirical result indicates that a significant portion of the variations in raising healthy and well-nourished child is determined by household composition and birth order. The regression result shows that the higher the number of children aged between 0-5 years and living in the household other than the index child the higher the child will be malnourished. This can be conceivably explained by lower resource share to the index child in the distribution of allocation of household's resources allotted for its preschool health and nutrition. Though allocation may not be fair and equitable among family members - especially in developing countries like Ethiopia, parents are expected to allocate resources among all members of the household. Accordingly, as the number of children living in the household

aged between years 0-5 increase (such as giving birth to a new child), parents are expected to re direct and redistribute resources for all members of the household including the index child. This resource re distribution will decrease the resource share of the index child which is allotted for its health and nutritional demand. Reductions in such resources will subsequently compromise children's early health and nutritional attainment captured by their height for age z scores.

This result can also be explicated in terms of birth order, i.e. birth order is significantly associated with height for age Z score of the sample children. More specifically, higher birth order is associated with stunting for children because young children born in close succession have to share scarce resources and are thus more likely to suffer from malnutrition than children in smaller families.

Moreover, community level infrastructure variables that characterize the environment where the child lives such as the availability of water and sanitation facility, immunization services and electricity influence children's health in the first five years of their childhood. At the community level, we find that provision of electricity and availability of public toilet are positively associated with improvements in children's health and nutritional status. Children residing in communities with electricity have 0.22 standard deviation higher z-scores compared to their counterparts residing communities without electricity moreover children residing in communities with public toilet have 0.11 standard deviation higher z-scores compared to their counterparts residing communities without a public toilet.

Determinants of Child Cognitive Development

Table 5.2 provides estimation results for the determinants of child cognitive development captured by PPVT raw score. Unlike the first life cycle stage, the analysis in this part is cross sectional because of data limitations. This is mainly because data on cognitive test scores for the younger cohort child is first administered in the third round (2010). The empirical result obtained from this cross-sectional data shows that children's educational achievement and thus their cognitive development is found to be significantly influenced by individual child and household level factors as shown in Table 5.2.

Table 5.2: Estimation Results for PPVT RAW Score

Explanatory Variables	Dependent Variable: PPVT RAW Score	
	Coefficient	Std. Err
School Type	0.64	0.03
Hours/Day Spent on HH Chores	-1.26	0.81
Hours / Day Spent on Family Activities	-2.40*	0.61
Hours per Day Spent for Working	-5.72	4.28
Hours / Day Spent for Studying	7.50*	1.36
Hours per Day Spent for Playing	-2.55*	0.53
Distance from the School	0.04	0.04
Mother's Education	-0.08	0.19
Mother's Age	0.50	1.10
Father's Education	0.16	0.60
Previous Period HAZ	1.11	0.77
Sex of the Index Child	-1.52	1.98
Caregiver's Education	0.75*	0.27
Caregivers Age	-0.34	1.08
No. of Males Aged 0-5 years	-4.35*	1.58
No. of Females Aged 0-5years	-2.87*	1.57
Service Quality Index	1.59	4.93
Consumer Durables Index	43.08*	6.75
Household Quality Index	17.18*	5.47
Education of the HH Head	-0.06	0.60
Sex of the HH Head	0.98	8.38
Age of the HH Head	-0.37	0.47
Constant	-5.86	11.72

Variables with association significant at 0.05

Accordingly the variations in the children's cognitive ability in the beginning of the second life cycle stage is attributed to hours per day spent in caring for household members, hours per day spent in household chores, hours per day spent in domestic tasks –like farming and family business, hours per day spent studying outside school, hours per day spent in leisure activities, caregivers education, father's literacy level, number of male and female children aged

between 0-5 years living in the household, consumer durables index, and household quality index.

Children's time allocation is found to be significantly associated with their educational achievement and thus their cognitive skills. As it is conventionally known child students time spent on non-educational activities will reduce their performance towards a better educational attainment. On the contrary, children's time spent on their education and a related activity is found to have a strong positive association with their educational achievement. More specifically, there exists a tradeoff between children's educational achievement and their time spent in non-educational activities. As mentioned above these activities include time spent caring for household members, for household chores, participating in domestic tasks like farming and working on family business and in playing and leisure activities. On the other hand, the number of hours spent by children for studying outside school is directly related with their PPVT RAW score. It is straight forward that children's time spent studying outside school is expected have a positive relationship with their educational achievement. This is perhaps because of the fact that children who spent more time in their education will be effective towards its betterment.

Moreover, as children spent much of their time in domestic household activities like caring for family members or participating in household farm activities or any other family business they will end up with lower quality time left for their education. And the same holds true for leisure as well, i.e, as a child student spend much of his time playing instead of studying, his per her PPVT RAW score will be lower because of the same reason mentioned above.

All in all, children's time as a major resource and its allotment is found to have a strong determining relationship with children educational achievement and thus their cognitive development. And, the sign of the relationship between the number of hours a child spend on a given activity and its PPVT RAW score depends how much the activity is related with the child's education.

The regression result also divulges that children's cognitive development in the second life cycle stage is dependent up on paternal literacy level and caregiver's education. As it is true for many research findings our paper also come up with the fact that parent's as well as caregiver's education level has a significant role to play in determining children's educational attainment. This is perhaps because well-educated care givers and literate parents (especially fathers) would tend to choose for better educational inputs for their children. Here we find that paternal literacy has a significant contribution towards a better cognitive development for children. This is surprising especially in conditions where maternal education is known to play a significant role in child educational attainment. This may be because of the fact that fathers have a dominant role in intra household bargaining in addition to the resultant role that parental education would play in determining children's educational attainment and thus their cognitive development.

Regression result in Table 5.2 also reveals that household wealth components – consumer durables index and household quality index - are found to be positively related with children's PPVT RAW score. Roughly speaking children of households with higher consumer durables index and higher household quality index have higher PPVT RAW score and thus higher educational achievement and cognitive development. This is mainly accredited to the fact that children growing up in quality houses and thus are nurtured well have better educational attainment explained by higher PPVT RAW score.

Our empirical result also tells that household composition and birth order have a significant contribution towards raising children with a better cognitive development and educational achievement. In connection with this, the regression result shows that the higher the number of children aged between 0-5 years and living in the household other than the index child the lower children's educational attainment and thus their cognitive development. This can be perhaps explained by the distribution of allocation of household's resources for children's preschool health, nutritional demand and their later educational inputs. Parents are expected to allocate resources among their children for their education and health. Accordingly, as the number of children aged between years 0-5 increase, parents are expected to re distribute

resources from other members of the household including from children in school. The resource allocated for children in school will decrease which will in turn decrease the educational input that the parents (the household offer) which will again reduce children's educational attainment and cognitive development explained by lower PPVT RAW scores.

Finally, though it's not the case in most of the research findings so far, our finding shows that preschool (one period lag) child health and nutritional status measured in terms of Height for Age Z score is found to be insignificant to have a strong influence on PPVT raw score at 5% significance level. However, at 10% significance level, HAZ is significant to have a considerable influence on children's educational attainment and cognitive development after one period. This is perhaps because of the fact that PPVT RAW score used in the analysis is administered in early grades of primary school which may not be suitable to capture the lagged effect of HAZ on child cognitive development.

6. Conclusion and Policy Implications

Childhood poverty (well-being) as part of the overall intergenerational wellbeing in Ethiopia is assessed using the first two life cycle stages in the light of the conventional three period life cycle frame work. These periods are the preschool period which covers children's age from their conception to their fifth birthday and schooling which covers children's years of primary school. In the first period children's health and nutritional status as measured by their height for age z score is considered as a summary outcome variable to capture their wellbeing.

In order to identify the major factors which affect preschool child health and nutritional status we have employed 2SLS Instrumental Variable random effects regression. Accordingly, children's height for age Z score is found to be significantly influenced by child, household and community level factors. Sex of the index child (male dummy), mother's education and father's education are individual child level factors that are found to have significant effect on children's preschool health and nutrition.

At the household level children's preschool health and nutritional status is found to be significantly determined by educational level of the household head, household quality index, consumer durables index and the number of male and female children aged 1 -5 years other than the index child living in the household. Moreover, access to public toilet and electricity are the community level factors which are found to have a detrimental effect on children's preschool height for age z-score. Among these factors only the numbers of male and female children aged 1 -5 years of age other than the index child living in the household have negative relationship with HAZ for the index child.

In the second period i.e. life cycle stage two, children's wellbeing is captured by their cognitive development which is measured using PPVT RAW score. In order to obtain the major factors associated with children's educational attainment and thus their cognitive development we have employed IV estimation strategy. From the regression result, we have obtained that children's time allocation, paternal and care giver's educational status, household wealth, household composition and birth order are the major factors that our IV regression result shows a significant relationship with children's educational achievement and cognitive development measured in the form of PPVT Raw score. Moreover, the link variable between the two life cycle stages (one period lagged value of HAZ) is found to be weakly significant to determine subsequent educational attainment and thus children's cognitive development.

Collectively speaking, household level factors take lion's share in determining children's health and nutritional status during their preschool years. During their years of primary school, on the other hand, children's cognitive ability is dominantly determined by both child and household level factors. However, the result shows that community level factors explain only small share of the variations in child wellbeing outcome variables in both periods. By and large, from the regression result we can observe that household level factors have a dominant role in determining child wellbeing.

Based on the results obtained in this study, we have forwarded the following policy implications for interventions towards the betterment of children and their wellbeing as children and future adults in the country.

Ample policy prescriptions aiming at reducing childhood poverty should target their interventions mainly at household level since they have a principal role in determining child wellbeing.

Adult education schemes for parents at national level can provide them with basic as well as updated knowledge about raising healthy, well nurtured and well-educated children.

Nutritious food supply programs implemented at the lower level health posts in the country, especially for infants, and school feeding programs at primary schools can also improve child wellbeing.

Besides awareness creation should be done among parents to raise their understanding towards the intergenerational paybacks of raising healthy and developed children to one self and to the country in general.

In addition to this, parents must also be well communicated about family planning using different media to have wider birth orders in order to produce quality children.

Moreover, child labor law enforcements in the country must also be strengthened especially for school aged children.

In addition to child labor law enforcements, enacting a more favorable and modest labor law on child rights which considers the nature and type of work that they are participating during their childhood could add to children's wellbeing.

Finally, infrastructural development especially power supply and sanitation facilities must be spread throughout the country.

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Determinants of Food Insecurity among Rural Households in East Wollega Zone: The Case of Diga Woreda

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Abstract

This study examines the determinants of food insecurity among rural households in western Ethiopia. The struggle to achieve food security at the household level in the rural area of Ethiopia dated back a long period. In light of this, the study aims to identify the determinants of household food insecurity and estimate the extent and intensity of food insecurity. For this purpose, data was collected from 338 randomly selected rural households (131 food insecure and 207 food secure) from five Kebeles of the randomly selected Peasant Associations using two-stage proportionate stratified random sampling technique. The study used descriptive statistics like mean, standard deviation, percentage, and frequency distribution on socio economic characteristics of the sampled households. In addition, t and chi-square tests were used to compare food secure and insecure sample groups with respect to the explanatory variables. Binary logistic regression was fitted to analyze the determinants of food insecurity. Besides the FGT poverty analysis was used to analyze the incidence and extent of food insecurity. The result indicated that family size, sex of the household head, age square of household head, status of education of household head, cultivated land size, livestock ownership and proportion of food expenditure pattern were found to be significantly influence food insecurity. The incidence, gap and severity were 38.76%, 8.4% and 2.64% respectively. The amount of resource required to bring all households to the minimum recommended daily requirements (2100kcal) is estimated to be 10203.63 quintals of cereals per year. The findings suggest limiting population size and giving priority to gender main streaming, capacity building for old household heads and subsidizing them, increasing rural household heads' enrolment ratio in adult education, enhancing appropriate land use, using of improved technologies and proper extension services to raise

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land productivity, improving the provision of adequate veterinary services, improved water supply points, introduction of timely and effective artificial insemination services to up-grade the already existing breeds, and enhancing the diversified income of the poor rural household were suggested.

Key words: Food insecurity, Intensity of food insecurity

1. Introduction

1.1 Background of the Study

Globally, more than one billion people are poor, 800 million are food insecure and where about 170 million children are malnourished (FAO, 2002). While food insecurity occurs in most countries to varying degrees, 75 percent of the food insecure lives in rural areas of developing countries (FAO, 2000); (IFPRI, 2002). Food is essential in human being's life. Lack of food in long terms will lead to hunger and starvation that can cause death. In view of the importance of food in human life, food is rate as the most basic of all human needs.

Food is both a need and human right. But food insecurity is prevalent in today's world in general, and in Sub-Saharan Africa in particular. Since early 2007, food-related riots have occurred in 15 countries, including seven in Sub-Saharan Africa (GAO, 2008).

Ethiopia faces daunting poverty and food insecurity challenges that are worsening over time. In the 1990s, an estimated 30 million Ethiopian were food insecure, and food crises were persistent. Among this food insecure people, the majority reside in the rural areas of the country. About 52 percent of the rural population and 36 percent of the urban population consume under the minimum recommended daily intake of 2100 calorie per person per day (FAO, 2002),(MEDAC, 1999).

Ethiopia is among the poorest and most food insecure countries of the world where 44 percent of its population live below the national poverty line and 46 percent of its population get below the minimum levels of dietary energy consumption compared with other Sub-Saharan and developing countries

(World bank, 2005). In terms of food security, Ethiopia is one of the seven African countries that constitute half of the food insecure population in Sub-Saharan Africa (SisayA., 1995).

Ethiopia has reasonably good resource potential for development of agriculture, biodiversity, water resource, and minerals. Yet, it is faced with complex poverty, which is broad, deep and structural. The proportion of the population below the poverty line is 44 percent in 1999/2000 (MoFED, 2002) and which was about food poverty of 33.6 percent, with overall poverty of 29.6 percent in the country (MoFED, 2012).

The presence of hunger in Ethiopian households due to insufficient resources to obtain food has been a long-standing challenge to Ethiopian government, donors, and other local and international organizations. In general, the Ethiopian government implements poverty reduction strategy (PRS) hence, examination of food insecurity at regional, zonal or household levels to identify the specific characteristic of the problem is crucial. Having this background, this study tries to investigate the level of food insecurity and its determinants in rural households of Diga woreda of East Wollega Zone.

1.2 Statement of the Problem.

Ethiopia faces both severe transitory and chronic food insecurity. Numerous studies have confirmed that there is a problem of food insecurity in Ethiopia. Empirical evidence of food security in Ethiopia indicates the prevalence of a high level of food insecurity, with significant idiosyncratic and spatial characteristics. The specific food security studies by Berhanu, A. (2004), Frehiwot F., (2007), Abebaw S. and Ayalnew B., (2007), and Hailu M., (2012) generally suggest that the depth and intensity of food insecurity are high, influenced by poor functioning of marketing systems and other household and socioeconomic factors.

Rural households are vulnerable to food insecurity not simply because they do not produce enough, but either they hold little in reserve or they usually have scant saving and few other possible sources of income to obtain adequate food to meet their daily subsistence food energy requirements (Ayalneh B., 2002).

Despite the general improvements in living conditions for Ethiopians around 25 million people in the country (29 percent of the population) live below the nationally defined poverty line (MoFED, 2013a), and (MoFED, 2012), and Chronic malnutrition is very high at 40 percent (CSA, 2014).

Diga woreda is one of the districts of East Wollega Zone which is endowed with potential natural resources that can be tapped for the well-being of the people (DBOA, 2014). The district is blessed with various potentials and opportunities mentioned above, but some of the population are in need of food aid. According to the annual report of Disaster Prevention and Preparedness Agency Bureau of East Wollega zone about 738 households (a population of 3375 people) of Diga woreda were supported by food aid in the year of 2013/2014 (EDPPA, 2014). The same source also identified that about 645 children and 601 females need immediate food aid support in this woreda.

Food insecure and food secure farm households reside as neighbors and could share common climate and weather situation and mainly similar socio-economic, cultural and land topography. Yet, one faces seasonal food crisis and become dependent on food aid, while the other remains food secure, requiring no food aid. Recent literature discovered that even in years of adequate rainfall and good harvest, the households in the study area remain in need of food assistance. This clearly reflects the deeply entrenched poverty and transitory situation of the area irrespective of conducive environmental conditions. This implies the existence of structural, socio-economic, cultural, demographic and other factors underlying the poverty and seasonal food insecurity problem in the study area.

Thus this study aims to analyze the level and determinants of food insecurity among rural households of Diga woreda of East Wollega Zone with specific objective to:

- Identify the determinants of food insecurity among the rural households of Diga woreda of East Wollega Zone.
- Estimate the food insecurity gap and its severity among rural households in Diga woreda

2. Research Methodology

2.1 The Study Site

Diga woreda, is one of the 262 districts in the Oromia regional state, located in the south-west of the Abbay basin and at 09 01' 29.2" N; 036 27' 28" E. It is approximately 343 kms west of Addis Ababa and about 12 kms from Nekemte town. The altitude in the area varies from 1200 to 2342m.a.s.l. and an annual rainfall that exceeds 2,000mm. The woreda comprises both lowland (60 percent) and mid land (40 percent) in an agro ecologies (DBOA, 2014). A survey of the land in Diga shows that 27,817ha (68.2 percent) is arable land, 4999 ha (12.2percent) is grazing land, 6894 ha (16.9 percent) is forestland and the rest 1078 ha (2.6 percent) is used for roads, housing, and others (DBOA, 2011).

Based on the 2007 national housing and population census reported a total population for the woreda is 106,664 (62513 were women and 44,351 were men) and 26559 of its population were urban dwellers.

This is to mean that about 80105 population of whom 39249 are male and40856 women were rural dwellers that can be grouped into a household of 11425 (that is about seven (7) persons per household) (CSA, 2007).

2.2 Data Sources and Sampling Technique

For the purpose of this study Diga woreda was selected purposively among the woredas of East Wollega zone due to the relative problem of food secure and the presence of high population of re-settlers in the woreda. Both primarily and secondary type of data were used. The primary data sources were the sampled household heads and the secondary data sources were government regional offices, like food security and disaster prevention and preparedness bureau reports, libraries, internet sources, agricultural offices and CSA reports. In order to obtain the primary data, the study used a multi-stage stratified random sampling technique. In the first stage, the PAs were stratified into mid and low altitude and then after five PAs (three low and two mid) from 21 PAs were selected randomly and finally 338 household heads were selected using systematic random sampling methods from five PAs (Jirata, Damaksa,

Arjokotebula, and MadaJalala) using probability proportional to size of the stratum.

The study used Kothari, C. R., (2004) to decide the sample size as:

$$n = \frac{z^2 \cdot p \cdot q \cdot N}{e^2 (N - 1) + z^2 \cdot p \cdot q} = 338 \text{ households}$$

Where:

n = sample size

N = Number of household in the study woredas

e = is the desired level of precision (5%=0.05)

z = is the Z-score value at 95 percent of level of confidence interval (z=1.96)

2.3 Methods of Data Collection

The study used structured questionnaire to collect primary data for the purpose of the study. Detail information on household demographic characteristics, household assets, land characteristics and management, institutional factors, food security status and vulnerability data were collected by interviewing sample household heads. Five enumerators who completed diploma and speak the local language of the study area were recruited and one-day training were given on the contents of questionnaire, method of data collection and the way to approach the respondents.

2.4 Method of Data Analysis

The study employed both descriptive and econometric method of data analysis. The descriptive method was employed to explain the situation of demographic and socioeconomic variables. The specific methods of data analysis involved were tabulation, frequency, percentages, and computation of descriptive statistics such as mean, and standard deviation and the econometric method was employed to analyze the determinants of food insecurity.

To test the intensity (level) of food insecurity of the study area FGT was employed (Ayalneh B., 2002.). And the FGT model could be expressed as follows:

$$P(\alpha) = \frac{1}{n} \sum_{i=1}^q \left[\frac{m - y_i}{m} \right]^\alpha$$

Where:

FGT= Footer Greer and Thorbeck

P= number of food insecure households

n= is the number of sample households;

y_i= is the measure of per adult equivalent food calorie intake of the ith household;

m= represents the cut off between food security and insecurity (in terms of caloric requirements);

α= is the weight attached to the severity of food insecurity.

In equation, m-y_i = 0 if y_i > m.

2.4.1 Specification of Econometric Model

To examine the association between food insecurity (dependent variable) and the relative importance of independent variables the study employed the logit model. The dependent variable in this case, food insecurity was binary variable which took a value one if a household would be food insecure, and zero otherwise the cumulative logistic probability model could be econometrically specified as:

$$P_i = F(Z_i) = F\left(\alpha + \sum_{i=1}^m \beta_i x_i\right) = \left[\frac{1}{1 + e^{-\left(\alpha + \sum_{i=1}^m \beta_i x_i\right)}} \right] \quad (1)$$

Where:

P_i is the probability that an individual being food insecure given x_i

X_i represents the ith explanatory variable and β_i are regression parameter to be estimated,

e is the base natural logarithm.

F is standard normal CDF. For ease of interpretation of the coefficients a logistic model could be written in terms of the odd and log of odd.

According to Hosmer, D. W, and Lemeshew, S., (1989) a logistic model could be written in terms of the odds and log of odds. The odds ratio was the ratio the probability that an individual or household would be food insecure (p_i) to the probability of household would be food secure (1-p_i).

$$(1 - p_i) = 1 / (1 + e^{z_i}) \quad (2)$$

$$p_i / (1 - p_i) = (1 + e^{z_i}) / (1 + e^{-z_i}) = e^{z_i} \quad (3)$$

$$p_i / (1 - p_i) = (1 + e^{z_i}) / (1 + e^{-z_i}) = e^{(\alpha + \sum_{i=1}^m \beta_i x_i)} \quad (4)$$

Or taking the natural logarithm of equation

$$Z_i = \ln \left[\frac{p_i}{1-p_i} \right] = \ln = e[\alpha + \sum_{i=1}^m \beta_i x_i] = \alpha + \beta_1 x_1 + \beta_2 x_2 \dots + \beta_m x_m \quad (5)$$

If the disturbance term (u_i) is taken to account, the logit model becomes

$$Z_i = \alpha + \sum_{i=1}^m \beta_i x_i + u_i \quad (6)$$

Where $x_1, x_2, x_3, \dots, x_m$ explanatory variable

u_i is the error term

e = represents the base of natural logarithms (2.7181)

α = intercept

$\beta_1, \beta_2, \dots, \beta_m$ slope of coefficient of explanatory variable in the model

Z_i = a linear function of m explanatory variable (x_i)

X_i = represents the i^{th} farmer explanatory variable $i=1, 2, 3 \dots m$.

The parameters of the model, α and β could be estimated using the maximum likelihood method.

2.5 Hypothesis

Based on review of literatures, past research findings, experts and authors knowledge of the food insecurity situation of the study area, the following variables were identified as the potential determinants of household's food insecurity.

Table 2.1: Definition of variables and the hypothesis

Variable code	Variable Type	Definition of variables	Hypothesis
FASZ	Continuous	Family size in number	+
AGE	Continuous	Age square of the household head in years	-
DPR	Continuous	Dependency ratio in number	+
EDUC	Continuous	Education level of household head	-
CLSZ	Continuous	Cultivated land size in hectare	-
AMDT	Continuous	Amount of Credit received per AE in birr	-
TOTANINC	Continuous	Total annual income per AE in birr	-
TLU	Continuous	Total livestock unit owned in TLU	-
TOFFI	Continuous	Total off farm income per AE in birr	-
NUOXEN	Continuous	Number of oxen owned in number	-
FODEXPT	Continuous	Proportion of food expenditure pattern per AE in birr	-
IRGN	Dummy	Use of Irrigation (1 for users and 0 otherwise)	-
FAID	Dummy	Food Aid Received(1 for access to aid and 0 otherwise)	-
HHLDS	Dummy	Household Head Sex(1 for male and 0 for female headed)	+ if female and – if male

3. Result and Discussion

3.1 Food Insecurity Status of the Households

The food security status of the household was best measured by direct survey of income, expenditure and consumption and comparing it with the minimum subsistence requirement was used to identify the two groups. For this study the daily calorie consumption per AE per day was used to identify food secure and food insecure households. The households' food security status was measured by direct survey of consumption. The data on available food for consumption from own production or purchased or from stock for the seven days' back was collected and converted to Kilocalorie and then divided for AE's of the households (Sisay, B., 2012).

After that this energy level was compared with the minimum subsistence energy requirement per AE per day, 2100 kcal. Following this procedure 131 that means 38.76% of the sample households were unable to meet their minimum energy requirements and 207 which means 61.24% sample households were found to meet their minimum energy requirements. The mean differences among the two groups on hypothesized variables were computed and found that food insecure and food secure household groups revealed significant mean differences with respect to some socio-economic variables like family size, total off-farm income/AE, total annual income/AE, food expenditure pattern/AE, age square of household head, dependency ratio, cultivated land size in hectare, number of oxen owned, total livestock owned, education level of the household head, and amount of credit received/AE were found significant at less than 1 percent probability level (Table 3.1).

On top of that out of 3 hypothesized categorical variables, sex of the household head, use of irrigation and access to food aid received, were analyzed and found that the two sample groups were differentiated in mean with respect to use of irrigation, and sex of household head at 5% and 1% probability level respectively (Table 3.2).

Table 3.1: Summary Statistics of continuous variables included in the model

Variable	Food Insecure=131		Food Secure=207		t-Value
	Mean	SD	Mean	SD	
FASZ	7.80	1.78	5.24	1.45	14.58***
AGE	45.42	11.27	38.20	10.30	5.95***
DPR	1.98	0.94	0.98	0.54	12.42***
EDUC	3.05	3.22	5.49	3.41	-6.35***
CLSZ	2.03	1.04	2.79	1.25	-5.86***
TOTANINC	2362.21	1374.73	5410.85	2504.10	-14.42***
AMDT	205.79	320.76	391.20	628.51	-3.57***
TLU	6.50	3.11	12.04	4.82	-12.82***
TOFFI	68.66	203.84	213.20	559.32	-3.38***
NUOXEN	1.41	0.94	3.11	1.43	-12.82***
FODEXPT	2402.85	1163.47	5487.96	2312.82	-16.22***

***, **, * , Significant at 1%, 5% and 10% probability level respectively

Source: Survey Result

Table 3.2: Summary statics of dummy variables

Variable	Score	Food insecure (N=131)		Food Secure (N=207)		X ²
		Number	Percent	Number	Percent	
HHLDS	Male	101	77.10	189	91.3	13.28***
	Female	30	22.9	18	8.7	
IRGN	Irrigation users	34	25.95	76	36.71	4.23**
	Non irrigation users	97	74.05	131	63.29	
FAID	Receive food aid	26	19.85	53	25.60	1.48
	Not received food aid	105	80.15	154	74.40	

***, **, Significant at 1% and 5% probability level respectively

Source: Survey Result

To test the extent and severity of food insecurity the FGT indices was used. It was specified as:

$$P(\alpha) = \frac{1}{n} \sum_{i=1}^q \left[\frac{m - y_i}{m} \right]^\alpha$$

Where:

P= number of food insecure households

n= is the number of sample households;

y_i= is the measure of per adult equivalent food calorie intake of the ith household;

m =represents the cutoff between food security and insecurity (expressed here in terms of caloric requirements);

α= is the weight attached to the severity of food insecurity.

In equation, m-y_i = 0 if y_i > m.

The three FGT indices employed were head count index, food insecurity gap and severity of food insecurity. The study result revealed that the head count ratio or incidence of food insecurity are 0.387 which indicates that about 38.7% percent of the sampled households cannot meet the daily recommended calorie intake of the household i.e. consuming below 2100 kcal/AE/day set by the Ethiopian health and nutrition institution and the household's food insecurity gap of the sampled household was calculated and found to be about 0.084. This is to mean that if the government or other non-government planned to mobilize and distribute resources that can meet the 8.4 percent of the caloric requirement of every food insecure households the food insecurity can be eliminated.

Assuming that the sampled households represents the whole woreda there are about 11425 households with a total population of 80105 for the study woreda, and based on the average Adult equivalent the total AE of the study area constitutes 54040.25AE. Considering the daily caloric requirements of the AE i.e. 2100kcal/AE/day, the amount of resource required to bring all households to the daily requirements (at least to the minimum subsistence caloric requirements of 2100 kcal) is estimated to $(F*n*2100kcal)$ becomes as $0.084*54040.25*2100kcal$ gives 9532700.1kcal per AE per day was required to bring all households to the minimum calorie requirements. When this was converted to cereals that constitute 3410kcal/kg leads to about 2795.52kg cereals or about 27.96 quintals of cereals per day was required to eliminate food insecurity in the study area. This shows about 10203.63 quintals of cereals or comparable amount of money that purchase this amount of cereal per year was required to eliminate food insecurity in the study woreda or to bring all households to obtain daily subsistence caloric energy in a year.

Finally, to approach the most food insecure sample households, severity of food insecurity was calculated by assigning a higher weight, $\beta = 2$. Thus, the survey result indicated that the severity of food insecurity becomes 0.0264.

In a similar way the incidence of household food insecurity was affected by some household factors like demographic (household head sex, age, education, and family size) and services (irrigation, credit and cultivated land size) of the households. The prevalence of food insecurity among household's shows that as family size increases the incidence of food insecurity increases which was confirmed by the incidence of food insecurity of the households showed that the households with having family size of between 11-14 were about 19 times of the households having family size of less than or equal to 4 members.

In line to education level, the head count index is decreasing as education level of the household is increasing. With regard to gender of household head, female-headed households have higher incidence of food insecurity than male-headed ones, i.e., 62.5 percent and 34.83 percent, respectively. Likewise, prevalence of food insecurity declines as farm size per capita of the household increases. This also supports the logit output result. On top of that the amount of credit received per AE was hypothesized as it was negatively correlated with household food insecurity. As the prior expectations the incidence of household

food insecurity decreases as the amount of credit received per AE increases (Table 3.3 below confirms the result).

Table 3.3: Distribution of incidence of food insecurity by household factors

House Hold Factor	Grouping Criteria	HHs Number	Number of food insecure HHs	Incidence of food insecure
Family Size	<=4	69	4	5.79
	5-7	189	58	30.69
	8-10	72	61	84.73
	11-14	8	8	100
	Total	338	131	38.76
Age of HH head	<=25	12	2	16.67
	26-45	230	78	33.91
	46-64	74	35	47.30
	>=65	22	16	72.73
	Over all	338	131	38.76
Sex of HH head	Male	290	101	34.83
	Female	48	30	62.5
	Over all	338	131	38.76
Education level	Illiterate	85	48	56.47
	Grade 1-4	82	44	53.66
	Grade 5-8	110	26	23.64
	Grade 9-10	51	11	21.57
	Grade 11-12	10	2	20
	Over all	338	131	38.76
Cultivated Land Size	<0.25	75	59	78.67
	0.25-0.50	161	62	38.51
	0.50-0.75	55	6	10.91
	0.7501-1.00	33	3	9.10
	>1.00	14	1	7.15
	Total	338	131	38.76
Amount of Credit Received/AE	<100	215	81	37.67
	100-500	30	25	83.33
	500-1000	55	23	41.82
	1000-1500	27	1	3.71
	>=1500	11	1	9.10
	Total	338	131	38.76
Use of Irrigation	User	110	34	30.91
	Non User	228	97	42.54
	Over all	338	131	38.76

Source: Survey Result

3.2 Results of Econometric Analysis

Logit model was employed to analyze the effects of fourteen determinants of household food insecurity of hypothesized explanatory variables from a randomly selected 338 households of five kebeles of the study area. For this study the variable food insecurity (FODINS) was used as a dichotomous dependent variable, with an expected mean value of 1, implying the probability of being food insecure and 0 indicating the probability of a household to be food secure. The model was estimated using STATA version 12. Codes, types and definitions of the variables were depicted in Table 3.4; and the maximum likelihood binary logit estimates were presented in Table 3.5 respectively. Before fitting the logit model, all the necessary tests were conducted. To this end the VIF result revealed that the value for VIF of total annual income of the household was become greater than 10. So this variable was omitted from the model. The result of the binary logistic regression model estimate revealed that out of the thirteen explanatory variables hypothesized to influence household food insecurity in the study area, seven variables namely household head sex, age square of the household head, education level of household head, family size of the household, cultivated land size of the household, proportion of food expenditure pattern, and tropical livestock unit were found to have a significant influence on the probability of being food insecure in the study area (Table 3.5).

Table 3.4: Variable Code, type and definition of variables included in the Logit Model

Variable code	Variable Type	Definition of variables
FASZ	Continuous	Family size in number
AGE	Continuous	Age square of the household head in years
DPR	Continuous	Dependency ratio in number
EDUC	Continuous	Education level of household head
CLSZ	Continuous	Cultivated land size in hectare
AMDT	Continuous	Amount of Credit received per AE in birr
TLU	Continuous	Total livestock unit owned in TLU
TOFFI	Continuous	Total off farm income per AE in birr
NUOXEN	Continuous	Number of oxen owned in number
FODEXPT	Continuous	Proportion of food expenditure pattern per AE in birr
IRGN	Dummy	Use of Irrigation (1 for users and 0 otherwise)
FAID	Dummy	Food Aid Received (1 for access to aid and 0 otherwise)
HHLDS	Dummy	Household Head Sex (1 for male and 0 for female headed)

Table 3.5: The Maximum Likelihood Estimates of the Logit Model

FODINS	Coefficient	Std. Err.	Z	P>z	Odds Ratio	Marginal effect
FASZ	.56	.175	3.18***	0.001	1.75	0.084
AGE	.001	.0003	2.26**	0.024	1.001	.0001
CLSZ	-1.02	.52	-1.96**	0.050	2.76	-.16
EDUC	-.59	.24	-2.45**	0.014	.56	-.091
HHLDS	-1.84	.71	-2.62***	0.009	.16	-.38
DPR	.41	.28	1.46	0.143	1.50	.063
IRGN	-.33	.46	-0.71	0.475	1.40	-.051
AMDT	-0.001	.001	-0.86	0.389	.99	-.0001
FAID	-.14	.21	-0.68	0.495	1.20	-.022
FODEPT	-.001	.0002	-3.14***	0.002	0.99	-.0001
TLU	-.18	.062	-2.95***	0.003	.84	-.03
NUOXEN	-.02	.07	-0.20	0.844	.99	-.002
TOFFI	-.001	.001	-0.61	0.545	.99	-.0001
_CONS	-2.03	1.92	-1.06	0.290	.13	
Number of obs = 338				Log likelihood = -80.14		
Wald Chi2(13) = 291.06				Pseudo R2 = 0.6449		
Prob>Ch2 = 0.0000				Sensitivity 87.79%		
Correctly classified 89.94%				Specificity 91.30%		

***, **, & * indicates the level of significance of variables at 1%, 5% & 10% respectively

Dy/dx is for discrete change of dummy variable

Source: own computation from Model output.

In light of the above summarized model results possible explanation for each significant independent variable are given one by one as follows.

Family size was positively related and it was found to be highly significant to determine household food insecurity at less than 1 percent probability level. The odds ratio in favor of food insecurity, ceteris paribus, increases by a factor of 1.75 as the family size increases by one. This indicates that larger household size tends to be more food insecure compared to smaller family size in the study area. The possible increase in household size implies more mouth to be fed from the limited resources and in an area where households depend on less productive agricultural land, increasing household size results in increased demand for food. But this demand will not be matched with the existing food supply so ultimately end up with food insecurity. The marginal effect of family size revealed that the probability of being food insecure will increase by approximately 8.4% with one additional family member in number. This result is in conformity with the findings of (Abebaw S., 2003) (Frehiwot F., 2007); and (Getachew D., 2003).

The age square of the household head was expected to have negative effect on food insecurity of the household head unfortunately the result of the logit model revealed that the sign was positive and significant. The positive relationship indicates that the odds ratio in favor of the probability of being food insecure increases with an increase in age square of a house hold head. Keeping other things constant the odds ratio in favor of food insecurity increases by a factor of 1.001 as the age square of the household increases by one year. The possible reason could be as the age of the person increase they transfer their land to others, they couldn't participate in other income generating activities and older household heads are less productive and they lead their life by remittance and gifts. On the other hand, older households have large number of families and their resources were distributed among their members. The marginal effect of age of household head indicates that the probability of being food insecure will increase by approximately 0.01% when age square of the household increases by one year. This result confirms with other findings of (Abebaw S., 2003), and (Frehiwot F., 2007).

The model output revealed that education of the household head affects food insecurity status negatively and significantly at 5% probability level. The negative relationship indicates that as the education level of the household head increases the chance for the household to be food insecure decreases. Keeping other variables constant the odds ratio in favor of food insecurity decreases the probability of a household being food insecure by a factor of 0.56 as education of the household increases by one level. This is due to educated individual largely contribute on work efficiency, in willing to adopt new technologies, accepting extension service advice, diversifying income, becoming visionary in educating his family, producing market oriented crops than illiterate ones. It is similar with what the findings of (Ramakrishna,G. and Asseffa,D., 2002) and (Haile, K, Alemu G., and Kudhlande,G. , 2005). The marginal effect of education level of the household head indicates that the probability of being food insecure will decrease by approximately 9.1 percent when the level of education of household increases by one year (level). Therefore, the finding of this study was found consistent with what had been found by (Girma Gezmu, 2012) and (Aschalew, 2006).

The logit-output result revealed that household sex influences household food insecurity negatively and significantly at 1% probability level. The odds ratio in favor of food insecurity decreases by a factor of 0.16 as the sex of the household head become male. This is to mean that male headed households are more food secure than female headed households. This is mainly because of differences between male and female heads to participate in non-farm activities that help to generate income (Adane T., 2008). On top of that male headed household have more exposure (have more opportunity) to real environment, receiving information, access to social services than female headed households. The marginal effect of household head sex indicates that the probability of a household to be food insecure decreases by approximately 38 percent when sex of household head become male. The finding was in agreement with prior expectations and also found consistent with findings of (Tsegaye Gebrehiwot, 2009).

Consistent with the hypothesis, cultivated land size influences household food insecurity negatively and significantly at less than 5% probability level. The negative sign of the result implies that households that have larger cultivated land size have less risk of food insecurity than the smaller ones. Keeping other things constant, the odds ratio in favor of food insecurity is decreased by a factor of 2.76 as the size of cultivated land of the household increases by one (1) hectare. The possible justification is that farm households who had larger farm size had better chance to produce more, to diversify the crop they produce and to get larger volume of crop residues. On top of that larger farms are associated with greater wealth and income and increased availability of capital, which increase the probability of investment in purchase of farm inputs that increase food production and ensuring food security. The marginal effect of households cultivated land size indicates that the probability of a household to be food insecure decreases by approximately 16 percent as the size of cultivated land size of the household increases by 1 hectare. This result is in an agreement with the prior expectations and supported by the findings of (Getachew D., 2003), and (Mulugeta, T., 2002).

Moreover, Food Expenditure Pattern is significantly and negatively associated with food insecurity status of the households in the study area at less than 1 percent probability level. The odds ratio of the logit model result revealed that

the probability of a household to be food insecure will decrease by a factor of 0.99 as the proportion of food expenditure per AE increases by one birr (Unit). The possible explanation for this is that farmers, who have good purchasing power or spend high proportion of income on food, have the likelihood of becoming food secure than those whose expenditure on food is relatively small. Or the proportion of expenditure on food increases, access to food by household also increases to the amount needed for household consumption. In addition, the amount of expenditure that a household incur is a good indication of income that the household have, the more the income the more food expenditure he pays for living standard. The marginal effect of the variable proportion of household food expenditure pattern of the logit result revealed that the probability of a household to be food insecure will decrease approximately by 0.01 % as the share of food expenditure per AE increases by one unit. This result was in an agreement with the prior expectations and also confirmed by other studies of (Aschalew, 2006), (Mulugeta, T., 2002) and (Frehiwot F., 2007).

The logit-output result of livestock holding revealed that it was negatively and statistically significant at less than 1 % probability level. This is an indication that ownership of livestock acts as a hedge against food insecurity in the study area. The possible explanation for the negative relationship is that livestock besides its contribution to the subsistence need and nutritional requirement, and crop production by provision of manure, it also serves as accumulations of wealth so that disposed during times of need, especially when food stock in the household deteriorate and also it is to mean that herd sizes being a proxy for farmer's resource endowment, those sample farmers with large herd size have better chance to earn more income from livestock production. This in turn enables them to purchase food when they are in short of their stock, and invest in purchase off-farm inputs that increase food production, and thus ensuring food security at household level. Keeping other things constant the odds ratio in favor of food insecurity decreases by a factor of 0.84 as the amount of livestock of the household rises by one TLU. The marginal effect of the variable, total livestock unit revealed that the probability of a household to be food insecure will decrease approximately by 3% as the total livestock unit increase by one unit in TLU. The result is supported by the studies of (Getachew D., 2003), (Mulugeta, T., 2002), (Abebaw S., 2003) and (Mequanint M., 2008).

4. Summary

The study was conducted with the objective to study food insecurity situation, identifying the intensity of food insecurity, mainly the incidence of food insecurity, food insecurity gap and severity and also further identifying the determinants of food insecurity in the study area. The study was conducted with the specific objective of examining food insecurity determinants and intensity of food insecurity. To come up with the objective of the study, it was realized through conducting a household survey from randomly selected five kebeles of the woreda by collecting a data from a randomly selected 338 rural household head. Household demographics, and other data deemed to be relevant were collected, organized, analyzed and interpreted to come up with possible results. The analysis employed both descriptive statistics and econometric methods. Descriptive statistics were employed to describe household characteristics with food insecurity status.

Binary logistic model was specified to identify determinants of food insecurity and FGT indices were used for the computation of incidence and severity of food insecurity among sample households. The sample households were classified into food secure and food insecure groups based on kcal actually consumed by collecting the food consumed by the households during the seven days back of survey date either through purchase or other means. The total amount of food consumed by each household during the survey date were converted into their equivalent kcal per AE and then compared with the recommended daily kcal per AE according to the daily kcal contents of the commodity type (Appendix-1).

Total daily food energy per adult equivalent 2100kcal was considered as cutoff point between food secure and food insecure households. To this reality the result of the study revealed that about 207 (61.24%) and 131 (38.76%) of the households were became food secure and food insecure households respectively. As discussed on the methodology part the study employed both descriptive and econometric method to analyze the result. So the descriptive statistics analyzed the households mean difference in household family size, sex of the household head, household food expenditure pattern, education level of the household head, cultivated land size of the household in hectare,

total live stock holding of the household in TLU, Use of irrigation, annual income per AE, Access to food aid, Amount of credit received per AE, Number of Oxen owned by the household head, Age of the household head, Total off farm income, Dependency ratio, were analyzed and discussed as follows.

The descriptive t- test statistics for mean difference on Family size, Age of household head, and dependency ratio, were positively and significantly differs in their mean between the two groups at less than 1 percent probability level, However Education level of the household head, Food Expenditure pattern, Total annual income, Total off farm income, Total Livestock in TLU, Number of oxen owned, cultivated land size, were found differ in their mean at less than 1 percent probability level and correlated negatively with the household food insecurity at the study area. On top of that the Chi square test for Food aid received, House hold head sex, and use of irrigation were analyzed and found that Household head sex and Use of irrigation was significant at 1percent and 5 percent probability level respectively. But the descriptive result for amount of credit received and access to food aid were statistically insignificant between the two groups at the study area. Binary logit econometric model was employed to estimate determinants of the probability of being food insecure as a function of various household characteristics among sampled Diga woreda rural households. From the 13 explanatory variables hypothesized and entered into the logit model as the determinants of household food insecurity, as a factors seven out of thirteen variables namely Family size, sex of the household head, proportion of food expenditure, and Total livestock unit were significant at less than one percent probability level where as Age square of the household head, Education level of the household head, and Cultivated land size were found to be statistically significant with the hypothesized signs as the determinants of household food insecurity in the study area except the household head age square that was statistically significant but opposite in sign with the hypothesized at less 5 percent probability level.

To test the intensity of food insecurity the FGT was employed and found the head count ratio (incidence of food insecurity) revealed that 38.76 percent and 61.24 percent of sampled households in the study area were found to be food

insecure and food secure respectively. The gap and severity of food insecurity were estimated to be 8.4 percent and 2.64 percent respectively. Considering the daily recommended 2100 kcal per adult equivalent; a resource needed to bring all households to daily subsistence requirement amounted to 9532700.1kcal per day. This shows daily requirements estimate of 27.56 quintals of cereal per day which is equivalent to 10203.63 quintals per year. This study highlighted to come up with the result of the analysis with the defined scope; however, a lot remained to be unanswered.

To give a relevant information on the determinants and level of food insecurity, the social, political, and environmental dimensions, roles of rural agriculture, lively hoods of the rural poor, purchasing patterns of food insecure, coping mechanisms demands future researchers' attention to give areal, crude, concrete information and all sided food insecurity situations of the study area.

4.1 Conclusion

The study deals with the level and determinants of food insecurity among rural households of east Wollega zone the case of Diga woreda. The results of the study revealed that family size and Age of the household head, were positively and significantly affects food insecurity at the study area where as cultivated land size, Total food expenditure, education level of the household head, Total livestock unit and sex of the household head being male influences household food insecurity significantly and negatively. We examined the determinants of food insecurity, surprisingly; the result does not support the importance of food aid received, Use of Irrigation, number of oxen owned and amount of credit received in the study area. This unexpected result was due to the credit delivering institution does not separate them to food secure and insecure households while delivering the credit. On top of that the importance of oxen and application of irrigation scheme was not as such important factor in influencing food insecurity situation of the study area.

4.2 Recommendations and Policy Implications

The result of the study underlines that the determinants of household food insecurity are complex and interrelated, requiring a multifaceted and all round interventions for improving the state and eventually alleviating the problem. This study examines the level and determinants of food insecurity at household level specifically of the Diga woreda rural households. Among the thirteen variables that were fitted to the logit model seven of them were found statistically significant. So based on the study result the possible policy recommendations and areas of interventions that emanate from the results of the research study are presented as in the following paragraphs.

Household family size was found to be directly related with household food insecurity. According to the result of the study family size was found significant among the major factors that lead households more vulnerable to food insecurity. As most related studies indicated in Ethiopia the proportion of population growth and level of food and agricultural production could not match each other that mean they did not meet the growing demand of farming community. This is to mean that the rate of food and agricultural production often grows slowly compared to the rate of growth in population. In line to this proper attention should be given to limit the rapid population growth in the study area. Activities that lead to boost agricultural production on one hand and limiting the fast growing population on the other hand are crucial to meet the demand of food. Government and non-government organizations working in the area are supposed to focus on intensive agriculture, integrated health and education services and family planning to equate food supply and demand equation in the long term. In addition, the policy that limits the acceptable number of children should be encouraged. On top of that, action based awareness creation on the impacts of population growth at the family, community and national level should be strongly advocated that lead to reduction in fertility and lengthen birth spacing should encourage households having acceptable number of children through provision of especial offer such as covering schooling cost, giving training and other related incentives.

The study has provided evidence that gender of head of a household play a key role in determining food security status of households. Thus, gender-sensitive

food insecurity alleviation policies that enhance endowments of female-headed households should be a key ingredient of food insecurity reduction strategy.

Age has positive impact on food insecurity. This means older households are more likely to be food insecure. Therefore, capacity building for old household heads should be given, and the policy that encourages old aged individuals and subsidize them should be encouraged. Also it is best if the social security issue that supports the households of the old age like that of government employees pension contribution should be designed to support the older households. In addition, a policy that encourages shareholding institution should be promoted to help the households at their old age from their contribution.

Reforms must be introduced in education system to make it productive in terms of food security. Special emphasis must be given to education for every member of the household. The effect of education on household food security confirms the significant role of the variable in consideration for betterment of living condition. The more household head educated, the higher will be the probability of educating family member and familiar with modern technology, which the twenty first century so badly demands. So, strengthening both formal and informal education and vocational or skill training should be promoted to reduce food insecurity in the study area. In addition, a policy that encourage adult education program should be designed. Generally, to address the issue of illiteracy, based on the Sustainable Development Goal (SDGS), rural household heads' enrolment ratio in adult education should be increased.

Size of cultivated land was found to have negative influence on household food insecurity. Agricultural strategies should be designed and implemented that would have effect on maintaining the existing land size on one hand and promoting intensive agriculture and livestock production on the other hand. Measures such as appropriate land use, improved technologies and proper extension services should be in place to raise land productivity. Rural development plans should include government and nongovernmental organization in promoting biophysical conservation activities, use of improved

seed and fertilizers, intensification of agricultural production should be emphasized.

Both livestock ownership and food insecurity have Negative association. Sticking to the findings of this study, livestock sub sector plays a great role in the struggle to eliminate food insecurity. Despite its prominent role in household food security, this sector has received less attention as compared to crop production. Thus, besides physical availability of animal health services, trained health personnel and necessary medical equipment and supplies should be fulfilled in the study area. Moreover, the introduction and distribution of crossbreed animals should be widely implemented to increase the productivity of livestock. Hence, necessary effort should be made to improve the production and productivity of the sector. This can be done through the provision of adequate veterinary services, improved water supply points, introduction of timely and effective artificial insemination services to up-grade the already existing breeds, launching sustainable and effective forage development program, provision of training for the livestock holders on how to improve their production and productivity, and improving the marketing conditions. Generally, Livestock was found as an important source of wealth that could contribute to food security in the study area. Hence, the output of the livestock sector should be strengthened through the provision or supply of better veterinary services.

The proportion of food expenditure pattern of the household and food insecurity in the study area was inversely related. Income and expenditure are the same coin of different faces. That means expenditure is the function of income. Therefore, increase in food expenditure decreases the food insecurity of the households. Moreover, rural households in the study area have very limited room for generation of income. Hence, for these households to enhance their welfare in general and food security in particular, they must have diversified access to income alternatives. In the face of this, provision of credit must be taken as a measure, though not the only one, to build the capacity of household to invest in the agricultural sector, such as purchase of fertilizer, pesticides, improved seed, live and productive animals. Moreover, development strategies should be able to identify income alternatives other than agriculture. In light of this, non-governmental organizations that are not

focusing on agriculture should also channel their scarce resources to creation of income generating activities, trading, crafting, etc. which would greatly help in strengthening off-farm activities which would enable the households to secure their food through purchase. Therefore, the policy that enhances the diversified income of the poor rural house hold should be promoted.

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Appendix 1: Calorie value of food items consumed by sample households

Food group Item	Unit	Mean Kcal	Food group Item	Unit	Mean Kcal
Cereals			Oil and fats		
Maize			Butter		
Teff			Oil	Kg	8120
Sorghum			Vegetables		
Finger millet	Kg	3410	Onion		
Barley			Tomato		
Wheat			Sweet Potato		
Oats			Beetroot	Kg	370
Lentils			Cabbage		
Pulses			Black pepper		
Beans			Carrot		
Peas			Irish Potato		
Cow pea	Kg	3450	Coffee/Tea		
Chickpea			Coffee	Kg	1190
Soybean			Tea		
Salt/Sugar			Spices	Kg	2970
Salt			Meat	Kg	1148
Sugar	Kg	1780	Milk and milk products	Lt	737

Source: (EHNRI, 1998)

Is Public Investment on Rural Road Transport Sector in Ethiopia Pro-poor? Evidence from the Ethiopian Rural Socio-Economic–Living Standard Measurement Survey Panel Data (LSMS)

Naod Mekonnen Anega¹ and Bamlaku Alamirew²

Abstract

Ethiopia has made relatively massive investments in the development of roads to tackle isolation. The overall disbursement over the past 15 years is about USD 12.2 billion. However, despite such investment, data show that Ethiopia's rural road transport has still remained low. A number of studies have been done to deal with this important issue. Nevertheless, several gaps remain. Against this background, this study aims at investigating the impact and pro-poorness of public investment in rural road in rural Ethiopia. The study used data from the Ethiopian Living Standard Measurement Survey. Both descriptive statistics and econometric techniques are used to address the aforementioned objective. From the descriptive mean comparison test, it emerged that the mean value of real consumption per capita for households in villages with good access to all weather roads is ETB 173. Whereas, the mean value of real consumption per capita for households in villages with poor access to all weather roads is ETB 113.38 ($p < 0.00$). The econometric analysis from the fixed effects model estimation reveal that improving the quality of rural roads and increasing access to all weather roads raise average real consumption per capita of households by as much as 10 per cent ($p < 0.00$). The result from the propensity score matching revealed that households in villages with good access spend between 58 and 62 more than those with poor access. However, the result of the fixed effects quantile regression indicate that access to rural roads has a positive and significant effect on welfare only for the 8th and 9th percentiles. To this end, improving rural roads to a level of all weather roads standards and provision of transport should be a strategic priority. inclusive growth approach is needed.

Key Word: Rural road transport, pro-poor growth, impact, quantile regression and fixed effect

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1. Introduction

Road transport in Ethiopia is the dominant form of transport in the country accounting for well above 90 per cent of motorized inter-urban-rural freight and passenger movements (ERA, 2013). Given that Ethiopia is landlocked and that there are only few navigable rivers that can serve both domestic and international transport services, the role of road transport in the country is vital (Admasu *et al.*, 2012). In addition, given the fact that about 83 percent of the population lives in rural areas being engaged in agriculture (which employs 80 percent of the labor force) using road transport (which accounts 90 percent of rural transport), the role rural road transport plays in the country in improving rural livelihoods and agricultural growth is expected to be tremendous (CSA, 2013; ERA, 2013).

Nevertheless, the level of road transport infrastructure in the country has been generally low. Asphalt and gravel road constitute only 11,301 km (15 percent of the total road network) and 14,455 km respectively (Annex I). This is relatively very small compared to the 1.1 million square kilometer area and 95 million people size of more than 95 million as of 2013. That the road network is very small is evident when one also looks at the following figures. The road density per 1,000 square kilometer and per 1000 population is 78 km and 1 km respectively (ERA, 2014).

Reports indicate that while the proportion of area further than 5 km from all-weather roads is 40.5 percent, the average distance to all-weather roads is 6 km (ERA, 2014). As a result, close to 70 percent of the rural population in Ethiopia still needs to travel about six hours to reach all weather roads. To make matters even worse, most rural roads are dry weather roads that cannot be passable by any formal transport modes during the wet season (Wondemu, 2015). Interestingly, while the average RAI for the country is around 50 percent (ERA, 2014), the proportion of number of rural population within 2km access is only 28.8 percent, very small compared to the size of 80 million people in rural areas of the country (ERA, 2014). Furthermore, reports also indicate that the level of rural mobility is low by any measure and rural communities mainly rely upon pack animals and carrying loads on their own

heads and backs to get goods to market and back (ERA, 2011; Arethun and Bhatta, 2012).

In the last couple of decades, however, the growth in road network has been progressive, as the country has made relatively massive investments in the development of roads to tackle isolation and improve the welfare of the rural poor. According to reports of ERA (2013), the overall disbursement over the past 17 years (1997- 2014) in road sector development program (RSDP) is about Birr 180.9 billion (USD 12.2 billion). Since the launching of RSDPs, the issue of access to roads has been linked with the country's development policies and strategies. Particularly, the various sectoral and multi-sectoral policies and strategies of the government of Ethiopia (GOE) have emphasized that access to all weather roads had remained the important unmet demand in rural areas. In this regard, in the first Growth and Transformation Plan (GTP) extending over the period 2010/11 to 2014/15, the government of Ethiopia (GOE) envisaged connecting kebeles³ to all-weather roads through the construction of 11,212 kms of new rural roads and of 71,523 kms of Woreda roads under its Universal Rural Road Access Program (MoFED, 2010). Currently, the country's overall road network is 85,966 km. Of this, the largest proportion is taken by rural roads (32,582 km, which is 37.9 percent).

Empirical studies have shown that access to rural roads can play a meaningful role in fostering rural income and reducing poverty. Dercon *et al.* (2009) used a panel data from fifteen rural villages in Ethiopia and examined 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 percent and increases average consumption growth by 16.3 percent after controlling for regional fixed effects and seasonal shocks. However, the paper fails to show the propenes of rural road across consumption quantile groups. On the other hand, in another study Ian and Ravallion (2002) found that geographic poverty trap of rural households using longitudinal data from 1985-90 on 5600 farm households in rural provinces of China. The study takes road density per ten thousand populations as one of the geographic variables which affect the productivity of private capital. Using

³ Smallest administrative unit in Ethiopia

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. Similar study on china 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.

Khandker and Koolwal (2011) examined the impact of rural roads in the long run by using household level panel data from Bangladesh between 1997 and 2005. They estimated 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. They also identified the initial difference in the households' characteristics and quality of roads determines the long-run impact of the roads. However, these studies didn't include the use of mode of transport (traditional or modern of transport) as one component of road transport system. The pro-poorness effect has not also been addressed in the analysis.

A recently study by Worku (2012) 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 used total road network per worker and he tested 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 how this might affect consumption or poverty at lower levels of administrative units and households.

Generally, less has been studied about the pro-poorness of such investments, as studies are scant showing whether providing better road access increases the consumption of the lower income quantile faster than the upper consumption quantiles. On top of that, the mobility effect has been largely

ignored in the empirical studies. This study is, therefore, unique in that it has a national coverage making it important for policy makers. Above all, it is imperative to look at this issue, as the country is envisioned to connect Kebeles to all weather roads so as to improve rural household's welfare. Thus, this study would like to fill what is an important knowledge gap by analyzing the impact of investment on rural road transport (accessibility and mobility) on welfare of households and examining whether such investments are the pro-poor.

2. Data and Methods

2.1 Data

The empirical data was drawn from two consecutive panel surveys of the Ethiopian Rural Socioeconomic Survey (ESS) –Living Standard Measurement Survey (LSMS). This data was prepared by the Central Statistics Agency (CSA) and the World Bank. The first round survey was conducted in 2011 and the second wave was conducted after two years in 2013. In agriculture and rural transport, middle and small-towns were excluded from the sample. The panel data was created using two criteria: (1) households must be from rural areas; (2) households cultivated some plot of land and on the other hand, they must have positive value of production; so households with zero or missing values cultivated plot of land, production and expenditure were excluded. Finally, a balanced panel of 2176 households consisting of 4352 observations over two rounds was created.

The data cleaning process required explanation for some of the variables used in the analysis. Farmers reported their cultivated land by using different local units of measurements. Thus, plots cultivated by households measured by local units were converted into standard measure, hectare, using the CSA's conversion factor. Finally, the plot level information was aggregated into household level. Aggregation of real consumption per capita involves four steps. First, total food and non-food expenditure is calculated. Second, the food and non-food expenditure was converted into real expenditure using the CSA's consumer price index (2011). Third, the data was aggregated at household level in order to get total real value of expenditure at household level. Finally, the real expenditure was divided by family size in adult equivalent to get real consumption per capita. Household size in adult

equivalent was converted using the Nutrition (calorie) equivalence scales prepared by FAO conversion factor.

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

Another important issue is a measure of the quality of road access and mobility. In the survey, the road quality of the sampled villages was compiled through a structured community level questionnaire. Community leaders were asked to identify the type if community/village roads in their respective villages. Following Dercon, *et al.* (2007); Wondemu and Weiss (2012), the road quality of the villages is categorized into two groups. The first one is 'good road access' that indicates access to all weather roads. The second one is 'poor road access' and it represents roads that do not allow reasonable access through the year. Therefore, while estimating the empirical model, a value of 1 is given for villages that have good road access and 0 for villages with poor road access. The other transport indicator variable is mobility or the mode of transport used for agricultural related activities. In this regard, foot, traditional mode of transport (pack animals, animal drawn carts, locally made carts) and modern mode of transport (Bajaj, motor cycle, cycle, mini-bus etc).

Finally, we used real consumption per capita in the welfare model. Consumption is defined as the sum of values of all food items, including purchased meals, and non-food items. Then, it is expressed in monthly per capita terms and deflated using the CSA food price index for 1994. The food and non food expenditure was converted into real expenditure using CSA's consumer price index. After this, the data was aggregated at household level in order to get total real value of expenditure at household level.

2.2 Research Method

2.2.1 Farm housed consumption model

The theoretical basis of consumption modeling in this article follows the work of Yesuf (2007). This consumption model is used to estimate the effect of rural road access and mobility on consumption. Moreover, the theoretical model serves as a basis to estimate the pro-pooriness of rural road investment.

Let us use assume that the household's income consists of both earned (Y^e) and unearned income (Y^u). The earned income is derived from business activities (both farm and off farm). The unearned income is comprised of government transfers (like food aid) and private transfers (like remittances). The unearned incomes depend on the household characteristics, their physical and human capital (high dependency ratio, lower land ownership, few livestock and) other physical assets that help households be entitled to government transfers. Moreover, households may also send some of the members to participate in the non-farm sector with the expectation of receiving remittances. This relationship is expressed as follows:

$$y^u = A + R = f(PC, HC, DC) \quad (1)$$

$$Y^e = f(p, Y, w) \quad (2)$$

Where, A refers to aid or any support from government and/or private individuals either in kind or in cash. R stands for remittances, which is the transfer of money from relatives; PC denotes physical capital; HC is vector of human capital; DC is demographic characteristics of the households; Y is the total output; p is price of inputs and outputs, and w is the wage earning. At this

stage, price can be suppressed for simplicity (Yesuf (2007.)). The total output (Y) depends on factors of production and can be expressed by using a Cobb-Douglas technology function which can be written as follows:

$$Y = A[PC^\alpha HC^\beta] \quad (3)$$

Where PC is the physical capital, HC is human capital, and α and β are parameters. In addition, the wage earnings of the households take the Mincerian type function based on human capital model developed by Becker (1993 in Yesuf, 2007).

$$W = \gamma_1 HC + \gamma_2 \text{expi} + \gamma_3 \text{expi}^2 \quad (4)$$

Where; W is wage; HC is the human capital; *expi* stands for experience and expi^2 is its squared value and $\gamma_1, \gamma_2, \gamma_3$ are parameters to be estimated. This model can be used as model for off-farm earnings and HC measures the educational attainment of the household head and household members and *expi* can be replaced by proxy variables such as age of the household head and its members. In sum, the total income of a household, Y^T can be written as:

$$Y^T = Y^e + Y^u = f(PC, HC, DC) \quad (5)$$

The theoretical establishment is based on the notion that a household maximizes utility that comes from consumption of commodities and home production activities. The household's problem is to chose the level of consumption C and home production activity level, x subject to the budget constraint given her/his welfare function.

$$\text{Max}U(C, x) \quad (6)$$

$$\text{Subject to } C + x = Y^t \quad (7)$$

Substituting (6) in to the budget constraint and the budget constraint into the welfare function the household's optimization will have the following functional form;

$$\text{Max}U(f(PC, HC, DC), x) \quad (8)$$

The first order condition implies that marginal utility from both consumption and home production activities should be zero. Given the above framework, households' utility/ welfare depends on several factors and using consumption expenditure per adult equivalent to measure household welfare, we can get the following consumption model at any time t .

$$C_{it} = f(PC, HC, DC, x) \quad (9)$$

2.2.2 Measuring pro-pooriness of rural roads

On the other hand, the quantile regression method is employed to see the pro-pooriness of rural roads. The quantile regression model is selected from other regression methods because it is more appropriate where ever there are policy implications and conclusions to be drawn in empirical analysis (Koenker and Bassett, 1978 in Kedi and Sookram, 2010) and it is also common in the case of welfare studies as it is more robust than OLS in the presence of heteroskedasticity (Kedi and Sookram, 2010). The quantile regression approach has also the advantage of allowing parameter variation across quantiles of the income or consumption distribution Pede *et.al.*, (2011). Moreover, this approach is considered in this study for two reasons: (1) with a skewed distribution, the median may become the more appropriate measure of central tendency, and (2) examining the marginal effects of rural road accessibility at different quintiles of income/consumption can provide a better picture of the benefits of rural road transport for farmers with varying unobserved characteristics. Thus, in order to estimate the effects of accessibility and mobility on total consumption per adult equivalent of different household categories, quantile regression is employed. In this regard, the term quantile model is used to distinguish between the numbers of equal size subsets used in econometric analysis (Duy, 2015).

As far as the dependant variable is concerned, in order to run the quantile regression, the consumption approached will be considered as an indicator of welfare or poverty because of its relative importance over income approach in the context of developing countries (Ravallion, 1992 and Cheema, 2005 in Jan

et.al., 2008). There two major reasons for choosing consumption over income are: (1) the majority rural areas population in developing countries derive their income from farm produce but farm production fluctuate because of the nature of seasonality and since consumption remain relatively stable⁴ as households rely on credit or savings to smoothen their consumption it can be considered as a better approach (2) in many instances not all income is consumed and also not all consumption is financed from income, so it is better to use consumption as a welfare indicator as it captures attained welfare as compared to income (Atkinson, 1989 in Jan *et al.*, 2008).

The quantile regression has the possibility of generating different responses in the dependent variable (total expenditure per adult equivalent) at different quantiles. These different responses may be interpreted as differences in the response of the dependent variable to changes in the regressor at various points in the conditional distribution of the dependent variable (Montenegro 2001 in Çaglayan and Astra, 2012). In this respect, in order to estimate the pro-pooriness of rural roads one can assume conditional quantile of a random variable Y (Logarithm of total expenditure per adult equivalent) to be linear in the regressor X ; where Y is the sum of food and non-food expenditure within a year and it takes the natural logarithm of total expenditure per adult equivalent. Following Çaglayan and Astra (2012), the quantile regression model for panel data has the following form:

$$L(y_{it}) = \beta X_{it} + \varepsilon_{it} \quad (10)$$

Where, $L(y_{it})$ is the natural logarithm of the total expenditure per adult equivalent of household i in period t ; X_{it} is the vector of the individual characteristics of the i^{th} household in period t ; β is a vector of unknown parameters to be estimated, and ε_{it} is the random disturbance term which is assumed to satisfy the usual properties of zero mean and constant variance. Here there is an important distinction to consider; that is OLS regression method assumes that the effects of regressor do not vary along the conditional distribution of the dependent variable. For example, in OLS regression, the effect of rural road access on total expenditure per adult equivalent is assumed

⁴ Consumption smoothing.

to be the same at the bottom as well as at the top of the consumption distribution. But in quantile regressions, the effect of rural road access on total expenditure per adult equivalent can be observed at different percentiles or expenditure per adult equivalent groups. In doing so, the quantile regressions help to understand how the effect of rural road access varies along the expenditure per adult equivalent distribution. The classical linear regression is an estimation method of the conditional average functions by minimizing the sum of squared residuals. Similarly, in the conditional quantile regression, we use an optimization of the linear objective function of residuals. Following Duy (2015), equation (10) can be specified in the form of the quantile regression as:

$$Q_{\tau} = \ln \left(\frac{Y_{it}}{X_{it}} \right) = X_{it} B_{it} + \varepsilon_{it, \tau} \quad (11)$$

Where $Q_{\tau} = \ln \left(\frac{Y_{it}}{X_{it}} \right)$ is used to estimate the logarithm of total expenditure per adult equivalent at τ^{th} quantile (Q_{τ}) of the distribution of the dependent variable (Y_{it}) conditional on the value of X_{it} (vector of explanatory variables). Following Koenker and Bassett (1978 in Duy, 2015), total expenditure per adult equivalent is in the τ^{th} quantile if total expenditure per adult equivalent is higher than the proportion τ of the reference group of individuals and lower than the proportion $(1 - \tau)B_{\tau}$ where B_{τ} is the estimated parameter for each explanatory variable. Assuming that the τ^{th} quantile of the error term conditional on the regressor is zero ($Q_{\tau}(Y_{it}/X_{it} = 0)$), then the τ^{th} conditional quantile of y_{it} with respect to x_{it} can be written as:

$$Q = \left(\frac{y_{it}}{x_{it}} \right) = \frac{x_{it}}{B_{\tau}} \quad (12)$$

Moreover, in order to control for the effect of household level unobservable heterogeneous effects, the study used an unconditional quantile regression estimator for panel data introduced by Powell (2009). The estimator conditions on fixed effects for estimation purposes, but the resulting estimates

can be interpreted in the same manner as traditional cross-sectional quantile estimates (Powell, 2009). The estimator conditions on fixed effects, but the quantiles themselves are not defined by the fixed effects. The Structural Quantile Function (SQF) is given by:

$$S_y(\tau|x) = x'\beta(\tau) \tag{13}$$

The SQF defines the quantile of the latent outcome variable $y_d = x'\beta(u)$ for a fixed x and a randomly selected $u \sim U(0,1)$. The estimator uses the following two moment conditions defined as:

$$E\left\{\frac{1}{N}\sum_t \mathbf{1}(y_{it} - x'_{it}\beta(\tau) \leq 0)\right\} = \tau \text{ for all } t \text{ and;} \tag{14}$$

$$E[\sum_i \sum_t \sum_{s < \tau} (x_{it} - x_{is})[\mathbf{1}(y_{it} - x'_{it}\beta(\tau) \leq 0) - \mathbf{1}(y_{it} - x'_{is}\beta(\tau) \leq 0)]] = 0 \tag{15}$$

The first condition defines the quantile category. This equation implicitly assumes the inclusion of year fixed effects by forcing the condition to hold for all t . The second condition makes within-group pair-wise comparisons, implicitly conditioning on the firm fixed effect. Notice that τ is never estimated or “differenced out.” Finally, the fixed quantile regression model developed by Powell (2009) was estimated at the 10th, 20th, 30th, 40th, 50th, 60th, 70th, 80th and the 90th percentiles of the distribution of expenditure of the households (these percentiles were selected in order to show both the lowest and the highest income groups). This will give the effect of accessibility, mobility, and other socio economic variables on different total expenditure per adult equivalent percentile distribution.

2.2.3 Isolating the impact of rural roads on rural welfare

The propensity score matching technique was used to isolate the effect of other covariates on rural welfare so as to single out only the effect of access to rural roads. The importance of estimating propensity score is twofold: first, to estimate the average treatment effect on the treated (ATT); and second, to obtain matched treated and non-treated observations as inputs for impact analysis. The expected value of ATT is defined as the difference between

expected outcome values with and without treatment for those who actually participated in treatment. Propensity score matching rests on two strong assumptions: conditional independence and common support condition. Following the works of Baker and Ichino (2002) and Heckman *et al.* (1998), the PSM provides reliable and low bias estimates of a given program or policy impact. Estimating the effect of participating program on a given outcome (Y) is specified as:

$$Ti = Yi (Di = 1) - Yi (Di = 0) \quad (16)$$

Where, Ti treatment effect;

Yi the outcome on household i

Di Whether household i has good access to road or not.

However, it is important to consider that $Yi (Di = 1)$ and $Yi (Di = 0)$ cannot be observed for the same household at once. Moreover, estimating individual treatment effect Ti is impossible and one has to shift to estimate the average treatment effects of the population than the individual. According to Heckman (1997), the most commonly used average treatment effect estimation is an average Treatment Effect on the Treated (ATT), which is specified as:

$$T_{ATT} = E(T|D=1) = E[Y(1) | D = 1] - E[Y(0) | D = 1] \quad (17)$$

This helps to know how much the households benefited due from the access to all-weather roads. As the counterfactual mean for those being treated, $E[Y(0)|D = 1]$ is not observed, one has to choose a proper substitute for it in order to estimate ATT. One may think to use the mean outcome of the untreated individuals, $E[Y(0)|D = 0]$ as a substitute to the counterfactual mean for those being treated, $E[Y(0)|D = 1]$. However, this is not a good idea especially in non-experimental studies, since it is likely that components which determine the treatment decision also determine the outcome variable of interest. Hence, the outcomes of individuals from treatment and control group would differ even in the absence of treatment leading to a self-selection bias. By rearranging and subtracting $E[Y(0)|D = 0]$ from both sides of equation 17, ATT can be specified as:

$$E [Y (1)|D =1] - E[Y (0)|D = 0] =TATT + E[Y (0)|D =1] - E[Y (0)|D = 0] \quad (18)$$

However, in non-experimental studies one has to introduce conditional independence assumption and common support. While the conditional independence assumption implies that the selection is solely based on observable characteristics and variables that influence treatment assignment, common support assumption ensures that households with the same X values have a positive probability of being both participants and non-participants. The PSM estimator is the mean difference in outcomes over the common support, appropriately weighted by the propensity score distribution of participants. Besides, independence, common support or overlap condition ensures that households with the same X values have a positive probability of being both participants and non-participants (Heckman, *et al.*, 1999). The principal drawback of this approach is that it does not have power against certain alternatives, but argue that these alternatives are rather exceptional. An estimate of the propensity score is not enough to estimate ATT, as the probability of observing two units with exactly the same value of the propensity score is, in principle, zero (Becker and Ichino, 2002). As such, various matching algorithms have been proposed in the literature to determine the region of common support, and the most widely used are the nearest neighbor matching, radius matching, Kernel matching, and stratification matching (Becker and Ichino, 2002; Smith and Todd, 2005).

3. Empirical Model Specification

Given the panel nature of the data, an estimable form (empirical specification) of the consumption model is formulated below with its fixed and random effects following Wooldridge (2009).

$$\ln C_{it} = \gamma_i + \alpha X_{it} + \varepsilon_{it} \quad (19)$$

Where γ_i captures all the household unobserved factors that affect C_{it} , α is vector of parameters to be estimated X_{it} represents exogenous regressor which serves as control and ε_{it} is the idiosyncratic error term which is assumed to be

uncorrelated with the exogenous variable X_{it} . However, in case where the unobserved heterogeneity is uncorrelated with any of the explanatory variables in all time periods, then estimating equation (19) using fixed effects is not efficient. This calls for the estimation of the random effects model, which is specified as:

$$\ln C_{it} = \alpha_0 + \alpha X_{it} + \varepsilon_{it} \quad \text{Where } \varepsilon_{it} = \alpha_i + \mu_{it} \quad (20)$$

The random effects model allows the inclusion of time-constant variables. Once the fixed and random effect models are specified, the next step is to select between the fixed and the random effect models and this was carried out by using the Hausman specification test. The estimable form of the fixed effects model is given as:

$$\ln C_{it} = \gamma_i + \alpha_1 age_{it} + \alpha_2 edu_{it} + \alpha_3 dratio_{it} + \alpha_4 famil_{it} + \alpha_5 yield_{it} + \alpha_6 oxen_{it} + \alpha_7 ext_{it} + \alpha_8 cred_{it} + \alpha_9 irr_{it} + \alpha_{10} accroad_{it} + \varepsilon_{it} \quad (21)$$

Table 3: Description of variables used in the consumption model

Variables	Descriptions the variables	Exp. sign
$\ln C_{it}$	natural logarithm of real consumption per capita for hh i at time t	
$accraods_{it}$	access to all weather roads	+
Age	The completed years of age for household i at time t	+
edu_{it}	years of schooling for the head of the household	+
$dratio_{it}$	dependency ratio for household i at time t	-
$famil_{it}$	family size in adult equivalent for household i at time t	-
$yield_{it}$	yield for household i at time t	+
$oxen_{it}$	number of oxen owned in TLU for the i^{th} household t time t	+
ext_{it}	extension contract for farmer i at time t	+
$cred_{it}$	access to credit for household i at time t	+
$irri_{it}$	irrigation for agricultural production for household i at time t	+

Source: Compiled from various empirical literature

In the same way, the estimable form of the random effects model for real consumption expenditure per capita is given by the following equation. All the variables are as defined above.

$$\ln C_{it} = \alpha_0 + \alpha_1 age_{it} + \alpha_2 edu_{it} + \alpha_3 dratio_{it} + \alpha_4 famil_{it} + \alpha_5 yield_{it} + \alpha_6 oxen_{it} + \alpha_7 ext_{it} + \alpha_8 cred_{it} + \alpha_9 irr_{it} + \alpha_{10} accroad_{it} + \varepsilon_{it} \quad (22)$$

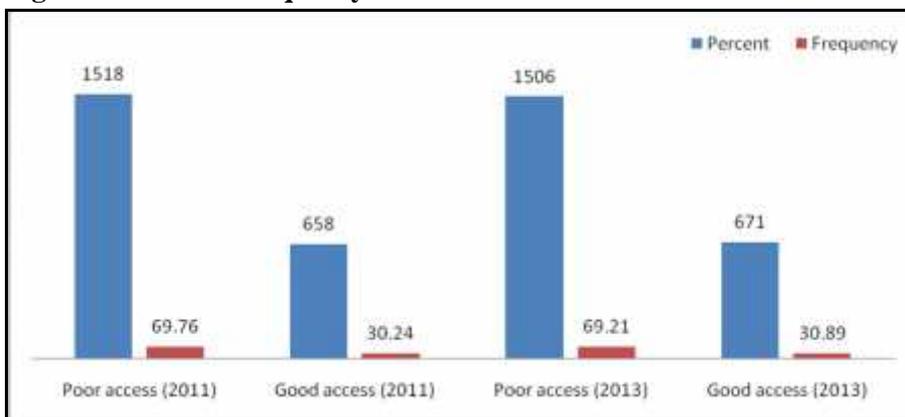
4. Findings of the Study

4.1 Descriptive statistics

4.1.1 Heterogeneity in rural accessibility and mobility

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

Figure 1: Rural road quality condition

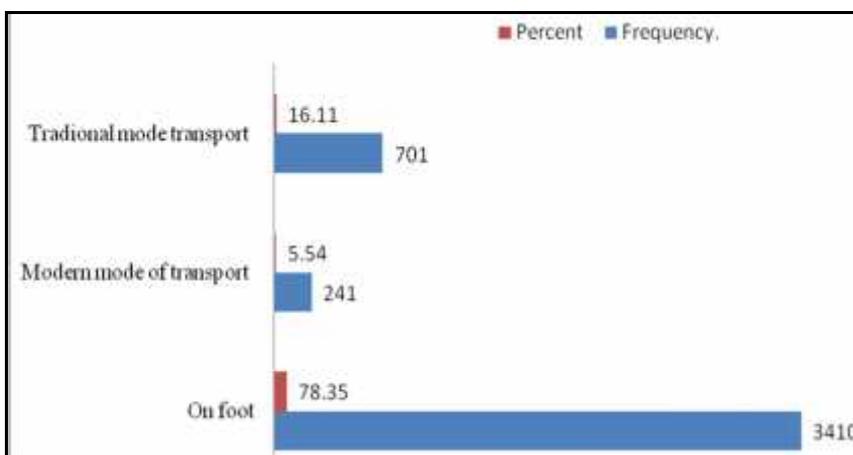


Source: Computed from LSMS data (2011 and 2013).

On the other hand, the overall distribution of the major mode of transport used for agricultural purposes is presented in Figure 2. The pooled distribution of mode of transport in Figure .2 shows that while 3410 (78%) of them have

used foot and 701 (16%) traditional mode of transport. Only 241 (5.4%) have used modern mode of transport.

Figure 2: Major mode of transport used for agricultural related activities



Source: Own depiction from the LSMS (2011 and 2013).

The comparison of mode of transport used between households in villages with good access and households in villages with poor access is presented in Table 2 below. The result shows that the proportion of households in villages with poor and good access tend to use similar mode of transport facilitates for agricultural purposes. In both categories, the dominant mode of transport is foot followed by traditional and modern mode of transport. The implication is that the level of adoption of both modern and traditional mode of transport is low both for households in villages with good access and poor access. Table 2 also shows that foot is the dominant mode of transport both for households in villages with good access and poor access.

Table 2: Comparison of households based on mode of transport and type of road quality

Type of mode	Good access (pooled)	Poor access (pooled)
On foot	1033 (77.79)	2377 (78.6)
Modern mode of transport	78(5.87)	163 (5.39)
Traditional mode of transport	217(16.34)	484(16.01)

Similarly, the comparison of mode of transport across time is presented in Table 3 below. The result shows a similar pattern of use of transport facilitates for agricultural purposes in both periods. In both periods, the dominant mode of transport is foot followed by traditional and modern mode of transport. The implication is that the level of adoption of both modern and traditional mode of transport is low in both periods. Table 3 further shows that foot is the dominant mode of transport in both periods suggesting that much remains to be done in terms of improving the transportation modality of rural areas in Ethiopia.

Table 3: Type of mode of transport used when compared by the two periods

Type of mode used	2011	2013
On foot	1841(84.6%)	1569(72.1%)
Modern mode of transport	99(4.55%)	142(6.53%)
Traditional mode of transport	236(10.58%)	465(21.37%)

4.1.2 Descriptive statistics for consumption analysis

The data used for consumption analysis is presented here. The mean comparisons of covariates used to explain real consumption per capita are presented in Table 4. According to the result, the mean real consumption per capita per month has increased from ETB 126 to ETB 138 ($p < 0.01$). The ratio of land to family labour has decreased from 0.63 in 2011 to 0.59 in 2013 ($p < 0.05$). Family economic burden is measured in terms of dependency ratio. Results show that dependency ratio increased from 0.069 in 2011 to 0.73 in 2013 ($p < 0.1$). The mean age of the head has slightly increased from 44.7 in 2011 to 46.3 in 2013 ($p < 0.001$). On the contrary, access to credit decreased from 25% in 2011 to 18% in 2013 ($p < 0.00$). The number of oxen owned measured in tropical livestock units increased from 6.3 units in 2011 to 7 units in 2013 ($p < 0.00$). Table 4 further shows that while logarithm of agricultural yield increased from 6.8 in 2011 to 7.1 in 2013 ($p < 0.00$), family size in adult equivalent (which is a proxy for family labour) increased from 4.5 in 2011 to 4.8 in 2013 ($p < 0.00$).

Table 4: Mean comparison of covariates used for the real consumption per capita model

Explanatory Variable	2013	2011	Difference	P-Value	
Real consumption per capita ⁵	138.12	126.011	11.587	0.0002	***
Land to family labor ratio	0.5924	0.6316	-0.039	0.0334	**
Dependency ratio	0.7329	0.6987	0.034	0.0767	*
Participation in off farm income	0.2472	0.2578	-0.011	0.4224	
Sex of the head	0.8111	0.8226	-0.011	0.3273	
Age of the head	46.3625	44.7499	1.613	0.0003	***
Head's years of schooling	1.8888	1.8617	0.027	0.7384	
Access to credit	0.1788	0.2597	-0.081	0.000	***
Access to irrigation	0.1443	0.1553	-0.011	0.3081	
Road quality	0.3079	0.3024	0.006	0.6929	
Oxen in tropical livestock units (TLUs)	7.1992	6.3639	0.835	0.000	***
Logarithm of agricultural yield	7.9254	6.8532	1.072	0.000	***
Family size in Adult equivalent	4.8731	4.5382	0.335	0.000	***
Level of significance *10% ; **5% ; ***1%					

Source: Own depiction from the Ethiopian Socio-economic survey data.

In Table 5, we present the mean comparison of the key covariates of real consumption per capita by type of road quality. The mean comparison test result shows that there is significant difference between households in villages with good access to all weather roads and households in villages that lack access to all weather roads at least for some of the covariates of real consumption per capita. For example, while the mean value of real consumption per capita for households in villages with good access to all weather roads is ETB 173, the mean value of real consumption per capita for households in villages with poor access to all weather roads ETB 113.38 ($p < 0.00$). The heads mean years of schoolings for households in villages with good access to all weather roads is 2.11, while it was just 1.77 for households in villages that lack access to all weather roads. A significant variation is also observed in the level of access to irrigation and land to family labor ratio (Table 5).

⁵ Real consumption per capita per month

Table 5: Mean comparison of variables of real consumption per capita

Explanatory variables	Good access	Poor access	Difference	p-value
Real consumption per capita	173.7248	113.3951	60.33	0.00
Land to family labor ratio	0.6662	0.5882	0.078	0.00
Dependency ratio	0.6865	0.7287	-0.042	0.04
Participation in off farm income	0.2688	0.2454	0.023	0.10
Sex of the head	0.8148	0.8178	-0.003	0.81
Age of the head	45.9683	45.3746	0.594	0.22
Head's years of schooling	2.1145	1.7702	0.34	0.00
Access to credit	0.2154	0.2209	-0.006	0.68
Access to irrigation	0.2319	0.1138	0.118	0.00
Oxen ownerships (TLUs)	6.5791	6.8704	-0.291	0.17
Logarithm of agricultural yield	7.3615	7.4016	-0.04	0.60
Family size in Adult equivalent	4.6409	4.7341	-0.093	0.14
Level of significance *=10% **=5% ***=1%				

In addition to the mean comparisons across the two periods, mean comparisons of consumption per capita is presented by the type of road quality and time periods. The summary of the result is presented in Table 6. According to the result in Table 6, for the year 2011, while the mean real consumption per capita was ETB 166 for households in villages with access to all weather roads, the mean real consumption per capital was ETB 108 for households with poor access to all weather roads ($p < 0.00$). For the year 2013, while the mean real consumption per capita was ETB 180 for those households in villages with access to all weather roads, the mean real consumption per capital was ETB 118 for households with poor access to all weather roads ($p < 0.00$).

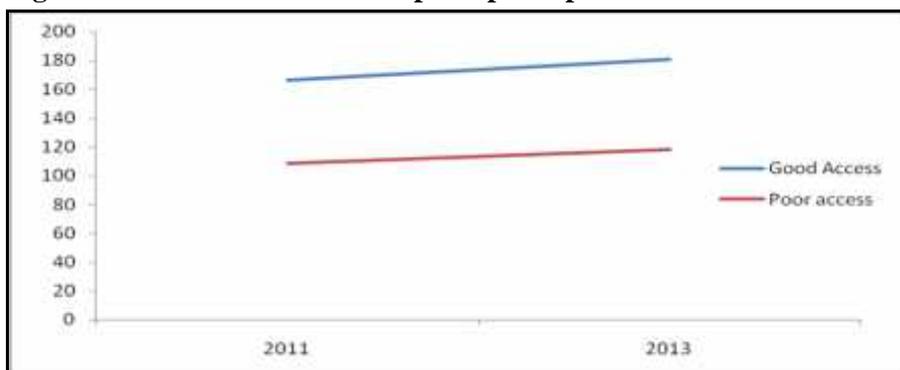
Table 6: Comparison of consumption variables by accessibility

Variables	Year	Good Access	Poor access	Diff.	P value
Consumption per capita	2011	166.47	108.471	58.003	0.00
consumption per capita	2013	180.85	118.35	62.488	0.00

Source: Own computation from the Ethiopian socio-economic survey data

The trend in real consumption per capita is also presented in Figure 3. Interestingly, the trend in mean real consumption per capita shows that while there is a general increasing trend in the level of mean consumption per capita for both groups of farmers (having good and poor access to all weather roads), the trend in the mean real consumption per capita for rural households with good access was found to be higher than the trend in the mean consumption for rural households in villages with poor access. This is evident as the increase in the mean real consumption per capita for households in villages with good access is greater than the increase in mean real consumption per capita for households in villages with poor access.

Figure 3: Trends in real consumption per capita



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

4.2 Result from the Econometrics Analysis

4.2.1 Fixed and Random Effects models

In order to understand the impact of rural road quality on real consumption per capita, the interaction of real consumption per capita with rural road quality (access to all weather roads) and other covariates was examined. The dependent variable logarithm of real consumption per capita is estimated using fixed and random effects model to identify the possible factors explaining the covariates of real consumption per capita among rural households. The Hausman test procedure is used to select between the fixed and the random effects model. The model is also tested for the possible appearances of Heteroscedasticity and multicollinearity problems.

The heteroskedasticity problem was adjusted with robust standard error and the multicollinearity problem was also checked and tested using the observed information matrix (OIM) during the estimation of the variance–covariance matrix. The group wise Heteroskedasticity problem was also checked by using Wald test statistics. The result of the diagnostic test shows that there is no problem of multicollinearity during the estimation for the determinants of real consumption expenditure per capita (Annex VII). According to the Hausman test, the null hypothesis that difference in coefficient is not systematic is rejected (Annex VI). Thus, we reject the random effects model in favor of the fixed effects model. As a result, the discussions made in the analysis are based on the fixed effects model results.

The result of the fixed effects model presented in Table 7 shows that most of the covariates used as control variables in the real consumption per capita analysis are significant with their expected signs. The findings from the fixed effects model show that access to all weather roads has a positive and significant impact on rural welfare. That is, improving the quality of rural roads to a level that allows all weather road access raises average real consumption per capita of households by as much as 10 per cent ($p < 0.00$). This result is similar to other studies made in Ethiopia. For example, the result is similar to the result by Dercon (2008). According the analysis made by Dercon (2008), while access to all-weather roads has increased consumption growth by 16 per cent, it has reduced the incidence of poverty by 6.7 per cent. Interestingly, the result is also consistent with empirical studies elsewhere. For example, Thomas (2008) found that road access has a substantial impact on consumption growth in rural Madagascar. Moreover, the result shows that access to paved roads would increase consumption by 8 per cent while remoteness decreases consumption growth by 4 per cent. The other transport indicator, mode of transport has also a positive effect on welfare. The result indicted that real consumption per capita for households using traditional mode of transport would increase by as much as 7 per cent when compared with those using foot as a major mode of transport ($p < 0.05$). The findings from the fixed effects model revealed that land to family ratio, participation in off farm income activities, access to irrigation, access to extension, oxen owned in tropical livestock units and logarithm of output per capita were found to have a significant positive effect on real consumption per

capita (Table 7). This result is consistent with what other studies have already found (Hagos and Holden, 2008; Dercon, *et al.*, 2007; Zewdu *et al.*, 2012).

The coefficient of land to family ratio shows that as land to family labour increases by one unit real consumption per capita will increase by 6 percent ($p < 0.05$). Since the outcome variable is log transformed, it can be interpreted as exponentiated regression coefficients. Thus, availability of land at household level that meets the growing family size means securing food at household level. However, land has already become a scarce resource in rural Ethiopia due to population pressure and further expansion of land frontier is not easy (Shimeles, *et al.*, 2009). However, it is not the shortage of land alone, which affects the output of agriculture and consumption in Ethiopia; it is the structure of land tenure, the lack of proper land ownership as well as lack of improved agricultural technology and changing climatic conditions (Shimeles, *et al.*, 2009). The coefficient of participation in off farm income is positive and significant and for rural households participating in rural off farm activities, consumption would increase on average by 10 percent as compared to households who are not participating in off farm activities ($p < 0.05$). Other studies have already found a similar result (Woinishet, 2010). However the effect of participation in off farm activities on consumption or poverty depends on the activity farmers engaged in and the level of off farm income earned (Davis 2003). On the other hand, as it is expected dependency ratio and family size in adult equivalent have a negative and statistically significant effect on the real consumption per capita at 5 per cent and 1 percent respectively. The coefficient of the parameters of dependency ratio and family size in adult equivalent is also consistent with the theoretical expectations (Ojimba, 2013; Bigsten, *et al.*, (2003). The result shows that dependency ratio reduces expenditure per adult equivalent at least by 7 per cent. The main reason is that for a given household size, a larger number of children and elderly members would imply a smaller number of earners in the household and equally important the burden on members of the labor force will increase as dependency ration increases (*ibid*). Similarly, the coefficient of family size in adult equivalent unit is found to reduce real consumption per capita by 8 percent. Similar patterns are found in most developing and low-income countries (Asogwa, *et al.*, 2012; Ojimba, 2013).

Table 7: Fixed and random effect model estimation result

Explanatory variable	Fixed effect model	Random effect model
Access to all weather roads (1=yes)	0.100*** (0.0272)	0.209*** (0.0232)
Mode of transport used ⁶ (1=foot)		
Modern mode of transport	0.0642 (0.0521)	0.0927** (0.0457)
Traditional mode of transport	0.0765** (0.0368)	0.0727** (0.0286)
Logarithm of yield	0.0186*** (0.00666)	0.0307*** (0.00536)
Land to family labour	0.0625** (0.0279)	0.0731*** (0.0217)
Participation in nonfarm income	0.102*** (0.0314)	0.0926*** (0.0244)
Dependency ratio	-0.0721** (0.0338)	-0.107*** (0.0212)
Age of the head	0.00321 (0.00432)	-0.00264** (0.00106)
Gender of the head(1=male)	0.0602 (0.0975)	0.0609 (0.0383)
Years of schooling	-0.00671 (0.00492)	0.0218*** (0.00396)
Access to irrigation (1=yes)	0.370*** (0.0481)	0.342*** (0.0321)
Access to extension (1=yes)	0.0864** (0.0351)	0.115*** (0.0244)
Access to credit (1=yes)	0.00467 (0.0299)	0.0448* (0.0246)
Number of livestock owned in TLU	0.00984*** (0.00272)	0.0140*** (0.00175)
Family size in adult equivalent	-0.0840*** (0.0213)	-0.0723*** (0.00848)
Constant	4.470*** (0.232)	4.481*** (0.0807)
Observations	4,346	4,346
R-squared	0.073	

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

⁶ Foot is drooped for comparison reasons

Among the key policy variables access to irrigation and extension were found to increase consumption expenditure. The coefficient of irrigation show that , on the basis of the fixed effect estimator, provision of irrigation access raises average real consumption per capita of households by as much as 3 percent ($p < 0.01$). The other implication is that consumption per capita would increase by as much as 3 percent for households with access to irrigation as compared to households with no access to irrigation. Huang, *et al* (2005) in china, Dillon, (2008) in Mail and Fitsum, *et al* (2012) in Ethiopia, have found similar results but using different models, indicating the role of irrigation as a key factor for poverty alleviation and improvement of rural household's welfare. The coefficient for access to extension service show that on average consumption per capita will increase by as much as 8 per cent for households with access to extension contact as compared to households with access to irrigation ($p < 0.05$). This result is constant with Dercon (2008) and Asogawa *et al* (2012). However, the result from Dercon (2008) is superior in that the result is robust and endogeneity problem is controlled. According to the result by Dercon (2008), while farmers receiving at least one visit from an extension agent raises consumption growth by 7 per cent and reduces poverty incidence by nearly 10 per cent.

4.2.2 Evaluating the impact of rural road access

The major purpose of impact evaluation is to isolate the effect of other variables on real consumption expenditure so as to attribute the impact on real consumption expenditure to investments on roads. The balancing property was selected in estimating propensity scores. The use of the balancing property ensures that a comparison group is constructed with observable characteristics distributed equivalently across quintiles in both the treatment and comparison groups (Smith and Todd, 2005). In constructing the matching estimates, the common support was imposed. Four matching methods, radius matching, the nearest neighbor and Kernel matching methods were used to estimate the impact. Comparing results across different matching methods can reveal whether the estimated project effect is robust (Khandker *et al.*, 2010). The PSM results presented in Table 8 support the conclusion that access to all weather roads does improve household consumption expenditure per capita, indicating that households in villages with good access spend between 58 and

62 more than those with poor access depending on the matching method used. The detailed PSM results are presented in Annexes.

Table 8: Impact of access to all-weather roads on household welfare: PSM results

Matching Method	Treatment	Control	ATT	Standard error	T-test
Stratification method	1221	2758	58.602	3.863	15.17
Kernel Matching method	1221	2758	59.982	3.5	1.96
Nearest Neighbor method	1221	880	56.157	4.962	11.317
Radius matching (0.1)	1221	2758	62.859	4.392	14.312
Radius matching (0.2)	1221	2758	62.859	4.392	14.312
Radius matching (0.25% of sd)	1220	2,763	61.1335	4.712	12.96

The choice of matching estimator is decided mainly based on the balancing qualities of the estimators. According to Dehejia and Wahba (2002), the final choice of a matching estimator should be guided by different criteria such as equal means test referred to as the balancing test, low pseudo- R^2 and large matched sample size. Balancing test was conducted to know whether there is no statistically significant difference after matching in the mean value of per-treatment characteristics of the two groups of respondents. After matching, matching estimators were evaluated whether the adopters and non-adopter observation lies in commonly support region. Ultimately, matching estimator with all variable mean balanced, and relatively low pseudo R^2 value with large matched sample size, was preferred.

4.2.3 The pro-poorness (inclusiveness) of rural roads access

In order to ascertain whether the magnitude and sign of the coefficient estimate of the road variable changes when one controls for differences in the level of welfare, a fixed quantile regression model was estimated. This would help to assess how different groups of households are affected by a change in road access conditions and ascertain whether the investment in roads sector is pro-poor. Thus, using a fixed quantile regression model technique and classifying the households into different strata, the welfare model is estimated (quantile regression). Although the model is estimated by including all the potential covariates of consumption, since our interest here is only to look at

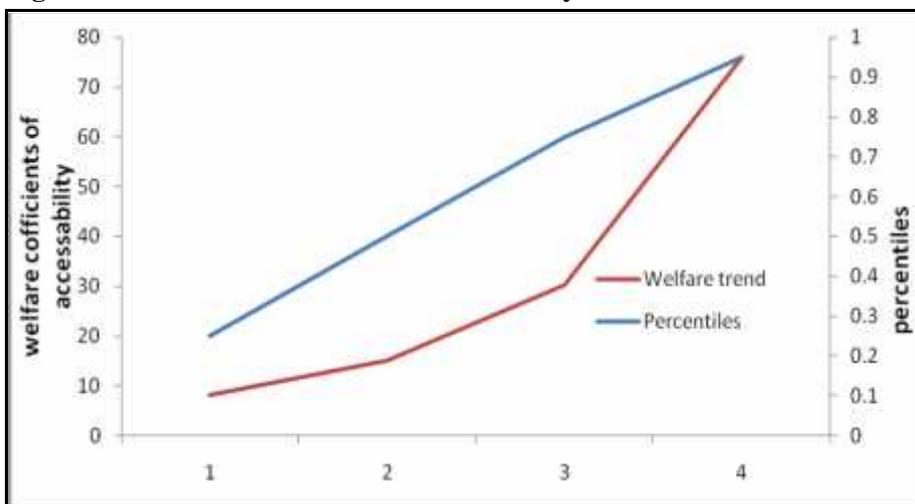
the pro-poorness of rural roads accessibility, only the coefficients of the real consumption per capita with their z statistics and p values are reported (Table 8). The result of the fixed quantile estimation in Table 9 indicates that rural road access has a positive and significant effect on welfare only for the 0.8th and 0.9th percentiles.

Table 9: Welfare distribution and rural access

Percentiles	Welfare effect	Std. Err	Z	P> z
0.2	3.126336	17.949	0.17	0.862
0.3	9.468921	26.186	0.36	0.718
0.4	12.93196	13.430	0.96	0.336
0.5	10.00797	17.821	0.84	0.4
0.6	20.47958	34.328	0.6	0.551
0.7	26.62714	16.762	1.59	0.112
0.8	34.00285	10.297	3.3	0.00
0.9	77.25115	12.008	3.5	0.00

Thus, according to the results in Figure 5 (drawn using the results in Table 8), rural roads are not pro-poor in the period considered. This is an important result as other studies did not address the question as to who is benefiting (which consumption group) from investments in rural roads. In this regard, the finding in this study gives an important insight for policy makers. The main concern here is the short time period considered whereby one should be cautious to make strong conclusions. However, the argument here is that since the inception of the URRAP in 2010 (with the objective of connecting all kebeles to all weather roads), there has been new construction of rural roads each year that can support the argument for relative changes in road infrastructure to see the impact of roads. Thus, even though the period considered is short, the change in road infrastructure cannot be underestimated. Thus, the conclusions made about pro-poorness of rural roads are reliable.

Figure 5: Welfare coefficients of accessibility and rural road access



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

7. Conclusions and Policy Implications

Rural communities in Ethiopia have different level of accessibility and mobility as far as access to all weather roads and use of mode of transport are concerned. There exists low utilization of modern mode of transport for agricultural related activities and by far foot is still largely dominant mode of transport for agricultural purposes. Even though there is an increase in the level of access to all weather roads still majority of rural farmers uses foot as a major means of transport for agricultural purposes. Thus, agricultural transportation system has not well developed. This calls for the adoption of more intermediate mode of transport (both motorized and non-motorized).

The study found that heterogeneity in rural accessibility and mobility can explain difference in real consumption per capita. The study found that provision of all weather roads access can increase real consumption per capita at least by 10 percent ($p < 0.05$). Besides, from the impact analysis it emerged that households in villages with good access spend between 58 and 62 more than those with poor access depending on the matching method used. However, the study did not find any support of pro-poorness of rural road investment. From theoretical perspectives, rural road investment is a core

component of a 'pro-poor' or 'inclusive growth' strategy. Therefore improving roads in areas where the poor live should help lower poverty, but this study found that the effect of investment in rural roads might be not be automatically progressive (gains are proportionately higher for the higher consumption group than the lower consumption group). The implication is that, apart from the investment in rural road access, The lack evidence for pro poorness of rural road investment calls for an inclusive growth that address equity to bring about pro poor growth and overall improvement of welfare.

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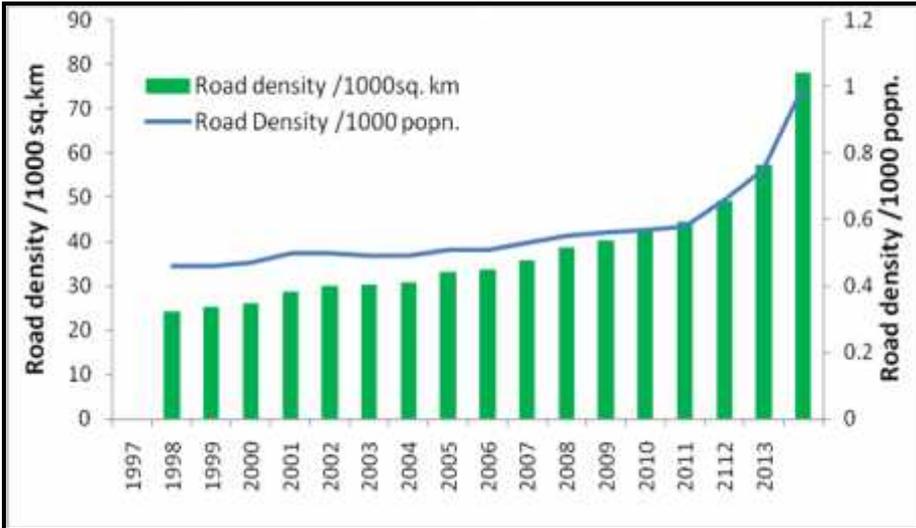
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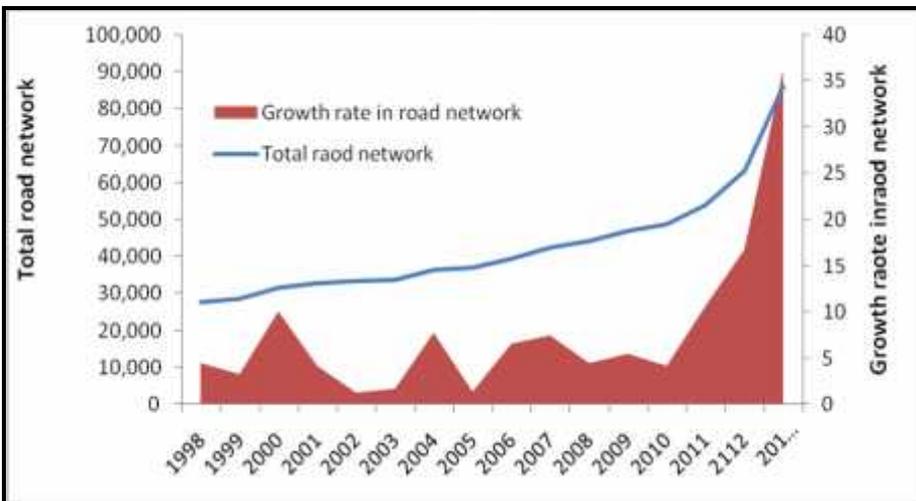
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Annexes

Annex I: Trends in road density/1000 sq.km and road density /1000 population in the past 20 years



Annex II: Trends in road network and growth rate in the past 20 years



**Annex III: The development of overall road infrastructure in Ethiopia
in the past 20 years**

Year	Road network in km				Growth Rate (%)	Road Density /1000 popn.	Road density /1000 sq. km
	Asphalt	Gravel	Rural	Total			
1997	3,708	12,162	10,680	26,550		0.46	24.14
1998	3,760	12,240	11,737	27,737	4.5	0.46	25.22
1999	3,812	12,250	12,600	28,662	3.3	0.47	26.06
2000	3,824	12,250	15,480	31,554	10.1	0.5	28.69
2001	3,924	12,467	16,480	32,871	4.2	0.5	29.88
2002	4,053	12,564	16,680	33,297	1.3	0.49	30.27
2003	4,362	12,340	17,154	33,856	1.7	0.49	30.78
2004	4,635	13,905	17,956	36,496	7.8	0.51	33.18
2005	4,972	13,640	18,406	37,018	1.4	0.51	33.6
2006	5,002	14,311	20,164	39,477	6.6	0.53	35.89
2007	5,452	14,628	22,349	42,429	7.5	0.55	38.6
2008	6,066	14,363	23,930	44,359	4.5	0.56	40.3
2009	6,938	14,234	25,640	46,812	5.5	0.57	42.6
2010	7,476	14,373	26,944	48,793	4.2	0.58	44.39
2011	8,295	14,136	30,712	53,997	10.7	0.66	49.09
2012	9875	14675	31550	63083	16.8	0.75	57.3
2013	11301	14455	32582	85966	36.3	1	78.2

Annex IV: Accessibility indicators of rural households

Accessibility indicators	Frequency	Percent
Poor access (0=yes)	3,024	69.49
Good access (1=yes)	1,328	30.51
Total	4,352	100

PSM Probit estimation result

Explanatory variable	Coef.	Std. Err.	Z	P>z	[95% Conf. Interval]	
Age of the head	0.0021	0.00147	1.49	0.137	-0.0007	0.005068
Years of schooling	0.0274	0.007869	3.48	0.00	0.011982	0.042826
Land size owned (Ha)	0.0432	0.012267	3.52	0.00	0.019171	0.067256
extension (Yes=1)	0.195	0.045542	4.3	0.00	0.10645	0.28497
credit(Yes=1)	-0.043	0.052286	-0.83	0.409	-0.14569	0.059268
irrigation(Yes=1)	0.5245	0.0571	9.19	0.00	0.41263	0.636457
Quantity of seed used	-0.000	0.000312	-3.08	0.002	-0.00157	-0.00035
Number of oxen owned	-0.007	0.020633	-0.34	0.733	-0.04749	0.033391
Livestock owned in TLU	-0.00855	0.003703	-2.31	0.021	-0.01581	-0.0013
Nonfarm income (Yes=)	1.25E-05	7.04E-06	1.78	0.076	-1.30E-06	2.63E-05
Dependency ratio	-0.03869	0.034208	-1.13	0.258	-0.10574	0.028353
Logarithm of yield	-0.003	0.010239	-0.29	0.769	-0.02307	0.017063
Constant	-0.77405	0.11985	-6.46	0.00	-1.00895	-0.53915
Number of obs = 3984 Log likelihood = -2379.6411 Prob > chi2 = 0.0000Log likelihood = -2379.6411						

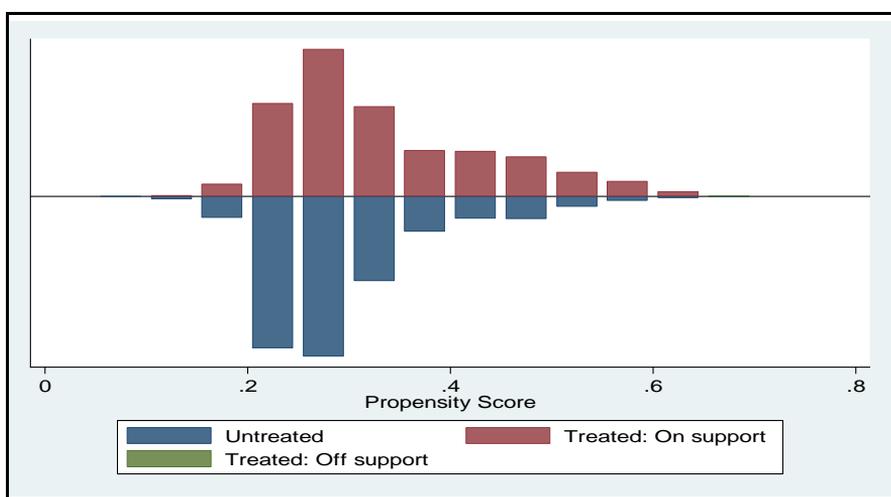
The region of common support is [.13326409, .67681892]				
Description of the estimated propensity score in region of common support				
	Percentiles	Smallest		
1%	0.172792	0.133264		
5%	0.205186	0.135784		
10%	0.218616	0.139377	Obs	3979
25%	0.243079	0.140427	Sum of Wgt.	3979
50%	0.281216		Mean	0.306669
		Largest	Std. Dev.	0.090896
75%	0.342541	0.63644		
90%	0.451769	0.658444	Variance	0.008262
95%	0.498542	0.675518	Skewness	1.192974
99%	0.581746	0.676819	Kurtosis	4.03242

The balancing property is satisfied

Inferior of block of p score	poor access	good access	Total
0.1332641	124	29	153
0.2	816	226	1,042
0.25	471	164	635
0.275	377	172	549
0.3	645	327	972
0.4	315	294	609
0.6	10	9	19
Total	2,758	1,221	3,979

Variable	Sample	Treated	Controls	Difference	S.E.	T-stat
Real consumption	Unmatched	175.5112	113.7543	61.75688	3.43533	17.98
	ATT	175.4876	114.3541	61.1335	4.716167	12.96

Treatment assignment	Common support		
	Off support	on support	Total
Untreated	0	2,763	2,763
Treated	1	1,220	1,221
Total	1	3,983	3,984



Ps R2	LR	chi2	p>chi2	Mean Bias	Med Bias	B	R	%Var
0.001		4.22	0.963	1.8	1.1	8.3	0.96	50

Annex V: Hausman test for fixed and random effect model

Variables	Fixed effect (b)	Random effect (B)	Difference	S.E.
Land to family ratio	0.06641	0.08954	-0.02313	0.019058
Participation on off farm	0.104514	0.087779	0.016734	0.019843
Dependency ratio	-0.07442	-0.10002	0.025599	0.023363
Age of the head	0.003875	-0.00333	0.007208	0.003028
Sex(male=1)	0.052731	0.058683	-0.00595	0.091209
Years of schooling of heads	-0.00677	0.020895	-0.02767	0.00361
Irrigation use (yes=1)	0.368634	0.314832	0.053803	0.036057
Access to extension	0.084054	0.10593	-0.02188	0.025197
Access to credit	0.003831	0.047057	-0.04323	0.018697
Livestock owned in TLU	0.010164	0.013991	-0.00383	0.002249
Family size in adult equivalent	-0.08019	-0.06939	-0.0108	0.018269
Access to all weather roads	0.100287	0.195299	-0.09501	0.017217
Distance to market	-0.00767	-0.00389	-0.00378	0.012101
Logarithm of yield	0.019813	0.031872	-0.01206	0.003767

Annex VI

Test: Ho: difference in coefficients not systematic

$$\text{chi2}(14) = (b-B)'[(V_b-V_B)^{-1}](b-B) = 107.09$$

$$\text{Prob}>\text{chi2} = 0.0000$$

Modified Wald test for group wise heteroskedasticity in fixed effect regression model

H0: $\sigma(i)^2 = \sigma^2$ for all i

$$\text{chi2}(2176) = 9.9e+35 : \text{Prob}>\text{chi2} = 0.0000$$

Annex VII: OMI Test result for real consumption per capita

e(V)	L/F	PP_F	DR	Age	Sex	EDU	AI	AE	AC	TLU	AEU	RQ	Dmkt	LogY	_cons
L/F	1														
PP_F	0.0189	1													
DR.	0.0523	-0.0126	1												
Age	-0.0481	-0.013	-0.0642	1											
Sex	0.0314	0.0208	0.0817	-0.1335	1										
Edu.	-0.0151	-0.0215	0.0371	0.0424	-0.0309	1									
A.I	-0.003	-0.0323	0.0619	-0.0118	0.0201	-0.005	1								
A.E.	-0.0406	-0.0239	-0.0173	-0.0571	-0.0067	-0.004	-0.0247	1							
A.C.	0.0157	0.0236	0.0031	0.0609	-0.0167	0.0057	0.0118	-0.0927	1						
TLU	-0.0456	-0.0142	-0.0277	-0.0139	-0.0231	-0.0157	0.0048	0.0293	0.026	1					
AEU	0.1735	0.0443	0.0728	-0.0583	-0.0146	-0.0393	0.0731	-0.0897	0.0528	-0.0686	1				
RQ	-0.0377	-0.0489	0.0444	0.0021	0.0196	0.0083	-0.0937	-0.115	0.0963	0.0061	0.0242	1			
Dmkt	-0.0114	0.0174	0.0753	-0.0112	0.0031	-0.0181	0.0044	0.014	-0.0133	-0.0312	-0.0019	0.0013	1		
LogY	0.3571	0.0145	0.0033	-0.0763	0.0585	0.0124	-0.0187	-0.0724	0.0594	-0.103	-0.0157	0.0368	-0.0093	1	
_cons	-0.0437	-0.031	-0.1063	-0.1389	-0.0811	0.0043	-0.0204	-0.0007	-0.0152	0.0256	-0.1036	-0.0176	-0.9737	-0.0425	1

Where L/F=land to family labour ratio

Households' Preferences and Willingness to Pay for Improved Solid Waste Management Interventions using Choice Experiment Approach: Debre Tabor Town, Northwest Ethiopia

Eshetie Woretaw¹, Dawit Woubishet² and Workineh Asmare³

Abstract

Adequate Solid Waste Management (SWM) practices are indispensable for maintaining quality environment and the health of urban dwellers in most developing countries, like Ethiopia. However, for successful implementation of adequate SWM options, households' preferences and their Willingness to Pay (WTP) should be taken in to consideration. The main aim of this study was to analyse the preferences of households' and estimate the WTP for improved SWM service attributes in the form of money income and labor effort using choice experiment approach (CEA). Multi-stage stratified random sampling design was used to draw sample households and primary data was collected from 220 households. In addition to the standard conditional logit model, the Random Parameter Logit Model (RPLM) and the Latent Class Models (LCM) were estimated to relax the independent of the irrelevant alternatives assumption and account preferences heterogeneity for various SWM attributes. The RPL results indicated that preferences for all attributes were heterogenous among households, a conclusion that was supported by the wide variation in LCM estimates between classes. Based on the implicit price, mode of transportation was the foremost attribute followed by solid waste disposal method, and service delivery institute and sorting of solid waste was the least important attributes. The welfare measure result indicated that households were WTP a considerable amount of money for the improved SWM interventions scenario. The result further revealed that

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The authors are grateful for patience of households' in Debre Tabor town to respond the complex choice experiment questionnaires.

respondents with higher level of income, higher level of education and female headed households preferred better SWM interventions. The finding showed that analyzing households' preferences is very important to prioritize among alternatives for the implementation of good SWM. Therefore, studying this aspect can contribute to the successful implementation of sound SWM practices. In order to achieve adequate SWM options, it is recommended that the urban planner or concerned body need to take account households' preferences for improved SWM interventions.

Key words: Choice Experiment Approach, Debre Tabor, Solid Waste Management, Willingness to Pay

1. Introduction

Population growth, urbanization and greater exploitation of resources resulted in an increasing demand for environmental management. Particularly, in developing countries urban areas', the people are facing sever challenges due to lack of healthy urban environment (Khtak and Amin 2013). Inadequate municipal solid waste management (SWM) is one of the major drivers to the degrading of environment quality in urban areas (UNPDDESA, 2005, Khattak, Khan et al., 2009, Wilson and Velis, 2014).

Efficient SWM plays a crucial role to improve environmental quality through increased amenity values, non-use values, and provision of source of livelihood (Behzad, Ahmad et al., 2011). However, managing solid waste is now becoming the major challenges of urban areas of all sizes, from megacities to small towns and large villages, which are home to the majority of human kind (Sankoh and Yan, 2013, Wilson and Velis, 2014). Due to increasing population in urban locations that creates situations where the generation of all forms of solid waste exceeds the capacity of effective collection and disposition (UNSAID, 2006, Das, Birol et al., 2008, Wilson and Velis, 2014). The resulting outcome is a severe threat to health and environmental quality deterioration(Balasubramanian, 2015).

Higher economic growth, population growth and rapid rate of urbanization in developing countries including Ethiopia has resulted in numerous environmental challenges (Commoner, 1991, Panayotou, 2000, Aruna.D, R. et al., 2013). Among the challenges, the continuous increase in the quantity and composition of solid waste is a major environmental problem (Amiga, 2002, Khattak, Khan et al., 2009, Yuan and Yabe, 2015). Municipalities in Ethiopia have experienced traditional practices to collect, dispose and reuse solid waste which is not aimed at promoting public health, environmental protection and alternative energy sources (Hailemariam and Ajeme, 2014). These form of SWM practices are now becoming the major causes to surface and ground water pollution, decline in cities and towns cleanness (Tsega and Reddy, 2013). Among the towns, Debre Tabor is one of them and faces challenges associated with poorly managed solid waste operation (EPA, 2014).

Over the last few years, the quantity and composition of solid waste in Debre Tabor town has increased significantly. Albeit, solid waste generated in the town seems not to undergo any treatment before their final disposal. The service provider faced challenges to deal effectively in managing solid waste and to minimize its impact on economic, health of the resident and deterioration of the quality of the town yet. The existing SWM situation in the town is inefficient due to traditional mode of transportation, irregular waste picking up program, having few required equipments and no fence for dumpsites. As a result, households are not satisfied by the prevailing solid waste service provision, and dispose their solid waste along vacant spaces. Generally, the urgent need of efficient SWM and the ever increasing problem of handling solid waste are still the main facet of the town. Accordingly, there is a need in addressing the aforementioned problems via deep investigation. Evaluating the demand side of SWM is the first move required to reduce the gap through designing an appropriate intervention packages. In this regard, the growing number of economic valuation studies on improved SWM from different part of the world reflect the increasing recognition of the importance of having good SWM. To find a solution for environmental and health related impact of poor SWM practices, enormous numbers of researches have been carried out in relation to economic valuation of SWM (Khtak and Amin 2013, Hagos, Mekonnen et al.,2012, Amiga, 2002, Hazra, Goel et al., 2015, Yuan and Yabe, 2015).

In attaching values for environmental goods and services, most of precursor studies (Amiga, 2002, Tarfasa, 2007, etc.) undertaken in Ethiopia in relation to SWM have employed the contingent valuation method (CVM) and most of these researches conducted are carried out in selected cities and towns of Ethiopia. Moreover, due emphasis is not given for households contribution in the form of labor for achieving the proposed SWM interventions. Evidences on households' contributions, the generation and composition of solid waste in Debre Tabor town are scanty or rarely available and making difficult in setting effective SWM system for the town yet. Thus, conducting a study on SWM in the town, which is one of the fast growing towns in Ethiopia is indispensable. In this vein, the main objective of this study was to evaluate households' preferences for SWM attributes of Debre Tabor town and to estimate their contribution both in the form of money and labor effort for various enhanced SWM interventions using CEA.

2. Description of the Study Area

Debre Tabor Town is one of the oldest in Southern Gondar Administration Zone situated in Amhara National Regional State of Ethiopia. It was established by Atsie Seyefe Aread in 1335. It is suited 50 kilometers East direction of Lake Tana and 667 km direction along Addis Ababa. The town was the capital of Ethiopia under Emperor Tewodros II and Yohannes IV. During the study period, the town has been serving as seat of South Gondar administration zone, Debre Tabor town administration and Farta district. The town administration is subdivided into four locally administrative kebeles (The smallest administrative unit in Ethiopia) with a total population of 78,706 (EPA, 2014).

The expansions of commercial activities, health and educational institutions, and high fertility have duly increased the population of the town. This led to over-stressing urban infrastructure services including municipal SWM because of poor resources and hence inadequacies of the prevailing practices to collect transport and disposed the solid waste. Putting bench mark information about existing situation of SWM system in the town can help to design appropriate SWM services, service charge rates, schedules and to write future concession agreements between the municipality and SWM service

providers. In line with this, it is very important and timely to look for the possibility of sharing the cost of handling solid waste by households, and for this we need to evaluate the demand side of improved SWM. Therefore, this study is designed to generate demand side information, which is vital for decision making process.

3. Methodology

3.1 Sampling Design and Data

The numbers of Kebeles in Debre Tabor town are four and summing up the total number of household head for these Kebeles yield 12098. A multi-stage stratified random sampling design was employed to draw sample urban households in Debre Tabor town. In the first stage, the four Kebeles were grouped in to two categories. Each of the two Kebeles is common in infrastructure, the quantity of solid waste generated, and access to the provision of SWM services. In this regard, Kebele 2 and 3 were comprised the first group and Kebele 1 and 4 formed the second group. Then, as a second stage using simple random sampling technique, two Kebeles were selected, namely Kebele 3 from group one and Kebele 4 from group two. In the third stage, five homogenous units were made within the selected Kebeles. The category was based on the monthly service charge payment for the SWM service delivered.

Accordingly, nonpayer⁴ (0 Ethiopian Birr (ETB⁵) per month and payer (ETB 8, 15, 20 and 25 per month) and majority of the households were nonpayer. Household heads from all categories within the selected Kebeles with a total of 5,638 were envisaged. Considering the nature of households and the tradeoff between cost and precision level, 220 households were selected randomly from which primary data was collected using questionnaire. The

⁴ For this study, non-payers are those urban household heads who were not actually sharing the cost incurred to handle solid waste by the service provider, this might not be necessary due to lack of income & unwillingness to participate in SWM practices. Rather lack of access to the service offered (inefficiency of the service provider to visit the households house, lack of road and necessary equipment) and to some extent due to closeness to the dumpsite.

⁵ ETB is Ethiopia's national currency and during the survey, the exchange rate for one US dollar (\$) was equal to ETB 21.45.

first part of the questionnaire comprised the presentation of the choice sets, the SWM choice experiments. A valuation scenario description was provided to respondents ahead of the choice experiment question. Data on socioeconomic characteristics and environmental awareness were collected to complement the choice experiment data. Pretesting was carried out on a small number of sampling units before doing the final survey. A critical field observation was also done to garner auxiliary information on the existing dump sites, gully, the surrounding of home and outskirt of the town. In so doing, the researcher used camera to delineate the current situation of SWM by taking photographs and video signals. Valuable secondary data was obtained from officials particularly from the town's cleaning and beautification department that are involved in the provision and planning of SWM services.

3.2 The Theoretical Background and Applications of the Choice Experiment Approach (CEA)

The basis for most microeconomic models of consumer behavior is the maximization of utility function subject to a budget constraint(Lancaster, 1966). Choice experiment is a recent innovation in stated preference method and its theoretical grounding were inspired by the Lancasterian microeconomic approach (Lancaster, 1966) in which individuals derive utility from the characteristics of the goods rather than directly from the goods themselves.

CEA originated in the fields of transport and marketing, where it was mainly used to study the tradeoff between the characteristics of transport projects and private goods respectively. This approach have a long tradition in those fields, and recently has been applied to non-market goods in environmental and health economics (Alpizar, Carlsson et al., 2001). The first study to apply CEA to non- market valuation was by (Adamowciz, Louviere et al., 1994). Since then there is an increasing number of research in environment and health sector using this approach due to the fact that the superiority of the method over Contingent Valuation Method (CVM) and the possibility of testing for internal consistency or validity, preferences are stable and transitive between the hypothetical and the actual choice experiment (Alpizar, Carlsson et al., 2001). Moreover, this approach can do better in

elicitation of preferences than CVM in measuring the marginal value of changes in the characteristics of environmental goods because it is easier to disaggregate values for environmental resources into the values of the characteristics that describe the resource (Hanley et al., 1998). The CVM gets the required answer for just one alternative to the status quo, whereas the CEA can generate estimates of the values of many different alternatives from the one time application (Alpizar et al, 2001, Adamowicz et al, 1994 and Bennett et al, 2001). As a result, from one set of choice data, the values of an array of alternative ways of reallocating resources can be estimated. This feature of the approach arises because it specifically investigates trade-off between attributes (Perman, Ma et al., 2003, Bennett, 2005). Thereon, CEA is a natural generalization of a binary choice CVM (Adamowicz, Louviere et al., 1998, Alpizar, Carlsson et al., 2001). This approach also provides an enormous amount of information elicited from each respondent as compared to CVM (Adamowicz, Louviere et al., 1994, Hanley, mourato et al., 2001). This huge amount of information enable a better understanding of the process underlying the statements of preferences made by respondents and the problems that may be associated with those processes. Finally, it is versatile in its application as the alternatives presented to respondents in the choice sets are hypothetical, the choice experiment analyst can design an application to estimate both use and non-use values of the environmental assets (Bennett, 2005).

3.3 The Econometric Base, Models and Analysis of Choice Experiment Approach

The econometric basis of CEA is from Random Utility Theory (RUT). The theory poses a notion that an individual consumers choose alternatives that provide them greatest utility (Adamowicz and Boxall, 2001). For RUT, the utility function for each respondent can be decomposed in to two components: the deterministic and the stochastic part (Adamowicz, Louviere et al., 1994, Hanley, Wrigh et al., 1998, Hanley, mourato et al., 2001, Othmal, 2002, Birol, Karousakis et al., 2006, Louviere, Flynn et al., 2010). The equation can be written as follow.

$$U_{in} = V_{in} + V_{in} \dots \dots \dots \quad (3.1)$$

Where U_{in} is the latent total utility derived from alternative i by any individual n , V_{in} is the vector of observable component of indirect utility function and v_{in} is the vector of random unobservable component associated with individual n and option i in which predictions cannot be made with certainty.

However, according to Lancaster (1966), any particular individual can drive utility not from the good per se rather from the characteristics of the good. And the equation become

$$U_{in} = V(Z_{in}, S_n) + v(Z_{in}, S_n) \dots \quad (3.2)$$

Where Z_{in} is a vector of the attributes of non-market goods and services or environmental good and S_{in} is the vector of marketable good and socioeconomic characteristics of the respondent. The reason why we are incorporating S_{in} is that the attributes may be viewed differently by different individuals arising from difference in socioeconomic characteristics that will also affect utility of an individual's (Louviere, Flynn et al., 2010). So, researchers can predict the probability that individual n will choose option i . The above equation implies that latent utility derived from various SWM alternatives depends on both the attributes of SWM practices and socioeconomic characteristics of the respondents.

RUT leads to families of probabilistic discrete choice models by putting different assumption on the distribution of the error term (Adamowic, Boxall et al. 1998, Green, 2003, Louviere, Flynn et al., 2010). For instance, the Conditional Logit Model (CLM) assumes that the stochastic component are Identically and Independently Distributed (IID) across individuals and alternatives with a weibull distribution (Birol, Karousakis et al., 2006). A consequence of this assumption is the property of Independence of Irrelevant Alternatives (IIA). The IIA assumption states that the probability of choosing the ratio of two alternative is independent of the addition or the deletion of the other alternatives (Blamey, Gorden et al., 1999, Green, 2003). If IIA property is violated, the estimate of CLM model will be spurious, misleading interpretation. The test used to identify the existence of IIA assumption is Hausman test (McFadden, 1974).

According to (McFadden, 1974, Green, 2003)⁶ the probability of choosing option i by respondent n from a complete choice set (equation 3.2) will be estimated using the conditional logit model.

$$Pr_{ob}(i_n) = \frac{\exp(-\mu V_{in})}{\sum_{j \in C} \exp(-\mu V_{jn})} = \frac{\exp(-\mu V(Z_{in}, S_n))}{\sum_{j \in C} \exp(-\mu V(Z_{jn}, S_n))} \dots \quad (3.3)$$

Where μ is the scale parameter and it is inversely proportional to the standard deviation of the error distribution. This parameter cannot be separately identified and usually assumed to be one⁷ (Hanley, Mourato et al., 2001). The model becomes deterministic as the scale parameter tends to positive infinity (Hanley, Wrigh et al., 1998).

According to Othman (2002), another advantage of the CEA is its ability to incorporate the importance of socio-economic and environmental factors in the indirect utility function. Then the conditional indirect utility equation will become (Birol, Karousakis et al., 2006)

$$V_{in} = ASC + S_1 Z_1 + S_2 Z_2 + \dots + S_k Z_k + u_1 S_1 + u_2 S_2 + \dots + u_m S_m \dots \quad (3.4)$$

Where, ASC is the alternative specific constant (ASC), which represents the effect of systematic but unobserved factors that explains the individuals' choices. Technically ASC reflects the differences in the error terms and it captures the effect on utility of any attributes that are not included in choice specific attributes (Birol, Karousakis et al., 2006). From this study the number of SWM service attributes are considered as k and the number of socio-economic and attitude towards the environment by the respondent are assumed to be m . The vector of coefficient 1 to k are attached to the attribute of SWM and 1 to m are the vector coefficient of socioeconomic characteristics of the respondent.

⁶ Equation 3.3 becomes multinomial logit when it uses only individual specific characteristics and assumes the error terms are IID across individuals and alternatives, and conditional logit model, when attributes and individual specific characteristics are present (McFadden, 1974, Green, 2003). Both models assume homogeneity preferences by individuals.

⁷ Implies constant error variance

Albeit the CLM does not violate the IIA property, there is also another problem with the specification, limitation in modeling variation in preference among respondents (Birol, Karousakis et al., 2006). This problem arises due to observed and unobserved heterogeneity. Conditional observed heterogeneity can be incorporated into the model by allowing for interaction terms either with the choice attributes or Alternative Specific Constant (ASC) but it could not detect unobserved heterogeneity. Thus an alternative method of estimation, which does not exhibit both the IIA and homogeneity preferences assumption are recommended, that is the Random Parameter Logit Model (RPLM) (Train, 1998, Alpizar, Carlsson et al., 2001). However, it should also be noted that even if unobserved preference heterogeneity can be accounted with the use of this model, it fails to explain the sources of heterogeneity (Adamowicz and Boxall , 2001). One solution to detect the sources of heterogeneity while accounting for unobserved heterogeneity would be by inclusion of respondents' socio-economic and environmental variables in the utility function as interaction terms with choice specific attributes and/ASC (Adamowicz and Boxall , 2001, Birol, Karousakis et al., 2006)). This would enable RPLM model to pick up preference variation in terms of both unconditional and conditional preference heterogeneity and allow the parameters to randomly vary over individuals (Train, 1998). Furthermore, accounting for heterogeneity enables prescription of policies that take equity concerns into account (Birol, Karousakis et al., 2006). An understanding of who will be affected by a policy change in addition to understanding the aggregate economic value associated with such changes is necessary. Thus, the RPL model which accounts for unobserved, unconditional heterogeneity (Train, 1998), should be used in order to account for preference heterogeneity in pure public goods (Kontoleon, 2003) such as the SWM studies in this choice experiment.

For (Birol, Karousakis et al., 2006), the random utility function for RPL is given by

$$U_{in} = V(Z_i(s + y_n), S_n) + e(Z_i, S_n) \dots \dots \quad (3.5)$$

Where, U_{in} is the total utility for respondent n from choosing alternative I in the choice set. Like the CL model, utility is decomposed into a deterministic component (V) and an error component (e). Indirect utility is assumed to be a

function of the choice attributes (Z_i), with parameters β , which due to preference or coefficient heterogeneity may vary across respondents by a random component ϵ_n and of the social, economic and attitudinal characteristics (S_i). By accounting for unobserved heterogeneity, equation 3.3 now becomes as the probability that individual n picks alternative i from each choice set C :

$$P_{in} = \frac{\exp(\beta V(Z_{in}(S_n + \epsilon_n), S_n))}{\sum_{j \in C} \exp(\beta V(Z_{jn}(S_n + \epsilon_n), S_n))} \dots \quad (3.6)$$

The estimated indirect utility function would be the same as with equation 3.4. Most recently, choice experiment practitioners have started employing the Latent Class Model (LCM) as an alternative model for accounting preference heterogeneity (Birol, Karousakis et al., 2006). This model revealed heterogeneity as a discrete distribution (Czajkowski, K dziela et al., 2012), a specification based on the concept of endogenous or latent preference segmentation (Greene and David Hensher, 2002). In LCM, the population consists of a finite and identifiable number of segments of individuals, each characterized by relatively homogenous preferences (Birol, Karousakis et al., 2006). These segments, however, differ substantially in their preference structure. The underlying theory of the LCM posits that individual behavior rely on observable attributes and on latent heterogeneity that varies with factors that are unobserved by the analyst (Greene and David Hensher, 2002, Greene, 2012). It is assumed that individuals are implicitly sorted into a set of K classes, but which class contains any particular individual, whether known or not to that individual, is unknown to the analyst (Ibid).

Though choosing the number of classes in the LCM is challenging (Birol, Karousakis et al., 2006) it is better than RPL, there is no technical challenges and it is easier to understand and leads to more straight forward estimates and model interpretation is easier (Sagebiel, n.d). With the LCM, the choice modeler can provide names to the classes, see (Czajkowski, K dziela et al., 2012). The number of classes can be chosen by the researcher but one has to keep in mind that the class probabilities are subject to a statistical procedure rather than behavioral assumptions (Kontoleon, 2003). To identify the optimal

number of classes statistically, measures of fit like AIC or BIC are commonly used (Sagebiel, n.d).

According to (Hanley, Wright et al., 2000), after parameters estimation with a better fit models are accomplished, a WTP for each attributes and a measure of economic values can be derived. Given the attribute being sacrificed is a monetary attribute, the tradeoff estimated is known as marginal WTP (Perman, Ma et al., 2003). It demonstrates WTP by any particular respondent to receive more of the non-marketed environmental goods, in our case SWM attributes.

$$imp (WTP) = \frac{S_{nma}}{S_{ma}} \dots \quad (3.7)$$

Where, S_{nma} is the coefficient of any of non-monetary attributes. In estimating the implicit price ceteris paribus assumption should be held. For instance to obtain the marginal rate of substitution between mode of transportation and the monetary attribute, the other non-monetary attributes should be held equal.

However, the marginal WTP estimates convey information only for the WTP of each single attributes; it does not provide any information for the economic surplus arose from a change in status-quo to the proposed alternative scenarios package. Then, the welfare measure from the initial to the improved options can be estimated. Economic surplus measures the change in money income that would make an individual indifferent between the initial level of wellbeing and the new level of wellbeing by considering the individual has the right to choose the status-quo (Othman, 2002). This change in money income reflects the individuals' WTP to obtain an improvement in environmental quality.

Welfare measures for a given SWM interventions package can be estimated by using the estimated coefficients of the attributes in the RPLM with interaction and the levels of the attributes in the different alternative scenarios. By subtracting the value of the improved alternative options from the value of the original level of utility and multiplying the difference by the negative

inverse of the coefficient of the monetary attribute yields the estimates of economic surplus. For (Adamowicz, Louviere et al., 1994), compensating surplus can be derived by

$$CS = \frac{-1}{(S_m)}(V_o - V_1) \dots \quad (3.8)$$

Where s_m is the estimate of the monetary attribute and it is the MU of money income.

3.4 Design of CEA and Application to Debre Tabor Town SWM Improvement

The issue of experimental design⁸ is to maximize the efficiency of the survey via following various procedures & hence extracting information from the respondents subject to the number of attributes, levels and other characteristics of the survey such as cost and length of the survey (Vega and Alpizar, 2011). The central question is then how to select the attributes to be included in the stated preference experiment in order to extract maximum information from each individual (Carlssona and Martinssona, 2002).

The practical issue of CEA is that respondents are presented with a series of alternatives, each varying in terms of the levels of attributes and they are asked to choose their most preferred alternative among several alternatives in a choice set (Hanley, Mourato et al., 2001). The do nothing situation is usually included in each choice sets (Bennett, 2005). This is due to one of the alternative must always be in the respondents current feasible choice set to be able to interpret the results in the standard welfare economics term (Alpizar, Carlsson et al., 2001, Hanley, mourato et al., 2001). In applying choice experiment to value the environmental goods and services, one should follow certain analytical stages (Adamowicz and Boxall, 2001, Adamowicz, Louviere et al., 1998, Alpizar, Carlsson et al., 2001, Hanley, mourato et al., 2001,

⁸ The foundation for any stated preferences experiment is an experimental design. An experiment defined in scientific terms involves the observation of the effect upon a response variable, given the manipulation of the levels of one or more other variables. The manipulation of the levels of the variables does not occur in a haphazard manner rather by design. Hence the name “experimental design” (Hensher, Rose et al. 2005).

Bennett, 2005): Characterization of the decision problem, selection of attributes and assignment of levels, choice of experimental design, construction of choice set, questionnaire development, sampling strategy and sample size, model estimation and reporting the result and policy analysis. In this study, the successful implementation of a CEA had passed all of the above steps.

Improvement in the provision of SWM services are believed to enhance environmental quality and the health of residents. However improvement in SWM per se is nothing, the improvement in SWM can be decomposed in to a combination of several attributes having different values. The demand driven approach was involved in selecting some demand and policy relevant attributes with their respective levels.

In depth interview with randomly selected households, small scale pilot study was held to identify preliminary attributes and their levels. Moreover, consultation with town's cleaning and beautification officials who specialized in SWM, leader of community based association and intense literature review were also implemented. Indeed, more weights were given for those households who were randomly selected followed by leader of community based association who have close intimacy with the households. The most relevant service attributes that were identified in the first stage of attributes selection and assignment of levels were seven. However, when the number of attributes are too many, it is difficult for households to choose from many choice sets (Hensher, Rose et al. 2005). Meanwhile, too few attributes cannot explain the value of SWM well because of small data set. Thus, considering these and consultation with concerned bodies, collection time, frequency of weekly solid waste collection were found to be insignificant and these attributes were dropped in the second stage.

Finally, five SWM attributes were selected for the design of the choice experiment along with monthly service charge which is required to estimate welfare changes. The selected attributes and their levels in the second stage of attributes identification and assignment of their levels are presented in Table 3.1. It was believed that the assigned levels of these attributes were feasible, realistic, easily understandable, span the wide ranges of households' preferences (Hanley, Mourato et al., 2001).

Table 3.1: SWM attributes, their levels and description used in the choice experiment

SWM Attributes	Description	Levels
Mode of transportation	The nature of the technology the service provider use to collect, transport and dispose solid waste.	Status-quo: Animal cart Improved one: Open truck with cart Improved two: Covered truck with cart
Segregation of solid waste at households level	The separation of solid waste by their nature where, solid waste which have the same characteristics can be put under the same category.	Status-quo: No segregation Improved one: Segregation of solid waste as bio and non-biodegradables Improved two: Segregation of solid waste as recyclables and non-recyclable
Service provider	Represent by whom the service would be provided	Status-quo: Private-public Improved one: Private institute service provider Improved two: Public institute service provider
Method of solid waste collection	The system used to collect solid waste	Status-quo: Door to door collection Improved one: Curbside pick-up schedule Improved two: Community bins
Types of solid waste disposal options	Methods of solid waste disposal used	Status-quo: Open landfill with illegal burying Improved one: Open landfill with incineration Improved two: Control tipping
price of delivering the service	Monthly payment levied on each household to cover the cost of handling solid waste	Status-quo ₁ ⁵² : ETB0 & proposed value (ETB 3,5, 8, 10 per month). Status-quo ₂ : ETB 8 & the proposed value (ETB 10, 12, 15, 17). Status-quo ₃ :ETB 15 & proposed value (ETB17, 20, 22,25). Status-quo ₄ :ETB 20 & new value (ETB 21,23, 25,28). Status-quo ₅ : ETB 25 & proposed values (ETB 27, 28, 30,33 per month).

⁵² During the survey, the price charged by the service provider was not unique to households, the choice experiment question was not the same and hence each group was confronted with different choice experiment question. Five different groups prevailed and this attribute did not have unique proposed value for all respondents. Consequently, for all status-quo levels an optimal choice sets or choice cards were prepared.

After the relevant attributes and their levels were identified, the next step was construction of choice sets through experimental design. The combination of different levels of attributes yields different intervention scenario and then choice sets. However, the creation of these choice sets were not in haphazard manner. The random choice sets creation were expected to follow the standard L^{MN} experimental design, containing N alternatives of M attributes of L levels of each (Sanko, 2001). In constructing the choice set from design of experiment, we assured the following basic criterion (WHO, 2012, Jaynes, 2013). Orthogonality: no correlation between attributes levels. Main effect: majority of the variation in the dependent variables were explained by the effect of the variation in a single attribute than their interaction (The effect heredity principle). Level balance: the level of the attribute appeared in equal number of times. Minimal overlap: the levels of attributes were not repeated within the choice set.

The D-efficient design of experiment was applied using the optex procedure in SAS 9.0 to generate the number of individual profiles. In so doing, the status-quo levels of attributes were excluded (Woubishet, 2014). Thus, the number of SWM scenarios that could be generated from five attributes with two levels each and one attribute with 4 levels was 128 ($2^5 * 4$) different alternatives. This full factorial design may lead to very large combinations which could not be practicable and it was more than the respondents could be expected to cope with. In such cases, there is a need to choose a subset of possible combinations (fractional factorial), reduce the number of runs in to manageable size.

Thus, from 128 possible combinations, 16 optimal individual profiles were created. Finally, choice sets were formed using individual profiles, 8 choice sets were constructed using the cyclical or fold-over fractional factorial main effect design. Thus, respondents from different (Five) categories were given with eight choice sets where each choice set stood with three SWM interventions, one was the status-quo and the remaining were improvement in SWM interventions and respondents were asked to choose their foremost option from each choice set. In this way, the presentation of various alternatives in a choice sets were an integral part of the questionnaire. One of the sample choice set is presented in Table 3.2.

Table 3.2: Sample choice set

Suppose these options were the only ones available, which one would you prefer?

SWM attributes	SWM intervention A	SWM intervention B	Business As Usual
Mode of Transportation	open truck with cart	Covered truck with cart	Animal cart
Sorting of solid waste	Sorting as bio & non biodegradables	Sorting as recyclable & non-recyclable	No sorting
Service Delivery Institute	Private	Town's municipality	Private-public
Method of solid waste collection	Curbside	Community bin	Door to door
Method of solid waste Disposal	Control tipping	Open dump and inciration	Open dump and burying
Monthly Service Charge	8	10	0
Tick (X)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

3.4.1 Econometric Specification of the SWM Choice Experiment

Given the said description of the attributes and levels, the conditional indirect utility function can be specified.

$$V_i = ASC + S_1 * colsys + S_2 * sort + S_3 * dlrvy + S_4 * modtra + S_5 * mtdwd + S_6 * price + V_i \tag{3.9}$$

Where V_i is the indirect utility function from choosing alternative i (intervention zero, one and two), ASC stand for alternative specific constant, colsys is for collection system, sort is for sorting of SW, dlrvy is service delivery institution, modtra is for mode of transportation, mtdwd is for waste disposal method and price is for monthly charge, S_1 to S_6 are the coefficients of the attributes. More specifically, the three the indirect utility function can be represented by:

$$V_1 = S_0 + S_1 * colsys + S_2 * sort + S_3 * dlrvy + S_4 * modtra + S_5 * mtdwd + S_6 * price + V_i$$

$$V_2 = S_0 + S_1 * colsys + S_2 * sort + S_3 * dlrvy + S_4 * modtra + S_5 * mtdwd + S_6 * price + V_i$$

$$V_3 = S_0 + S_1 * colsys + S_2 * sort + S_3 * dlrvy + S_4 * modtra + S_5 * mtdwd + S_6 * price + V_i$$

The multinomial logit model formulation is usually a starting point for most choice experiment models. However, it has some limitations, arising mainly from restrictive assumptions about the distribution of the error term and preference homogeneity. Thus, the study employed models that relax this rigid assumption, random parameter logit and latent class model. Then, the extended logit model become,

$$V_i = ASC + S_1 * colsys + S_2 * sort + S_3 * dlrvy + S_4 * modtra + S_5 * mtdwd + S_6 * price + \gamma_1 * HHsex + \gamma_2 * HHmozinc + \gamma_3 * HHeduc + \gamma_4 * HHmar + \gamma_5 * HHage + \gamma_6 * HHcomp + \gamma_7 * HHliv + \gamma_8 * qtysw + \gamma_9 * ocurdzz + \gamma_{10} * HHown + \gamma_{11} * HHsize + \gamma_{12} * HHsats + e_i \dots (3.10)$$

Definitions of variables and their expected sign (Hypothesis)

Where S_1 to S_6 , γ_1 – γ_{12} , are coefficients and e_i is the error term.

ASC: represent for Alternative –Specific Constant and takes values 1 for improved option 1 and 2 in the choice sets and 0 for the status-quo.

HHSex: is a categorical variable and represent sex of the household head or the respondent. The researcher expect female headed households may be more WTP as compared to male headed households, this is due to traditionally sweeping, cleaning the house and dumping SW are exclusively given to females task often assisted with maid.

HHmozinc: it is continuous variable and represents the monthly total income of the household head in the form of birr from all sources. Economic theory and many environmental literatures suggested that there is a positive relationship between income and demand for improvement in environmental quality. Hence, the researcher hypothesized, households' income have significant and positive effect on preferences and WTP for better SWM plans, presuming SWM services is a normal good.

HHeduc: this variable represent educational status of the household head/respondent, which is taken to capture the level of understanding of the respondent about social, economic and environmental challenges of poor SWM system. Household heads with higher level of education can better understand the existing SWM and its impact, care about town's cleanness and environment and positively contribute to WTP comparing households who have low level of education. It is dummy variable; HHeduc take zero if the respondent attends nothing (Not read and write, one, if s/he attend basic school, two, if s/he attend primary school, three for secondary school, four for award college diploma, five for BA and MSc degree.

HHmar: it is the marital status of the household head and a categorical variable taking 0 if the respondent is single, 1 for married and 3 for other. The researcher expects those respondents who are married are more likely to contribute positively for the improvement in SWM practices due to they may have large family size and they are vulnerable to more risk as compared to those who are single.

HHage: it is the age of the household head in years. It is expected to have a positive effect on household's preferences and their WTP for improved SWM plan. This indicates that the probability of a household adopting an improved method increases as the age increases. Meaning as respondents advance in age, they tend to be more conscious of their health and may really concern about managing their waste. They may prefer improved SWM option.

HHcomp: is the composition of the family and dummy variable taking 0 if the composition are more of young and old and 1 if children. The researcher expects that respondents whose family composition is much of children may be WTP pay for improved SWM as compared to others.

HHsize: is a continuous variable representing family size of the respondent. A positive sign is expected for these variables. Households with higher family size are expected to generate more SW and then preferring and WTP for improved SWM interventions than lower family size.

HHliv: is a continuous variable, representing the period spent by the respondent in Debre Tabor town. The direction of influence is expected to be positive; respondents who stay there for long period may WTP more as compared to those respondents who stay for short period.

qtysw: is the total quantity of SW generated per month. There is a local unit of measurement, small sack and plastic bags but more formally this sack

weighted 50 kilogram. The researcher expects those households who generate higher quantity of SW may prefer and WTP more as compared to those respondents who generates lower amount of SW.

ocurdzz: Represent the occurrence of disease in the vicinity like common cold, and trachoma stemmed from mishandling of SW. This is a dummy variable taking one if the respondent were a victim of waste related disease and zero otherwise. The researcher expected high WTP for those households who were a victim of SW related diseases.

HHowzn: is the arrangement of house of the respondent. This is a dummy variable taking 1 if the household is renting the house from kebele, individuals; 0 otherwise (if the household owns the house in which it is living). The study anticipate those respondents who live in their own house may prefer the improvement in SWM more as compared to those respondent who live in renting and others.

Satf: represent perception or satisfaction of respondents by the existing SWM and taking one for those who are satisfied and zero otherwise. This variable is expected to affect WTP for improved SWM negatively. Households who perceive the existing SWM system as good will be less WTP than households who perceive the current SWM system as bad.

4. Results and Discussion

4.1 Descriptive Statistics of the Survey Data

For this study a total of 220 household heads out of which 141 (64.09%) from non-payer and 79 (35.91%) from payer of the resident were interviewed. The total number of observation was 5280 elicited from 220 respondents and one-third of this number was the proportion of selecting one option among the three mutually exclusive interventions from each choice set. Thus, 1760 choice sets were provided from 220 completed questionnaires.

The socio-economic characteristics of the sample units are revealed in Table 4.1. The result showed 52.3% were female headed households and the average years of household stayed in the area was 48.3. The average family size of the household was 4.51. A wide range of responses were recorded for income starting from ETB 300 to 36,000 with mean of 5,450.89. This shows a high

degree of income inequality, where very few people have high income while many are poor.

Respondents were also solicited to rank the importance of various socio-economic sectors among others for source of government revenue. The result in Table 4.2 indicated that the environment sector on average was one of the most important areas next to the public health services and public education and thus, ranked 3rd out of the included eight revenue generating sectors. Majority of the respondents stated, that the issue of solid waste are as important as several other environmental problems such as water, air and noise pollution. As a result, proper SWM is paramount significance aspect of human welfare and can be considered as one component of protecting environmental pollution, can scale-up households' welfare.

Almost all of the respondents reported that they were concerned with SWM issues in the vicinity, and considered themselves as actors to implement good SWM practices and aware of the importance of quality environment. Information on respondents' overall perception to the existing SWM practices were gathered and about 7.3% rated the existing SWM practices as very good, 20.2 % as good, 36.17% deemed it average and 43.5 % as poor and the remaining 29.1 % of the respondent expressed it as very poor. This reflects the current condition of SWM system was the major challenges for the town environment and the residents of the town. On average each household produces nearly 50 kg of solid waste per month, which is really shudder.

The dominant type of solid waste generated (91.8%) comprised biodegradable⁵³. This was due to the nature of the houses in the town is old without maintenance. Although it is known both open dumping⁵⁴ and open

⁵³ Examples of biodegradable solid waste generated in Debre Tabor town were ash, dust particles arose from sweeping house, vegetable peelings, vegetable and fruit related solid waste, onion coats, grasses and straw, food leftovers, stalk of chat and wood, papers, cartons and paper packaging materials etc.

⁵⁴ Of the respondents 36.4% used open dump (nearby dump, gully, river, street and along the road side) and 21.8% used backyard with no lids, and mostly the solid waste is dispersed off by chickens and other domestic animals. This became the source of unpleasant view, odor and resulting for fly breeding sites. About 2.7 % replied that they used illegal burying; appropriate incineration of solid waste is hardly available in

burning are causes to environmental pollution, they were the primary disposal methods of the households in the study area. About 35.4% of the respondents mentioned that they were the beneficiary of the services offered by the community based association. However majority of the respondents were not satisfied with the services delivered due to inefficient service provision, the provision of the service was far below residents' expectation. Respondents strongly complained about the scarcity of skip and proper transfer station site. Even the door to door collectors themselves dumped the solid waste on open spaces and nearby rivers. In addition, there was lack of environmental friendly, advisable and efficient solid waste disposal methods in the town. Picture 4.1 in the Appendix presented to illustrate the existence of these situations.

About 87.3% of households were willing to contribute in the form of labor for achieving proper SWM system in the town. The mean labor participation was 1.15 day per month, or ETB 12, 650 for the sampled household per month & ETB 695, 635 for the whole households per month. The implication was managing solid waste through community participatory approach can reduce operational cost, ensure timely collection, and transportation of solid waste. Active participation of the community had a paramount significance to improve sustainable SWM plans. Hence, any policy to bring about efficient SWM service needs to consider the households' participation in the form of labor effort too.

4.2 Results and Discussion of the Choice Experiment Data

The econometrics software package, LIMDEP10.0 NLOGIT5.0 was used to estimate the three discrete choice models: conditional logit, random parameter logit and latent class model (of the first two with basic and extended models⁵⁵). In the basic model, the basic SWM services attributes in explaining

the study area. Lastly, 3.2% of the respondent employed worker for transporting their solid waste to the out skirt of the town, but they didn't knew from where the worker was actually dumped it.

⁵⁵ In estimating the extended/ hybrid models the ASC was interacted with a set of socio-economic and awareness variables. Where ASC represent the welfare effect that was not captured by the product attributes considered and took value one for the improved SWM interventions, and zero otherwise.

respondents' choice for different SWM interventions were considered. In addition to the SWM attributes, socio-economic and environmental variables as the driving factor of respondents' choice for upswing SWM interventions were considered in the extended models.

In the first step, the simple conditional logit specification were estimated. Both the basic and hybrid CLM (Greene, 2012, Sagebiel, n.d) were statistically significant. However, estimates of the CLM is based on the IIA assumption and preferences homogeneity. The IIA assumption test results presented in Table 4.3 revealed that significance difference was observed from results obtained by holding the IIA assumption and relaxing it. The result indicated that the IIA assumption does not holds true for dropping any one of the option, and the null hypothesis were rejected and we refrained from interpreting CLM's estimates. Consequently, an alternative method of estimation, which does not exhibit the IIA assumption was applied to consider preference variations in terms of both unconditional preference heterogeneity or random heterogeneity and individual characteristics or conditional heterogeneity, that is the random parameter logit model (Train, 1998).

Before estimating the RPL model, the model requires an assumption about the distribution of the coefficients that make choices on what parameters to be randomly distributed and what parameters should be fixed (Hensher, Rose et al. 2005). Thus, all the choice attributes except the payment attribute (Hensher, Rose et al. 2005, Greene, 2012) were specified as random parameters drawn from a normal distribution and gave the reasonable fit model though the appropriateness of distributional assumptions of the random parameters comprised in RPL model is not yet tested (Hensher, Rose et al. 2005). In the estimation of both the basic and the hybrid RPL models a standard or intelligence Halton sequence was applied and 1000 replications (Ibid) were used for the simulation of the random parameters and the simulated log likelihood function was maximized using the BFGS estimator. The RPL models parameter estimates are presented in Table 4.4.

The log likelihood function and the pseudo R^2 values showed the model improved the overall goodness of fit than the standard CLM. The explanatory power of the basic and hybrid RPL model was 35 and 36% respectively.

Therefore, the model best explained the data with interactions from which the interpretation of all coefficients were made. The estimated result of these models revealed that the sign and significance level of the coefficients of attributes were similar with the result of CLM. The mean random parameter estimates of mode of transportation and method of solid waste disposal were significant and possess the expected positive sign. These were the same with results reported by Othman (2002), Tarfas (2007), and Berihun (2010). The implication was that improvements in the levels of these attributes increase the utility of respondents, *ceteris paribus* and thus the likelihood of selecting one of the improved options was higher than the status-quo. While, the mean random parameter estimates for service delivery institute and sorting of solid waste were significant with negative sign. Changes in the levels of these attributes were considered as disutility. Though majority of the solid waste generated in the town were biodegradable, households had shown reluctance for sorting of solid waste due to time and effort cost of sorting, lack of enough space and materials to sort, and rural-urban linkage in terms of demanding compostable solid waste. Thus, in order to improve sorting of solid waste and reduce household solid waste that would be going to disposal site, policy makers should promote intensive public awareness of the benefits of sorting, and provide resources which facilitate sorting at source. Alongside, market and recycling industry should be encouraged and developed which will generate employment opportunities and promote environmental friendly disposal method.

The ASC and price were significant and had a positive and negative signs respectively. The positive sign of the coefficient for ASC indicates that the utility of respondents on average increased as they move away from the existing situation to the suggested interventions. Whereas, the implication of the negative sign of the payment coefficient was that options with lower payment level were more preferred. This was consistent with respect to economic theory; an increase in the cost of the program reduce the demand for it. Furthermore, the derived standard deviations of all random parameters for both the basic and extended model were statistically significant and suggested the spreads of each of the random parameters around their respective means exhibit preference heterogeneity. The data supports choice specific unconditional unobserved preferences heterogeneity for all attributes

considered (Hensher, Rose et al. 2005). Different individuals possessed individual-specific parameter estimates that may be different from the sample population mean. Hence a single parameter estimate like that of the standard CLM was insufficient to represent all sampled respondents.

Among the included socioeconomic and awareness variables, the coefficients for the interaction of the ASC with age, educational level, income, quantity of solid waste generated per month, ownership of the house, satisfaction on the prevailing SWM, sex were statistically significant to affect households WTP and their sign were in previous intuition. However, the coefficients for the interaction of ASC with time spent in the area, occurrence of disease as a result of miss-handling of solid waste at household level, family size, composition of family and marital status were found to be insignificant.

To obtain an enhanced understanding of how various segments of households are affected by the presence of improved SWM programs, the latent segmentation model was used which is a relatively new approach for accounting preference heterogeneity (Kontoleon, 2003). Albeit choosing the number of classes in the LCM is challenging (Biro, Karousakis et al., 2006). Arguing with classes instead of distributions of the population gives more scope for policy recommendations (Sagebiel, n.d).

A balanced assessment of the statistics (Kontoleon, 2003) should be done, and AIC statistics (Sagebiel, n.d) was used to determine the optimal number of segments and reported in Table 4.5. The value started was the usual basic CLM. The log likelihood and Pseudo R^2 statistics improved as more segments were added to the model, supporting the existence of multiple segments in the sample. However, the LCM with two segment solution provided the reasonable fit to the data since, though, AIC decreased and Pseudo R^2 increased as segments were added, the marginal changes were smaller from 2 to 3 and from 3 to 4 segment, and decreased when segment 5 and 6 were added to the model.

The relative size of each segment was estimated and provided the series of probabilities that each respondent belongs to either one of the two segments. The respondents were assigned to one of the segments on the basis of their

largest probability score (Birol, Karousakis et al., 2006). It was found that 81.6% of the respondents belong to the first segment and 18.4% belong to the second segment.

The result of the two segments LCM are reported in the Table 4.5. No matter which model is considered, the estimated coefficient of price was statistically significant and negative for the two classes. For segment one the utility coefficients for all SWM attributes were significant determinant of respondents' choice. Alike the CLM and RPLM, the parameter estimates of the mode of transportation and method of solid waste disposal in the first segment were positive, suggested that households positively preferred these attributes to be part of the improved SWM program. Whereas, method of solid waste collection, sorting of solid waste and service delivery institute were negatively preferred and improvements in these attributes increased the disutility of the respondent.

Segment two was distinct and the household were in different to all of the SWM services attributes considered in the choice experiment survey. Except the monetary attribute, the remaining SWM attributes were insignificant. The implication was that the existence of bipolar or bimodal preferences for some attributes between groups of the resident in the town. For instance, in segment one the parameters for method of solid waste disposal was positive and negative in class two though it was statistically insignificant.

This was also held true for some of the other attributes across classes although they were insignificant. The existence of such kind of preferences by respondents for the same attributes could lead to insignificant parameters in simple standard models (Sagebiel, n.d). This was true for method of solid waste collection, which was significant for LCM, in class one and insignificant in CLM and RPL models. In conclusion, respondents in the first class were highly preferred the improved SWM options as ASC was highly significant. While, the second class respondents were indifferent between the status-quo and the improved options. This was reflected by the statistically insignificant estimate of ASC.

To find the best statistical fit for this data, we had tried out different utility specifications, chose one based on certain criteria and then began interpreting then estimation results. Indeed, comparison of the three models relied on the estimates of the basic model. It was not made for the three hybrid models as the estimated variance matrix of estimates in LCM was singular when the auxiliary variables were considered. Here we applied, choice experiment data result of the LCM was statistically superior over the basic CLM and RPLM in terms of the log likelihood function, pseudo R^2 , the AIC and consideration of the bimodal preferences(Greene and David Hensher, 2002). This result may indicated the fact that the LCM can provide added information that was not conveyed in the other two models (Birol, Karousakis et al., 2006).However, the selection of the choice model relies on the purpose of the study and a priori assumption about the nature of the sampled households. Since identifying the socio economic driving factors of respondents' choice for improved SWM intervention was one of the research objectives, interpretation of parameter estimates and welfare measures were based on the estimated result of the RPLM with interaction.

4.2.1 Estimation of the Marginal WTP Values and Compensating Surplus

The table in the appendix reports the implicit prices for each of the SWM attributes estimated using the Wald procedure (Delta method) (Karousakis and Birol, 2006, Greene, 2012). For comparisons, WTP were calculated using the estimates of all models. Thus, estimates of each attribute revealed that the WTP estimates from the three models were significant at 5% significance level (Except for the WTP for the solid waste collection system attribute for the CLM and RPLM). The relative importance of attributes remains consistent for basic and hybrid CLM, and RPLM.

Specifically, results from Table 4.6, revealed that the marginal WTP for mode of transportation was ETB 1.969. This means households on average were WTP an additional charge of ETB 1.969 per month if mode of transportation is improved from status-quo the suggested options. The marginal WTP for sorting of solid waste can be interpreted as the net increased in disutility (cost) worth ETB -1.015 associated to a change from the status-quo to the improved.

It is natural that sorting of solid waste is good for those households who are engaged in recycling and reusing activities. However in most developing countries like Ethiopia, market for reusable and recyclable materials are not well developed and residents in Debre Tabor town were not preferred and WTP for the improvement in this attribute. The implication in terms of relative importance of attributes, mode of transportation ranked top followed by solid waste disposal method, service delivery institute and sorting of solid waste. Thus, any policy maker intended to bring efficient and sustainable SWM can allocate scarce resources in favor of the foremost attributes.

In order to compute the economic welfare, nine hypothetical alternative scenarios with their attribute levels were considered and compared with that of the “business as usual” scenario.

The welfare measure, compensating surplus indicates the amount that respondents are WTP in order to experience an improvement in their utility. As such, respondents were WTP ETB 55.183 per month when the levels of all attributes are highly improved, and would be higher for scenario 7 (58.41 per month), Table 4.7. The welfare of the society improves while there is improvement in solid waste management interventions. In conclusion, the CEA can be applied to evaluate a range of alternative resource use scenarios in SWM. Given the potential of choice experiment question and households preferences towards improved SWM, any concerned body would be able to identify the most feasible and policy relevant SWM scenarios that yields the greatest net benefit to the community. By then, the mismatch between demand and supply side of SWM would be reconciled.

5. Conclusion

It is undoubtedly important to note that adequate SWM is vital and provides remarkable benefits for the urban households that should be given top most priority in order to have quality environment and maintain the health of the residents. However, for successful implementation of adequate SWM plans, residents preferences and their WTP for improved SWM should be considered. The main aim of this study was to analyse the preferences of households' for improved SWM interventions and estimate the WTP using a

CEA. Data from choice experiment survey questionnaire was collected from 220 households. In addition to the standard conditional logit model, the random parameter logit and the latent class logit model were employed. The result of the standard CLM and RPLM revealed that except solid waste collection system, all attributes were significant, and mode of transportation and method of solid waste disposal had positive sign, implied the upswing in these attributes could boost the welfare of the respondents. Whereas, the service delivery institute and sorting of solid waste attributes had negative relationship to the WTP, respondents did not WTP for the improvement in these attributes. Moreover the result of this study indicated that factors related to socioeconomic and environmental variables were responsible for households' choice of any one of the improved SWM interventions.

Results from the RPL and LCM proved that heterogeneity prevailed over the whole sample and between classes respectively. Unlike other models, results from the first class in LCM revealed that all attributes were significant in which households had positive preference for mode of transportation and method of solid waste disposal and negative preferences for solid waste collection system, sorting of solid waste and delivery institute. Meanwhile, all attributes were insignificant in the second class and respondents were indifferent between the in situ condition and the improved SWM alternative scenarios. This reflects the existence of bipolar preferences' between groups of the resident. In general, it was found that a significant group of respondents preferred the improved SWM interventions.

The marginal WTP of the SWM attributes for the three models showed that respondents gave more value for mode of transportation followed by method of solid waste disposal. Further, the estimates of welfare measure, WTP for the improved SWM intervention confirmed the indispensability of proper SWM practices to the welfare of the community. This result can be used to reconcile the mismatch between the demands for the supply side of SWM. Therefore, any concerned body needs to take measures to improve the aggregate welfare by making improvements in the existing SWM practices. This would be true if due consideration are given to households' preferences for SWM interventions.

Finally, the methodological issue of the whole practices made in this study clearly showed that CEA can be successfully applied in the context of environmental valuation and developing countries. With careful identification of demand relevant attributes, construction of the optimal choice sets, appropriate identification and then specification of models, choice experiment can successfully be used in identifying households' preferences for proposed policy options and then forward policy relevant information about SWM alternative. The methodology is unexploited yet and researchers should deem this approach to investigate the public preferences for non-marketed environmental resources.

Policy Implications

Based on the result found, the following policy implications were forwarded. There is considerable preference heterogeneity within households in Debre Tabor town. Thus, any policy makers intended to bring efficient SWM should take into account information about households' preferences ahead of designing appropriate SWM plan in the town. The implication of household's contribution for SWM attributes and options were that the service provider can generate income from households to enhance SWM system and at the same time reduce the cost of handling solid waste and then the disparity between the demand for and the supply side of the SWM can be settled. Households were also willing to participate in the form of labor and this can be much fruitful in improving SWM. Thus, any policy to bring about efficient SWM service needs to consider households' participation in the form of labor effort too.

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Appendix

Table 4.1: Descriptive statistics for selected variables of the respondents

Qualitative Variables	Labels	Percentage
Sex of the household head	1, if female, 0 otherwise	52.3
Marital status of the household head,	1 if married, 0 otherwise	78.2
Composition of the household,	1, if many of composition are children, 0 otherwise	30.9
Housing arrangement of the household	1, if rented, 0 otherwise	18.2
Educational level of the household head	1, if not attend any school, 0 otherwise	26

Quantitative Variables	Minimum	Maximum	Mean	Std.dv
Age of household head	22	78	44.08	12.486
The number of family size	1	10	4.51	1.908
Time spent in the area in years	1	70	25.33	17.709
Monthly household income in ETB	600	36000	5450.89	5080.798

Source: Authors' Computation from Field Survey Data, 2016

Table 4.2: Important sectors as sources of government revenue

Sectors	No. of respondents	Mean	St.dv	Rank
Protecting the natural environment	220	3.20932	.0216856	3
Public health service	220	2.74086	.0224713	1
Public education	220	2.823073	.0224347	2
Crime prevention	220	5.126918	.0225856	6
Poverty/ unemployment reduction	220	5.276946	.0267377	7
Housing service	220	4.881985	.0288294	5
Expanding basic infrastructure	220	4.795416	.0324675	4
Public defense	220	7.027467	.0212004	8

Source: Authors' Computation from Field Survey Data, 2016

Table 4.3: Hausman and Mc-Fadden test of IIA assumption for CLM

Intervention excluded	X-square	d.f	Number of observation skipped due to exclusion	Pr(C>c)	Remark
Intervention one	32.2	7	815	0.000003	Violated & H ₀ was rejected
Intervention two	25.07	7	604	0.000739	Violated & H ₀ was rejected
Intervention three	22.53	7	341	0.002079	Violated & H ₀ was rejected
# of respondents	220				
# of observations	1760				

Source: Debre Tabor Town SWM Improvement Choice Experiment Survey

Table 4.4: Result of the basic and hybrid RPL models

SWM attributes & Variables	Basic RPL Model			Hybrid RPL Model		
	Coeff.	St.err	P-value	Coeff.	St.er	P-Value
<i>Random parameters in utility functions</i>						
Collection system	-.21037	.36876	.5684	-.21696	.19323	.2615
Delivery Institute	-.28388***	.07465	.0001	-.27512***	.06652	.0000
Method of Disposal	.30235***	.07428	.0000	.26004***	.07162	.0003
Mode Transportation	.37481***	.08005	.0000	.33723***	.07481	.0000
Sorting of SW	-.18572**	.08946	.0379	-.17383**	.08364	.0377
<i>Non- Random parameters in utility functions</i>						
ASC	3.87744***	.41209	0.0000	9.15338***	2.05213	.0000
Price	-.17718***	.01690	.0000	-.17125***	.01592	.0000
ASC*Age				.04128*	.02318	.0750
ASC*Composition				.65849	.46960	.1608

ASC*Education				1.01999***	.14428	.0000
ASC*Income				.00018**	.8603D-04	.0334
ASC*Live				.00703	.01559	.6523
ASC*Martial Status				.17382	.30106	.5637
ASC*Occurrence of dzz				-.39267	.38620	.3093
ASC*Own House				-.69923***	.25163	.0055
ASC*Quantity SW				.02238***	.00747	.0027
ASC*Satisfaction				-12.8035***	2.73214	.0000
ASC*Sex				.79727*	.41435	.0543
ASC*Size				-.00426	.11093	.9694
<i>Derived standard deviation of parameters distribution</i>						
<i>NsCOLSYS</i>	3.91613***	.51097	.0000	2.62549***	.27420	.0000
<i>NsDLVRY</i>	.44718***	.12964	.0006	.32462***	.08953	.0003
<i>NsMTDWD</i>	44541***	.13109	.0007	.43399***	.11168	.0001
<i>NsMODTRA</i>	.63369***	.12752	.0000	.57627***	.11112	.0000
<i>NsSORT</i>	.36065*	.19138	.0595	.36228***	.10336	.0005
Summery statistics						
Number of observation			1760			1760
Number of respondent			220			220
Log likelihood function			-1253.36845			-1223.12773
Null model	-1933.55763			-1923.67012		
Pseudo R ²	.3496			.3598		
iteration completed	25			47		
Chi-Square	1360.37836 [sig. 000000]			1343.07319 [sig.0000000]		
AIC	= 1.438			1.424		

Note: nnnnn.D-xx or D+xx => multiply by 10 to -xx or +xx. And ***, **, * ==> Significance at 1%, 5%, 10% level.

Source: Authors' Computation from Field Survey Data

Table 4.5: Criteria for determining the optimal number of segments and result of LCM

Test	Number of segments				
	2	3	4	5	6
Loglikelihood function	-	-	-	-1078.46	-1092.28
Chi-square	1471.318	1557	1712.56	1710.195	1682.554
AIC	1.378	1.339	1.259	1.27	1.295
Pseudo R ²	.377	.398	.4379	.436	.427
Result of LCM	Coefficients		Std.err	P-value	
Utility parameters in latent class -->> 1					
ASC 1		3.73361***	.32616	.0000	
Collection system 1		-.26770**	.13554	.0483	
Delivery institute 1		-.21249***	.05828	.0003	
Method of SW disposal 1		.29353***	.05966	.0000	
Mode of transportation 1		.38810***	.05791	.0000	
Sort of SW 1		-.14667*	.07587	.0532	
Price 1		-.13963***	.01448	.0000	
Utility parameters in latent class -->> 2					
ASC2 2		.71632	2.51599	.7759	
Collection system 2		.08926	.70478	.8992	
Delivery institute 2		-.14573	.57564	.8001	
Method of SW disposal 2		-.25152	.87911	.7748	
Mode of transportation 2		.44131	.71322	.5361	
Sort of SW 2		.65678	.90156	.4663	
Price 2		-1.61837***	.32363	0.0000	
<i>Estimated latent class probabilities</i>					
Average class probability for class one		.81545***	.02636	.0000	
Average class probability for class two		.18455***	.02636	.0000	

Note: ***, **, * ==> Significance at 1%, 5%, 10% level

Source: Authors' Computation from Field Survey Data, 2016

Table 4.6: Mean marginal WTP for the three models of improved SWM interventions

SWM Attributes	Basic CLM	Hybrid CLM	Basic RPL	Hybrid RPL	Basic LCM Class1	Class2
	Coeff. (S.e, P-value)	Coeff. (S.e, P-value)	Coeff. (S.e,p-value)	Coeff. (S.e,P-value)	Coeff. (S.e,P-value)	Coeff. (S.e,P-value)
Collection system	-1.111 (.738,.1326)	-1.183 (.762, .1209)	1.187 (2.08,.5688)	-1.266 (1.145,.2687)	-1.917** (.07, .02)	.05 (.32,.21)
Delivery Institute	-1.513*** (.435, .000)	-1.5*** (.43, .0005)	-1.602*** (.433,.0002)	-1.606*** (.408,.0001)	-1.521*** (.15, .0000)	-.09 (.04, .78)
Method of Disposal	1.982*** (.442, .0000)	2.027*** (.438,.0000)	1.706*** (.432, .0001)	1.518*** (.430,0.0004)	2.1*** (.017,.0000)	-0.15 (.47,0.18)
Mode Transportation	2.694*** (.473,.0000)	2.694*** (.468,.0000)	2.115*** (.486,.0000)	1.969*** (.468,.0000)	2.78*** (0.12,.0000)	.27 (.68,.29)
Sorting of solid waste	-1.084** (.518, .036)	-1.025** (.516, .047)	-1.048** (.513,.0412)	-1.015** (.499,0.422)	-1.05* (.008,.09)	0.4 (.27, .44)

Note: ***, **, * ==> Significance at 1%, 5%, 10% level

Source: Authors' Computation from Field Survey Data.

Table 4.7: Estimation of compensating surplus for various SWM intervention scenarios

SWM Scenarios	SWM attributes			Compensating Surplus	
	Mode of transportation	Sorting solid waste	Disposal method	Delivery institute	ETB per month
Baseline	Cart	No sorting	Open dump & illegal burying	Private-public	-
1	Cart	Recyclable& non recyclable	Control tipping	Public	50.1
2	Open truck with cart	Bio & non bio degradable	Open dump & illegal burying	Private	52.3
3	Open truck with cart	recyclable & non recyclable	Open dump & icineration	Private	53
4	Open truck with cart	No sorting	Open dump& icineration	Private	55.33
5	Covered truck with cart	recyclable & non recyclable	Control tipping	Private	56.79
6	Covered truck with cart	No sorting	Control tipping	Public	57.213
7	Covered truck with cart	recyclable & non recyclable	Control tipping	Private-public	58.41
8	Open truck with cart	Bio & non-biodegradable	Open dump& icineration	Private	54.316
9	Covered truck with cart	recyclable & non recyclable	Control tipping	Public	55.183

Source: Authors' Computation from Field Survey Data, 2016

Picture 4.1: Partial view of inadequate solid waste disposal methods in Debre Tabor town



Source: Author's photograph during main and pilot survey, 2016.

Productive Technical Efficiency of Ethiopian Basic Metals and Engineering Industries: A Stochastic Frontier Approach

Yibeltal Gelaye¹

Abstract

This study figure out the level of technical efficiency and determinants of the Ethiopian Metals and Engineering industries overtime using stochastic frontier production function model. All the parameters of the frontier function and the inefficiency model have been estimated simultaneously using maximum likelihood estimation. The study considered one hundred forty six Metals and Engineering industries over the period of 2010 -2014 using firm level unbalanced panel data. The empirical result indicates that the time varied Translog functional form with maximum likelihood estimation better explains the production behavior of the Metals and Engineering industries .The study estimates the average technical efficiency of the Metals and Engineering industries is 55.3%.Therefore, the results indicate that there is a great potential exists for Metals and Engineering industries to further increase the value of production by 44.7% using the available input, technology and technical efficiency improvement, thereby reducing the cost of production. It is noted that out of the four technical inefficiency factors included in the Translog model there were only two factors (investment intensity and labour capital ratio of firms) had significant effect on technical efficiency. The study further identifies that the average technical efficiency of Metals and Engineering industries vary among the industries and yearly average seems to be unstable during the study period. Therefore, in order to effectively utilize the potential of the industries, efforts have to be made in improving investment intensity, financial and non-financial capital access, availing raw material access and infrastructural and institutional development.

Keywords: Basic Metals and Engineering industries, stochastic production function, Technical efficiency, Ethiopia

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1. Introduction

The iron and steel or in Ethiopian case named as Metals and Engineering Industry (MEI) industry is core industry for any nation's sustainable development. Metals Industries are concerned with the refining and production of raw metal and primary metal products, i.e., the production of metal from ore, scrap and conversion of billet, slabs etc. into primary metal products such as metal sheet, tubes, bars, wires, cables and nails; while Engineering Industries are industries which use these metal products as an input and fabricate them into various engineering products such as metallic structures, tanks, pressure vessels, machine parts, machineries, transport equipment, electrical and electronic equipment, measuring and control instruments, and others (MPDC, 1999 G.C).

Globally, the industry is the second largest industry worldwide after oil and gas with an estimated turnover of 900 billion USD per annum. Over the last 35 years, the industry has shown significant changes. In 1980, 716 million tons of steel was produced and the leading producers were Russia (21%), Japan (16%), USA (14%), Germany (6%), and China (5%) of global steel production. However, in 2014 the leading country has changed significantly, i.e., China ranks first and far ahead of other countries (60% of world steel production), and then followed by Japan (8%), USA and India (6%), South Korea and Russia (5%), Germany (3%), Turkey, Brazil and Taiwan (2%); and the world steel production reached 1665 Million tons (World Steel Association, 2015).

The Africa region, even though has two larger producers of steel; South Africa and Egypt which they are lacking capacity to supply the rest of the continent, import steel to fulfill the demand for the growing construction and infrastructural development around every corner of the continent. From the period of 2006-2012 the top five Sub-Saharan Africa countries Nigeria (20%), Angola (12%), Kenya (10%); and Ethiopia and Ghana each (8%) comprises a total of 58% share of the net import of steel of the entire continent (World Steel Association, 2014).

The level of per capita consumption of steel is treated as an important index of the level of socio economic development and living standard of the people in any country. Taiwan-China (837.1 kg), Czech Republic (582.4 kg), Japan (531.7 kg), China (510 kg), and Germany (473.9 kg) were the top five highest steel per capita consumers of the world in 2014. Among the African average steel per capita consumption of 32.4 kg in the same period; Egypt (122.1 kg) and South Africa (97.5 kg) were the two registered highest steel per capita consumption (World Steel Association, 2014).

Metals are used in every important industry: energy, construction, automotive and transportation, infrastructure, packaging and machinery, defense and heavy engineering. Besides, it is closely related to the chemical and light industry, it also delivers materials for renewable energy such as thermal, solar and tidal power. The construction sector is the largest steel consuming sector; accounting for about 52.2% of the global steel use in 2013. The other two sectors: Machinery and Automotive are also key steel consuming sectors, absorbing 14.2% and 11.6% of the global steel consumption respectively (World Steel Association, 2014).

Ethiopian metals and engineering industry comprises both medium and large number of state-owned enterprises including the newly established metals engineering corporation (METEC) and growing number of private sector participants that have flourished recently. According to the Central Statistical Agency, recently there are 241 medium and large scale sized firms of metals and engineering manufacturing producers. The distributions of establishments are by regional state as well as in the two city administration of Addis Ababa and Dire Dawa (CSA, 2014).

According to the 2015 annual report of Metals Industry Development Institute, Ethiopia's metals and engineering industries have been engaged in the areas of manufacturing Sheet metal cutting, galvanizing, cold rolling and corrugation plants; Tube and hollow section and Cold sheet metal rolling mill plants; Reinforcement bar rolling mills, wires and nail plants; Aluminum profile for window and door manufacturing plants; mechanical workshops for sheet metal and structural fabrication; truck body, bus body, trailer body, tankers

manufacturing plants; Mechanical workshop for reconditioning of engines and part manufacturing plants; and Electric wire and cables, transformers, etc.

The basic metals industries are providing the required raw material to all engineering industries engaged in the manufacturing of components, spare parts, and other capital goods etc. The construction sector consumes concrete reinforcement and pre-engineered buildings, hollow sections, corrugated iron sheet, electric and communication cables, aluminum profiles, wire rods, nails and wires, etc. The agricultural sector is also a consumer of the output of these industries such as structures for green house, pipes for irrigation, etc for its requirements (MIDI², 2015).

However, the least developed traditional Ethiopian economy, the contribution of industry particularly, the metals and engineering industry to the overall GDP is the lowest as compared with other sectors. This is due to the sub-sector is characterized by inefficiency and low level of productivity growth which shows a stagnant value added (MPDC, 1999 E.C).

In Ethiopia, started from the 19th century onwards due to the emergence of a strong central government and political state, modern manufacturing has been started. During the imperial era; the government formulated the 1950's industrial development strategy proclamation based on import substitution; to facilitate the introduction and expansion of the industrial sector. However, due to its shortcomings it was revised in 1964. As a result of these, few numbers of manufacturing enterprises such as the Ethiopian Iron and Steel Foundry and Akaki Steel Industry were established to process reinforcement bars and corrugated sheet, Kotebe Metal Tools Factory and several sheet metal fabrication shops were also established towards the end of the imperial era (MPDC, 1999 G.C).

During the Derg era, the metals and engineering sub-sector was organized under National Metal Corporation which then established industries in the areas of industrial spare part, Tractors and Pumps. After the Derg period; the

² Metals Industry Development Institute established by the government for the promotion of MEIs

current government through the Agricultural Development-Led-Industrialization (ADLI) strategy carries out an economic development strategy with the central objectives of increasing agricultural production through the use of modern inputs and creating sufficient market for industrial products. Production of goods for overseas markets and export standard is also seen as strategy to increase competitiveness of local industries. In line with this framework there has been a number of manufacturing industries established in the areas of metals and engineering subsector (MPDC, 1999 E.C).

The Metals and Engineering Industries are heavily relying on imports since the industries are not developed enough to meet the emerging demand from user industries both quantitatively and qualitatively. The total value of imported metals and engineering products in 2012 amounted Birr 19.64 Billion while the domestic production was 126.45 Billion Birr, i.e., the country covers only 37.9% by the domestic production. In the same year the country's per capita steel consumption was 12 kg which is still low. However, there has been a recently growing up in the output of the sub-sector due to the massive investment taking place in the country, especially construction and public sector infrastructure investment led by METEC³ and other public and private firms in supplying the existing domestic demands of large construction and infrastructural projects like large trunkway sugar factories, hydroelectric and irrigation dams, etc, and the trying of light machinery development locally rather than imported (MIDI, 2014).

By 2014, the Ethiopian government formulated a second five-year strategic plan called the "Growth and Transformation Plan" GTP-2 with the objective of bringing development in the country. The improvement of the efficiency of the manufacturing sectors is an essential aspect in the process of achieving the desired target of development. The metals and engineering sub-sector is among the sub-sectors in the manufacturing which has role to the attainment of the GTP target in line with by minimizing the inefficiency and increasing the volume of production; substitute the imported products and improving domestic designing and engineering capacity in order to support other

³ Metal Engineering Corporation a government owned corporation

domestic manufacturing. Thus, the government gives special attention to domestic improvement of efficiency in the factors of production (Ermias, 2013).

The contribution of the industrial sector to the country's GDP (12%) is small as compared to the other sectors while the growth rate (18.5%) of the sector is the highest of all. Among the industry sector, the contribution of manufacturing and construction to GDP was 4.2% and 5.6%. Due to its inefficiency the production and productivity of the manufacturing sector is low (MOFED⁴, 2014).

The economic policy formulation at macro or micro level of every country needs the analysis of efficiency level of every manufacturing activity. In particular, the impact of technical efficiency give some guidance in order to develop policies aiming to achieve growth and increase the GDP share of the manufacturing sector, in particular the metals and engineering sub-sector. It helps to understand whether gains in industry productivity levels are achieved through the efficient use of inputs or through technological progress (Melaku, 2013).

However, despite the critical importance and need of the efficient metals and engineering firms to the Ethiopian economy, there is hardly possible to find any studies of analytical nature in the areas of MEI of Ethiopia. But there have been studies in other sub-sectors of the manufacturing sector and also studies at the country's overall manufacturing industries. Melaku (2013) by conducting an empirical study using stochastic frontier analysis pointed out that there is large inefficiency in the Ethiopian manufacturing in general. Likewise, Gezahegn (1987) figure out that efficiency is a major problem of state owned textile industries in Ethiopia. On contrary, countries like China has been given due attention for the sector and the researcher of this paper found out research papers in this regard such as; J. W. Kim et al (2005) were examined the technical efficiency and the factors contributing to the efficiency of 52 iron and steel industry of china using a time-varying stochastic frontier

⁴ The name is changed to Ministry of Finance and Economic Cooperation (MOFEC) in 2016.

model. The highest efficiency level was 97%. Degree of privatization, adoption of new technology and equipment were critical to the pursuit of efficiency in the iron and steel industry. Additionally, (Wu, 1995) using time-varying production frontier model estimate firm-specific technical efficiency and analyze the impact of firm attributes on productive performance. He took vintage capital, economies of scale, enterprise ownership and location and found that there were ample scope and space for efficiency improvement at the industry level and the efficiency gains might be possible by closing the gap between the coastal province and the rest of the country.

Actually, little or no attention has been given to the analysis of the technical efficiency of resources in the Ethiopian metals and engineering industries, in spite of the potential and strategic benefits, i.e, long term implication on the economy by creating a better enabling environment for the advancement of industrialization and downstream technologies (Kyoji, 2010). This may be gained by proper identification of the extent, causes and possible remedies of production technical efficiency in the sub-sector. Therefore, this study aims at assessing the level of technical efficiency of the sector and their determinants at firm level.

2. Methodology

2.1 Data and Description of Variables

Data

The study used firm level unbalanced panel data of large and medium scale (LMSM) Metals and Engineering manufacturing industries collected annually by the Central Statistics Authority (CSA) for the period of 2010 –2014 (note that 2010-2014 is chosen in this study for keeping the uniformity and it represents the period of 2002-2006 in Ethiopian calendar assuming that the period is past). The annual surveys conducted by CSA covers all manufacturing establishments either by private or government ownership that employ at least 10 workers and use fuel and electricity in their production. Each firm level survey comprises the data items such as gross value of output, value of fixed capital, wages and salaries of employee, cost of raw materials, cost of fuel and energy, ownership status, age, location, and a range of other related and relevant information.

Prior to using the data which represents the metals and engineering sub-sectors, a series of data consistency and data availability checks were performed and inconsistent data is left out. Accordingly, the final sample observations consists of 146 metals and engineering firms categorized under the three sub-sectors; Basic metals manufacturing, fabricated metal product manufacturing short for fabricated metal products, except machinery and equipment and Structural metal manufacturing short for manufacturing of machinery and equipment. This classification is adopted by the CSA which uses the International Standard Industrial Classification of All Economic Activities (ISIC). The following table (Table 2.1) shows the sample distribution of firms over the panel period.

Table 2.1: Number of Metals and Engineering firms covered in the study period

S.No	Sub-sector Industry	2010	2011	2012	2013	2014
1	Basic Metals Manufacturing	34	34	25	35	34
2	Structural Metal Manufacturing	98	57	96	94	95
3	Fabricated Metal products Manufacturing	11	14	13	17	17
	Total	143	105	134	146	146

Source: Filtered from CSA

Each respective firms covered in this study use their own respective raw material and technology and produces their own product categorized under basic metals product manufacturing, structural metal product manufacturing and fabricated metal product manufacturing. These are the categories which largely dominate the sub-sector manufacturing sector of Ethiopia by employment, production, and value added.

Description of Variables

In the study, the following variables were considered to estimate the production efficiency scores of basic metals and engineering manufacturing industries.

1. **Gross Value of Output (Y_{it}):** total production output of a firm is measured either in gross value of output or in terms of value added expressed as in ton of Birr. Production is the result of the interplay of capital, raw materials, labour, fuel and energy and other inputs. The study assumes that a single firm produces a single product. Hence, gross value of output of a firm in birr used as a dependent variable.
2. **Fixed Capital (X_{1it}):** represents those assets of the establishments with a productive life of one year or more. It shows the net book-value at the beginning of the reference year plus new capital expenditure minus the value of sold and disposed machineries and equipment and depreciation during the reference period.
3. **Labour (X_{2it}):** in the frontier productions the amount of wages and salaries paid in birr to the workers in each time are proxies for the labour input. This variable includes all payment made to permanent and temporary workers during the study period.
4. **Cost of Raw Materials (X_{3it}):** this includes all cost of material used in the production process measured in birr.
5. **Fuel and Energy (X_{4it}):** used in production process that affect the technical efficiency of metals and engineering industries since these industries are highly dependent and consumed energy as a means to transform input to outputs. The monetary value of fuel and energy expressed in terms of Birr was considered.

Knowing that firms are technically inefficient might not be useful unless the sources of the inefficiency are identified (Admassie and Matambalya, et al, 2002). Thus, the second objective of this analysis investigates the sources of the firm level technical inefficiency for the industries.

Since economic theory does not offer us a clear model to explain the determinants of technical efficiency, the study does not aim to find causal relations but only correlation between efficiency and a set of variables. Therefore, in order to suggest relevant policy ideas; identifying the factors responsible for technical inefficiency is an essential component of efficiency analysis.

The following variables were used to identify the sources of inefficiency of the firms.

1. **Investment Intensity:** it is measured by the ratio of net capital additions of the firm during the year to total employment. The expected positive relationship is not confirmed, i.e, got negative relationship.
2. **Labour-Capital Mix:** measured by the ratio of labour expressed in terms of wages and salary to fixed capital of the firms. Based on the assumption of surplus labour found in this country the expected sign was negative implying labour intensive manufacturing practices and the result is also confirmed.
3. **Distance:** this term is measured by the distance of industries from the main capital city, Addis Ababa. This variable is included in the inefficiency model to examine whether the location of a firm within sub-sector matters in determining the technical inefficiency of firms. And the expected negative sign as a source of inefficiency was not confirmed.
4. **Age:** firm age is included to capture the effect of experience on the technical inefficiency of industries. Included in the model because of the strong diminishing returns in the learning by doing process so that the gains in technical efficiency from experience eventually exhausted Lund Vall and Battese (1999). The expected positive relationship as a factor of technical inefficiency was confirmed. It is measured with the number of age a firm has lived started from the establishment to the end of the panel period (2014).

Model Specification

From the different literatures reviewed, the concept technical efficiency was defined simply as the ratio of actual output to the maximum output attainable (often called a frontier) with the given amount of inputs. As a measurement of performance, frontier analysis has been widely used not only in commercial firms, but also in many other economic areas, such as electricity, education, hospital, and public transportations.

All producers are assumed to attempt to obtain the optimum outputs, but not all of them can obtain the optimum result. Thus, the frontier describes the optimum result that producers want to and can produce given the technology

level which describes efficiency as the distance between the frontier and the observed result producers actually get. Amongst the economists to suggest reasons for under-performance were Kumbhakar and Lovell (2000), where agency problems arising from asymmetric information are cited as being major reasons why producers may show a lack of constraint concern when analyzing the producers' performance.

Early studies of technical efficiency were based on the deterministic frontier model suggested by Aigner and Chu (1968), but this model cannot account for the random factors that may move production off the frontier. Subsequently, various stochastic production frontier models were introduced to take these factors into account (Woe, Lee, et.al, 2005).

Studies done by Debreu (1951), Shephard (1953), Aigner and Chu (1968) and Kumbhakar and Lovell (2000) had influenced by the development of Stochastic Frontier Analysis (SFA). It was originally introduced by Meeusen and Van Den Broeck (1977) and Aigner, Lovell and Schmidt (1977). Their initial work was done by a cross-sectional data set. The panel data estimation analysis is then extended by the work of Pitt and Lee (1981), Schmidt and Sickles (1984), Kumbhakar (1990), Battese and Coelli (1988, 1992, 1995) and Hamit Hagggar (2009).

The study employed the productions function of panel data fitted as an output function to estimate the technical efficiency of Metals and engineering industries. It specified the production frontier proposed by Battese and Coelli (1995) which defines output as a function of a set of inputs together with technical inefficiency of production. In the model these inefficiency effects are modeled in terms of other observable explanatory variables and all parameters are estimated simultaneously. According to Kumbhakar S.C et al (2012), the inefficiency specification used by Battese and Coelli (1995) is most frequently used in empirical studies. Their model allows inefficiency to depend on some exogenous variables so that one can investigate how exogenous factors influence inefficiency. The panel data model of Battese and Coelli (1992) is somewhat restrictive because it only allows inefficiency to change over time exponentially.

The general representation of the panel data model employed in the study is:

$$\ln Y_{it} = X_{it} \beta + V_{it} - U_{it} \quad (2.1)$$

Where;

Y_{it} , denotes the output of i^{th} firm with cross sectional unit ($i = 1, 2, \dots, 146$) at time t^{th} observation ($t = 1, 2, 3, 4, 5$) of time periods. X_{it} , is the column vector ($1 \times k$) of value of input of i^{th} firm at time t and β is a vector of unknown parameters to be estimated. The error term ϵ_{it} is divided into two components: the random error V_{it} , which shows producers specific external shocks on observed output; and the other non-negative term U_{it} , captures the technical inefficiency. Thus, the stochastic production function $\ln y_{it} = x_{it} \beta + v_{it} - u_{it}$; defines maximum feasible output in an environment characterized by the presence of either favorable or unfavorable events beyond the control of producers. On the other hand, the one sided non-negative error term implying that observed output lie beneath or on the stochastic production frontier.

The stochastic random error component, V_{it} s are assumed to be independent and identically distributed with mean 0 and constant variance i.e., ($V_{it} \sim N(0, \sigma_v^2)$) and the non-negative random error component U_{it} s assumed to be independently distributed, such that it is obtained by truncation (at zero) of the normal distribution with mean, and variance constant, i.e, $N^+(\mu, \sigma_u^2)$ Battese and Coelli (1995).

Thus, the summation of the two random variable V_{it} and U_{it} are expressed as ϵ_{it} in which

$$\frac{\sigma_v^2}{\sigma_\epsilon^2} = \frac{\sigma_v^2}{\sigma_v^2 + \sigma_u^2} \text{ and } \frac{\sigma_u^2}{\sigma_\epsilon^2} = \frac{\sigma_u^2}{\sigma_v^2 + \sigma_u^2} \quad (2.2)$$

Where; $\frac{\sigma_v^2}{\sigma_\epsilon^2}$ is the variance ratio; explaining the total variation in output from the frontier level of output attributed to technical inefficiency. The $\frac{\sigma_u^2}{\sigma_\epsilon^2}$ parameter lies between zero and one, if $\frac{\sigma_u^2}{\sigma_\epsilon^2} = 0$ then all deviations from the frontier are due to noise, while $\frac{\sigma_u^2}{\sigma_\epsilon^2} = 1$ indicates all the deviations are due to technical inefficiency (Battese and Coelli, 1995).

In line with this, firm level technical efficiency becomes the ratio of observed or realized output to the stochastic frontier or potential output (3.3), and the industry efficiency has been viewed as the average of the efficiencies of all the firms in the industry, i.e, the natural predictor of industry efficiency is the average of the predicted efficiencies of the firms in the sample (Battese and Coelli, 1992).

$$TE = \frac{y_{it}}{\exp(x_{it}\beta + v_{it})} = \exp(-U_{it}) \leq 1 \quad (2.3)$$

Here $-U_{it}$ represents technical inefficiency effect and the technical inefficiency effect can be assumed to be constant over time or can vary over time. The assumption of time invariant inefficiency considers that inefficiency of the industry has persistent nature and is time irresponsive. In order to identify which model best describes the inefficiency was tested using a log likelihood ratio test, however, this study assumes that technical inefficiency changes overtime. The technical inefficiency effects as a function of time are defined as;

$$U_{it} = \{\exp[-(t - T)]\}U_i \quad (2.4)$$

Where $i=1, 2, \dots, 146$ and $t=1, 2, \dots, 5$, u_i are non-negative random variables associated with the technical inefficiency of production. δ is unknown scalar parameter to be estimated, which determines whether inefficiencies are time varying or time invariant. If δ is positive, then $-(t-T) = (T-t)$ is positive for $t < T$ and; so $\exp[-(t-T)] > 1$, which implies that the technical inefficiencies of firms decline over time. If δ is zero, then the technical inefficiencies of firms remain constant. However, if δ is negative, then $-(t-T) < 0$ and thus the technical inefficiencies of firms increase over time.

However, both the Cobb-Douglas and Translog models were tested in the analysis part, the production function representing Metals and engineering manufacturing industries during the given period is translog production function. The translog functional form has advantages over other functional form especially from the Cobb-Douglas is that, the translog stochastic frontier production function is widely adopted in empirical studies, more flexible than

the Cobb-Douglas production function and it also helps to see the cross input relationships (Battese and Coelli, 1992).

The stochastic production function can be specified as Cobb-Douglas or translog functional form.

The general Cobb-Douglas functional form is defined as:

$$\ln y_{it} = \beta_0 + \sum_i \beta_i \ln x_{it} + V_{it} + U_{it} \tag{2.5}$$

The translog stochastic frontier production function of the metals and engineering industries can then be written as:

$$\begin{aligned} \ln y_{it} = \beta_0 + & \beta_1 \ln x_{1it} + \beta_2 \ln x_{2it} + \beta_3 \ln x_{3it} + \beta_4 \ln x_{4it} + \frac{1}{2} \beta_{11} (\ln x_{1it})^2 \\ & + \frac{1}{2} \beta_{22} (\ln x_{2it})^2 + \frac{1}{2} \beta_{33} (\ln x_{3it})^2 + \frac{1}{2} \beta_{44} (\ln x_{4it})^2 \\ & + \beta_{12} (\ln x_{1it})(\ln x_{2it}) + \beta_{13} (\ln x_{1it})(\ln x_{3it}) + \beta_{14} (\ln x_{1it})(\ln x_{4it}) \\ & + \beta_{23} (\ln x_{2it})(\ln x_{3it}) + \beta_{24} (\ln x_{2it})(\ln x_{4it}) + \beta_{34} (\ln x_{3it})(\ln x_{4it}) \\ & + V_{it} + U_{it} \end{aligned} \tag{2.6}$$

Where;

y_{it} is value of production output in Birr for the i^{th} firm, ($i=1,2,\dots,146$), in the t^{th} observation period ($t=1,2,\dots,5$); x_{it} are vectors of inputs such as fixed capital in Birr, Labour in terms of wages and salaries paid, industrial cost of raw material in Birr and cost of fuel and energy for the i^{th} firm in the t^{th} year of observation; β 's and β_{ij} 's are unknown parameters to be estimated; and U_{it} is as defined in equation (3.2).

The technical inefficiency effect, U_{it} , in the stochastic frontier model (2.7) defined:

$$U_{it} = z_{it}\delta + w_{it} \tag{2.7}$$

Where z_{it} is a vector of explanatory variables associated with technical inefficiency of firm i at time t , and δ is an unknown vector of coefficients, and

the random variable, w_{it} is defined to have the normal distribution truncated at $-Z_{it}\delta$, i.e., $w_{it} \geq -Z_{it}\delta$, and is consistent with the assumption that U_{it} has the truncated normal distribution, $N(Z_{it}\delta, \sigma_u^2)$ (Battese and Coelli, 1995).

To determine why some of the metals and engineering industries are less efficient than others, the following technical inefficiency model used to identify the source of inefficiency:

$$U_{it} = \delta_0 + \delta_1 Z_{it} + \delta_2 Z_{it} + \delta_3 Z_{it} + \delta_4 Z_{it} + w_{it} \quad (2.8)$$

Where;

U_{it} is defined above, δ_i 's unknown parameters to be estimated, w_{it} is defined by the truncation of the normal distribution with mean and variance, i.e., consistent with the assumption of U_{it} , and the variables Investment intensity, Age, Distance from the capital city, and Labour-Capital mix are the variables used for estimation of the parameters.

2.2. Estimation Procedure

The parameters of the stochastic frontier model (2.1) will be estimated using maximum likelihood estimation (MLE). The MLE method has been found to be significantly better than Corrected Ordinary Least Square (COLS) where the contribution of the inefficiency effects of the total variance is large, and is the preferred estimation technique whenever possible (Coelli, Rao and Battese 1998). Additionally, Coelli (1995) suggested that the ML estimator significantly outperforms the COLS estimator when the contribution of the technical inefficiency effects to total variance output is relatively large.

The estimated parameters in the stochastic frontier models were s , σ_v^2 and σ_u^2 . Industry or sector efficiency was computed as the average of the technical efficiencies/inefficiency of the firms in the sample. STATA-13 software program were used to estimate the inefficiency model.

3. Results and Discussion

3.1 Descriptive Results

The study examines the technical efficiency of metals and engineering industry of Ethiopia. The data set utilized in this thesis consists of companies operating in the Ethiopian metals and Engineering industry during the years 2010 to 2014. The data was extracted from the CSA annual manufacturing survey raw data bases. The data consists of maximum 146 and minimum 105 individual firms' observation throughout the panel period of five years. The following table indicates that the data is an unbalanced panel, and among the firms in 2010 twelve firms, 2011 five firms and in the remaining each study period 4, 9, and 5 firms were owned by government.

Table 3.1: MEIs by ownership

S. No	Type of Ownership	2010	2011	2012	2013	2014
1	Public	12	5	4	9	5
2	Private cooperative	131	100	130	135	141
Total		143	105	134	146	146

Source: Filtered from CSA

The average age of the metals and engineering industries, computed by taking 2014 as a reference period, is around 11 years of age old. The highest maximum establishment of firm's age is 53 years old which a firm was established in 1961 during the imperial era. The minimum firm age is almost one year old, which considers those firms established in 2013 and 2014. The study considered those firms who were established in 2014 as one year old firm.

Table 3.2: MEIs Average Age and Distance

S. No	Statistics	Age (year)	Distance (km)
1	Mean	11	275
2	Max	53	1066
3	Min	1	5
4	SD	11.7	358.9

Source: own computation

By taking the capital city (Addis Ababa) as a reference, on average a firm is far from the capital city by around 275 km. The minimum distance is 5km which a firm is located inside the capital city while the maximum distance is 1066km where a firm is located in the northern part of the country.

As indicated in Table 3.3 below, the average annual production of metals and engineering industries during the period of 2010 – 2014 at industry level was birr 67.97 million. The average inputs used in the production process includes; fixed capital, wage and salaries for employed labour, cost of raw material used and cost of fuel and energy was birr 21.02 million, 1.9 million, 44.4 million, and 1.3 million, respectively.

Table 3.3: Descriptive Statistics of MEIs (in 000 Birr)

Statistics	Output	Fixed Capital	Wages and Salary	Cost of Raw Material	Cost of Fuel and Energy
Mean	67,971.33	21,017.42	1,922.48	44,425.30	1,310.84
Max	2,582,635.42	789,452.49	69,396.16	1,254,639.95	90,408.59
Min	8.06	(389.69)	540.00	400.00	60.00
Std. Dev.	218,607.91	66,985.92	4,949.24	125,461.27	6,653.44

Source: Own Calculation

As shown in the Table 3.4 below, fixed capital grew by 94.63% on average, while wage and salary, cost of raw materials and cost of fuel and energy grew by 52.19%, 125.15%, and 34.97% respectively.

Table 3.4: Annual Average input cost of MEIs (in 000 birr except for growth ratios)

S.No	Statistics	2010	2011	2012	2013	2014	Average Growth Rate (%)
1	Average Fixed Capital	7,051.42	6,001.25	31,033.25	25,274.71	23,971.12	94.63
2	Average Wages and Salary	1,020.16	667.56	2,312.67	2,481.54	2,223.18	52.19
3	Average Cost of Raw Material	14,936.15	12,683.44	78,035.04	63,620.90	75,636.42	125.15
4	Average Cost of Fuel and Energy	721.99	634.66	1,618.22	1,477.11	1,561.75	34.97

Source: Own Calculation

The following table describes that, there was an increase in annual metals and engineering industry production with an average growth rate of 45.76% during 2010 – 2014. The partial productivity of labour which shows the value of one unit of output produced by one birr of labour increased by 13.06 % on average and capital which shows the value of output produced by one birr worth of capital increased with average growth rate of 14.42%.

Table 3.5: Partial Productivity of MEIs (in Birr except for ratios)

S. No	Statistics	2010	2011	2012	2013	2014	Growth rate (%)
1	Average Output (million birr)	37.1	91.09	96.66	94.94	126.45	45.76
2	Output per Fixed Capital	69.336	33.159	15.572	16.725	23.437	14.42
3	Output per wages and salaries	42.249	40.698	48.084	36.259	58.867	13.06
4	Labour-Capital Mix	4.567	8.111	0.716	0.759	4.492	1.76

Source: Own computation

The average labour-capital mix which is the ratio of wage and salaries of permanent and temporary workers to fixed capital growth rate during the study period was 1.76% which shows on average the growth rate of labour expressed in wages and salaries was greater than by 1.76% that of capital in their combination in order to produce one unit of output.

3.2 Econometrics Results and Discussion

The econometrics analysis used a comprehensive unbalanced panel dataset covering a total of six hundred seventy four observations; a cross-section of one hundred forty six industries over a period of five year (2010 - 2014) and to estimate and predict the technical inefficiency and the different parameters that affect and determine the technical efficiency of metals and engineering industries.

Before interpreting the variables and the technical efficiency estimation a hypothesis test of the null hypothesis test was conducted. Since the model base in the topic of interest in this study is the formulation of Battese and Coelli (1995), assumed that U_{it} has a truncated normal distribution, the likelihood function is a generalization of the likelihood for the half-normal stochastic frontier model. As a result, this model is estimated by the maximum likelihood method, the hypothesis concerning more than one coefficient is usually tested using the likelihood ratio (LR) test (Coelli et al, 2005).

The first test was conducted to choose the correct functional form which better represents the production function of the metals and engineering industries among the two common functional form of production function employed in studying technical efficiency using stochastic production frontier namely Cobb-Douglas and Translog functional form. This test is performed using log likelihood ratio test based on maximum likelihood estimation values of the two models.

In order to test the two models using the likelihood test distributed as chi-square (χ^2) under H_0 , the first step is imposing a restriction. The null hypothesis constrains the existence of all the interaction terms between explanatory variable. It ignores the effect of the interaction between fixed capital with

wage and salary, fixed capital with cost of raw material, fixed capital with fuel and energy consumption, wage and salary with cost of raw material, wage and salary with fuel and energy consumption, and cost of raw material with fuel and energy consumption. Additionally it disregards the effect of the square of each of the four inputs.

$$H_0 = \beta_{11} = \beta_{12} = \beta_{13} = \beta_{14} = \beta_{22} = \beta_{23} = \beta_{24} = \beta_{33} = \beta_{34} = \beta_{44} = 0.$$

The log likelihood ratio statistics LR is given by;

$$LR = -2[\text{LLF}_0 - \text{LLF}_1]$$

Where LLF_0 is the value of the likelihood functions for the frontier model in which the null hypothesis (H_0) is imposed (Cobb-Douglas function) and LLF_1 is the value of likelihood functions of the alternative hypothesis (H_1) for the Translog functional form.

Reject the null hypothesis when $LR > \text{Chi}^2(r)$ where (r) is the number of restrictions. In our case we have 10 restrictions (all interactions and quadratic terms).

If the null hypothesis is accepted we select the Cobb-Douglas functional form be the appropriate functional model and if it is rejected the Translog function will be the appropriate functional form which represents the stochastic production frontier model of the metals and engineering industry sector.

$$\begin{aligned} LR &= -2[\text{LLF}_0 - \text{LLF}_1] \\ LR &= -2[-1329.7186 - (-1316.13)] \\ LR &= 27.18 \end{aligned}$$

Therefore the likelihood test ratio LR is 27.18. The critical value of the Chi-square distribution statistics at 5% level of significance and 10 degree of freedom equals 18.31; i.e., 27.18 is greater than the table value of 18.31. As a result of this, the null hypothesis is rejected. Hence we can conclude that the Translog functional form (Table 4.6) soundly explains the stochastic

production function of metals and engineering industry sector relative to Cobb-Douglas production functional form.

The second hypothesis test performed in order to make analysis to meet the second objective of the thesis was to find out whether there is any technical inefficiency in the metals and engineering industry. This is done by imposing the restrictions on the translog model that $\alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$ where α_i is technical inefficiency and Z_i s are the source or the determinants of the technical inefficiency of the industry i.e. investment intensity, age, distance from the main capital city, and labour-capital mix. The alternative hypothesis, there is no technical inefficiency is not true.

For the metals and engineering industries with the selected Translog functional form, comparing the results of the computed LR with the critical value is done. The log-likelihood ratio test statistics is given by:

$$LR = -2[\text{restricted Translog minus the unrestricted Translog}]$$

$$LR = -2[-1326.193 - (-1302.159)]$$

$$LR = -2[24.034]$$

$$LR = 48.068$$

From the computation, if LR value is greater than the critical value we conclude that the null hypothesis of no technical inefficiency effects on the industry is rejected, i.e, the likelihood ratio test statistics is 48.068. The critical value at 1% and 5% significance level using the Chi-square distribution with 5 degree of freedom is equal to 15.09 and 11.07 respectively. Therefore, the null hypothesis is rejected, implying that there is a technical inefficiency effect in the metals and engineering industry.

The third hypothesis tests specifies whether there is a technical inefficiency variation over time or not, i.e, the null hypothesis $H_0: \alpha = 0$, which specifies that the technical inefficiency effect is time invariant. If the null hypothesis is rejected showing that the technical inefficiency effect varies significantly over time (time varying inefficiency effect). On the other hand if the value of α is positive indicating that the industries technical inefficiency effects decreases

over time and if the () value is negative implying that the industries technical inefficiency increases over time.

The likelihood ratio statistics LR is given by:

$$LR = -2[\text{Time invariant} - \text{Time variant}]$$

$$LR = -2[-1336.23 - (-1316.13)]$$

$$LR = 40.46$$

The likelihood test ratio LR is 40.46. Using the Chi-2 distribution critical value at 5% significance level and with 19 degree of freedom is equal to 30.14. Hence, it is strongly reject the null and accepting the alternative hypothesis of the occurrence of time varying inefficiency effect.

The following table shows the summary of the hypothesis test and the decision of the null hypothesis.

Table 4.6: Summary of the hypothesis tests using log likelihood ratio statistics

S. N	Null Hypothesis	LR Test Statistics	X ² Value (a=0.05)	Critical Value	Decision
<i>C-D Production Function is appropriate</i>					
1	Ho: Ho= 11= 12= 13= 14= 22= 23= 24= 33= 34= 44 =0.	69.148	18.31		Reject Ho
<i>No technical inefficiency effect</i>					
2	Ho: =Z1=Z2=Z3=Z4=Z5=0	48.068	11.03		Reject Ho
<i>TE is time invariant</i>					
3	Ho: = 0	40.46	30.14		Reject Ho

Source: own computation

3.2.1 Interpretation of the stochastic Production frontier Estimation Results

The Maximum likelihood Estimation result of the Translog stochastic frontier form of the Metals and Engineering industries as indicated below presents the estimated parameters value of the coefficients and its sign at 5% and 10%

level of significant. All the explanatory variables and the dependent variable were transformed in to logarithm before estimation was undertaken.

Table 4.7: Time-varying decay inefficiency model

LnY	Coef.	Std.Err	Z	
+				
Fixed Capital (LnX1)	1	0.5158	0.2441	2.11**
Labour (LnX2)	2	0.4631	0.5031	2.23**
Cost of Raw Material (LnX3)	3	-0.2326	0.2326	-2.56***
Fuel & Energy (LnX4)	4	-0.4518	0.2266	-1.99
LnX1LnX1	11	-0.0071	0.0195	-0.36
LnX1LnX2	22	0.0741	0.0307	2.41**
LnX1LnX3	33	0.0503	0.0119	4.24*
LnX1LnX4	44	-0.0071	0.0134	-0.52
LnX2LnX2	12	-0.2431	0.1186	-2.05**
LnX2LnX3	13	-0.0292	0.0310	-0.94
LnX2LnX4	14	0.0158	0.0332	0.47
LnX3LnX3	23	-0.0140	0.0163	-0.86
LnX3LnX4	24	0.0110	0.0118	0.93
LnX4LnX4	34	-0.0435	0.0192	-2.26**
_cons	0	12.0593	2.1241	5.68*
+				
Mu	μ	-2.3762	12.8924	-0.18
Eta		0.5020	0.1154	4.35
+				
sigma2	2	3.0162	1.4273	1.1930
Gamma		0.316	0.041	0.25
sigma_u2	2u	0.3057	1.4251	-2.4875
sigma_v2	2v	2.7105	0.1610	2.3949

** , *** are significant at 5% and 10%

As we have seen before, the identified model for the stochastic production frontier is a Translog production function, the coefficients in the stochastic frontier model output (Table 4.7) do not have a direct interpretation like a Cobb-Douglas production function. Hence, the results are discussed based on the following (Table 4.8) elasticity estimates of the production function.

Table 4.8: Output Elasticity for MEIs estimated at the mean of input level.

Variables	Delta-method ey/ex	Std.Err
Fixed Capital (X1)	0.263423	0.109094
Labour (X2)	0.1224	0.059779
Cost of Raw Material (X3)	-0.22049	0.22056
Fuel and Energy (X4)	-0.306754	0.153842

Source: own estimation output

The elasticity estimate of the input at their mean level fixed capital and labour had a positive sign while cost of raw materials and fuel and energy got negative sign. The positive sign and level of significance at 5% of the coefficient of fixed capital indicates a one percent increase in the value of fixed capital expenditure results to a 26.34% increase in the gross value output production. While the square of fixed capital is not significant and the sign is negative which implies it is inconsistent with the rational of the existing literature. This positive and significant result of fixed capital is also consistent with the result of Habtamu (2010), Nebyou (2011), Dilbetigle (2012), and Melaku (2013) study of Pasta and Biscuit, Brewery, Textile and Garment and manufacturing industries as a whole.

The positive sign of labour expressed as the number of permanent and temporary employee of the industries at 5% level of significant results an increase in the gross value of output production by 21.24% in a one additional employment of labour as a unit of production in the production process. From this result the contribution of one additional unit of fixed capital is essentially important and significantly greater than that of one additional labour employment in order to increase the gross value of output. This shows the metals and engineering industries are highly capital intensive manufacturing sector. While Melaku (2013) in his study on the total factor productivity and technical efficiency of the manufacturing sector of Ethiopia found out that, fabricated metals product manufacturing were labour intensive, i.e, the

coefficient of labour was greater than that of capital. On the other hand, Gebeyehu (2003) in his study of technical efficiency of leather industries found that labour input had a reducing effect on the output of leather and leather products manufacturing firms.

On the other hand, the negative sign of the cost of raw material even if significant at the 10% level of significance shows there is an inverse relationship between gross value of output and cost of raw material, i.e, a reduction of a one percent in the value of cost of raw material results an increment in the gross value of output by 22.05%, keeping other variables constant. This is due to the fact that, most of the metals and engineering industries have been used imported raw materials which is highly dependent on the foreign currency results import has becoming expensive than the previous periods. More over the, the current government devaluated the national currency for five times since 2008. This negative relationship result is the same with that of Nebyou (2011) studied on the Brewery manufacturing.

Similarly, the coefficient of the cost of fuel and energy is negative but it is statistically insignificant. Even though, the variable has been important and used in most literatures, it does not able to explain the technical efficiency of the metals and engineering industries. However, the elasticity estimates indicated that a 30.66% reduction in the value of fuel and energy results a one percent increment the output if metals and engineering firms, keeping other variables constant. But the square of fuel and energy is significant at five percent level of significant with a negative sign indicating that output is inversely related with the square of fuel and energy. This might be due to the large number of structural metal product manufacturing firms included in the estimation of efficiency outweighs the rest of the other firms.

On the other hand, when we see the interaction between the second order variables, there exists a positive interaction between labor square and fuel and energy, show that there exist an inverted U-shape relationships among the two variables, that is, after the two inputs labour square and fuel and energy square reaches to their optimum label, the output will decrease (Nebyou; 2011).

All the cross interaction parameters of fixed capital with labour, fixed capital with cost of raw material, fixed capital with fuel and energy, labour with cost of raw material, labour with fuel and energy, and cost of raw material with fuel and energy are significantly different from zero, even if, only the interaction of fixed capital with labour and fixed capital with cost of raw material parameters are significant. This result conforms the selection of the Translog stochastic production function as an adequate representative functional model for metals and engineering industries is justified. The inconsistent of the unexpected and insignificance of some of the coefficients of the parameters might be due to the nature of the translog functional form which is exposed to a multicollinearity problems occurring from the inclusion of cross-product and a square terms of the input variables. However, the purpose of the study is to predict efficiency, tolerating and assuming the existence of some degree of multicollinearity is possible (Maddala, 1992).

3.2.2 Production Efficiency of ME Industry

It is assumed that the values of the inefficiency measure during prediction may be influenced by the different assumptions of the distribution of the inefficiency effect (U_{it}). In this study since the prediction of the inefficiency U_{it} assumed to distribute a normal distribution of truncated at zero of $N^+(\mu, \frac{\sigma^2}{u})$ Battese and Coelli (1992); despite the different distributional specification produce a relatively similar scoring of firms according to their efficiencies (Kumbhakar and Lovell 2000).

The parameter gamma (γ) indicates the ratio of the variance of firm specific variability, i.e, stochastic frontier inefficiency output to the summation of total output variability (V_{it} and U_{it}). Table (4.7) indicates γ is 0.3161 which shows 31.61% of the observed output variability is due to firm specific performance, where as 68.39% variability is due to random shocks, i.e, the difference or variability of output is due to the occurrence of the technical inefficiencies of the firm. Whereas when we saw the results of other sectors like past and biscuit, Brewery, and leather and leather products, the variation of output due to technical inefficiency were 16%, 86%, and 94% respectively (Habtamu 2010, Nebyou 2011, and Dilbetigle 2012).

The mean technical inefficiency score for the three sub sector of the metals and engineering industry namely manufacturing of basic metals manufacturing industry, manufacturing of structural metal products, and manufacturing of fabricated metal products were 0.44, 0.45, and 0.44 respectively. Even though, there is no significant difference in the inefficiency score among the sub-sectors industries, manufacturing of structural metal products industries had the lowest average technical efficiency.

Table 4.9: Average Inefficiency Score of the MEIs

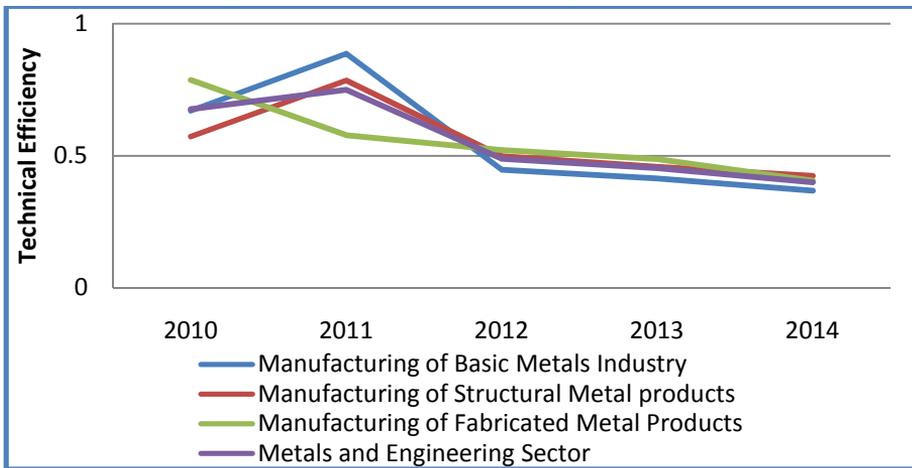
S.N	Sub Sector	Statistics	2010	2011	2012	2013	2014	Cumulative
1	Manufacturing of Basic Metals Industry	Average	0.329	0.113	0.554	0.586	0.633	0.443
2	Manufacturing of Structural Metal products	Average	0.427	0.215	0.502	0.542	0.576	0.452
3	Manufacturing of Fabricated Metal Products	Average	0.214	0.422	0.478	0.512	0.594	0.444
4	Metals and Engineering Sector	Average	0.323	0.250	0.512	0.547	0.601	0.447
		Max	0.818	0.736	0.741	0.746	0.808	0.818
		Min	0.0008	0.0001	0.1236	0.1562	0.058	0.0678

Source: Own computation

The average technical inefficiency score of the metals and engineering industry sector during the study period was 44.7%, which means the sector experiences 55.3% efficiency in production. It also implies that, on average, the metals and engineering industries produced 55.35% of the maximum attainable output level over the period under consideration. The highest average technical efficiency score of the metals and engineering sector during the study period was 93.22% and the lowest was 18.2%, that is, 81.8% and 6.78% maximum and minimum inefficiency were attained, respectively (Table 4.9).

The Figure 4.1: depicts the average technical efficiency score shows in 2011 the sector firms experienced the highest technical efficiency achievement. In the same year, among the sub-sectors the basic metals firms were experienced the highest technical efficiency achievement. While in the then period the sector firms were experienced a reduction in technical efficiency. In 2014 the sub-sector industries experienced the minimum technical efficiency in their production process. Starting from 2012 till 2014, the fabricated metals manufacturing firms experienced the highest and followed by structural metals manufacturing firms in their technical efficiency manufacturing processes.

Figure 4.1: Average MEI Technical Efficiency



Source: Own computation

Even if it is unstable, on average metals and engineering industries sectoral technical inefficiency level increased by 24.7%, implying that there was an increment in the level of technical inefficiency during the study period. Among the three sub-sectors, the basic metals firms were experienced the highest positive inefficiency growth rate showing that starting from at the beginning of the study period, there had been experiencing a technical production capability reduction. Next to basic metals manufacturing, fabricated metal products manufacturing firms were also experienced a positive and increasing growth rate of inefficiency. While the average inefficiency of the structural metals shows a reduction in the growth rate during the study period (Table 4.10).

Table 4.10: Average Technical inefficiency growth rate of MEIs

Year	Basic Metals	Structural Metals	Fabricated Metals	Sector Average
2010	-	-	-	-
2011	-0.658	-0.084	0.972	-0.2279
2012	3.926	0.006	0.133	1.0485
2013	0.058	-0.031	0.072	0.0694
2014	0.079	0.089	0.159	0.0984
Total	0.851	-0.005	0.334	0.2471

Source: own computation

3.2.3 Determinants of Technical Inefficiency

There are a number of firm specific and non-firm specific exogenous variables which is used to explain the causes for technical inefficiencies of manufacturing firms. In this study as it was explained in chapter three only four variables are used to explain the causes for technical inefficiencies of metals and engineering industries of Ethiopia due to unavailability and incompleteness of data.

Table 4.11: Technical inefficiency Determinant Estimation result

Ui		Coef.	Z
Investment Intensity	Z1	-0.0396	-2.82**
Age	Z3	5.37E-05	0.38
Distance	Z4	0.00006	0.37
Labour-Capital Mix	Z5	-0.027	-1.75***
_cons	0	-4.03104	-0.36
sigma_u	2u	0.936669	0.61
sigma_e	2v	2.026642	1.84

** , *** significance at 5% and 10%

Source: own estimation

In this, in order to evaluate the results of the various determinants that affects the technical efficiency of metals and engineering industries, four determinant variables; investment intensity, age, distance and labour-capital mix were

used. The variables were chosen, first from their common appearance in most manufacturing and other technical efficiency studies and literatures related with the topic of interest, and secondly, based on the sectors specific characteristics.

Investment Intensity: measured by the ratio of net capital addition of the firm to total employments during the year. The study found that the sign of the coefficient of investment intensity is negative but statistically significant at 5% significance level. The result indicates that the variable plays an important role in explaining technical inefficiency in the industry. In other words technical inefficiency declines with an increase in investment intensity.

Labour-Capital Mix: measured by the ratio of labour to that of fixed capital during the given study period. However, the result depicts there is a negative sign and significant at 10% level of significance, its contribution to the firms inefficiency is minimum, i.e, technical inefficiency declines with an increase in labour-capital ratio. Meaning technical efficiency of the industry would be improved by increasing the employment and productivity of labour. With one unit of fixed capital increasing the payment of labour which is either due to productivity of labour is improving and demands higher payment of wage and salaries or due to the increment in the number of personnel results higher payment for their services, results an improvement in technical efficiency. Seemingly, the result conforms to Oczkowski and Sharma (2005); a higher labor-capital ratio indicates that firms are more likely to be operating close to its technically efficient level of production.

The other variables distance and age are statistically insignificant. But the positive sign of the coefficients indicate that they have an impact on the technical inefficiency of the metals and engineering industries. For example as explained by Malerba (1992) the positive sign of age which as firms stock of experience grows and identify and eliminate previously used inefficient production methods they could became technically efficient in their production.

4. Conclusion and Policy Implications

4.1 Conclusions

Using unbalanced panel data of five years from 2010 to 2014 the study examined the technical efficiency of 146 metals and engineering firms of Ethiopia and investigated the factors that contributed to the inefficiency of the firms. It formulates a hypothesis that all the metals and engineering firms are technically inefficient. This hypothesis was estimated by a stochastic production frontier model of Battese and Coelli (1995).

The main finding of the study revealed that; the log likelihood ratio statistics estimated using maximum likelihood estimation procedure for the metals and engineering industries were better specified by a translog production formulation. The likelihood ratio test also realized the existence of a time varied technical inefficiency in the metals and engineering firms.

The output result of the estimated input variables coefficients shows that fixed capital and wages and salary (Labour) were statistically significant and got positive sign. While the coefficients of cost of raw material and fuel and energy were negative and only cost of raw material was significant.

The cumulative average technical efficiency score of the metals and engineering industries was 55.3%, i.e., on average technical efficiency of the MEI can be raised by about 44.7%. The identified mean technical inefficiency indicates that there was a slight difference in the inefficiency score among the firms in the sector. The structural metal product manufacturing firms were experienced the highest inefficiency score (45.2%), followed by fabricated metals and basic metals manufacturing plants, 44.4%, and 44.3% respectively. Among the four determinant variables incorporated to explain technical inefficiency, only two factors investment intensity and labour-capital ratio had a significant effect on the technical inefficiency of the metals and engineering industries.

The gamma value (γ) showed that 31.6% of the inefficiency was due to firm specific technical inefficiency effect while 68.39% is due to statistical noise which is beyond the control of the firms.

4.2 Policy Implications

Based on the findings of the analysis of the technical inefficiency and its determinants of the metals and engineering industries of Ethiopia, it is going to figure out and suggest the following recommendations which are relevant for improving the technical efficiency of the sectors manufacturing industries. The output of the MEIs has been greatly affected by fixed capital which shows that, the metals and engineering industries of the country are practicing capital intensive production processes. This demands the availability of investment capital accesses for the industries in order to equip them with the necessary capital intensive production equipment and facilities, i.e, installing and replacing equipment/machineries and facilities, and the necessary technologies. The financial provision also supported by the availing of foreign exchange requirements to the industries since most of the machineries are imported.

The estimation result revealed that the output of the sector is strongly influenced by cost of raw materials next to fixed capital. This is due to the fact that, most of the raw materials for the sub-sector manufacturing firms are imported and it also requires large amount of capital to provide. Hence, the respective government institutions and ministries should work regarding to this variable in order to avail the raw material for firms either in least cost or in the domestic market.

However, the implication is low; the finding of the negative relationship of Labour-capital mix with technical inefficiency indicates that increasing the employment of labour in the sub-sector will lead firms to improve their technical efficiency. Hence, it might be essential to increase either the quantity or the quality of labour in the sub-sector manufacturing production process. The inversely relationship of investment intensity with the technical inefficiency of the sectors industries implied that, increasing the domestic and foreign direct investment in the areas of metals and engineering sector has an impact on reducing the technical inefficiency. Therefore, the government should work to attract investors to invest in this sector.

The study found that 68.39% the inefficiency arises due to statistical noise which is beyond the control of the firms; this source of inefficiency might be institutional and infrastructural problems. Therefore, the respective government bodies have to give due attention to tackle these institutional and infrastructural problems.

The estimation result shows the technical inefficiency of metals and engineering firms of Ethiopia is almost near to half (44.7%). This revealed that there can be a gain in technical efficiency improvement by the sector industries. Therefore, the government and other stakeholders have to work in this regard.

When doing this study, during data cleaning process it was found that some firms were only joined the sector at the end of the panel period especially in 2013 and 2014. These industries were not included in the study to get free of statistical noise and data consistency. This evidence also supported by the different reports of Metals Industry Development Institute and other respective concerned Ministries. This might be due to the recent establishment and intervention of the Metals Engineering Corporation. Therefore, as we have been observing, the role and impact of the corporation in the improvement of the sectors technical efficiency output, and value addition to the country's GDP is open area for research. Hence, it is recommended for those who would be interested to figure out the impact of the intervention and also in parallel with the context of policy framework. Beside this, studying the allocative and economic efficiency of the sector is a room for further research topic since this study is only limited to technical efficiency and determinants.

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Information Communications Technology and Economic Growth in Sub-Saharan Africa: A Panel Data Approach

Haftu Girmay Giday¹

Abbreviations

ICT	Information Communication Technology
SSA	Sub-Saharan Africa
ITU	International Telecommunication Union
UN	United Nations
OECD	Organization of Economic Cooperation and Development

Abstract

This research empirically analyzed the impact of mobile phone and the Internet on per capita income of Sub-Saharan Africa (SSA) for the period of 2006-2015 using a panel data of 40 countries. We have employed the robust two-step system GMM. Results showed that growth in mobile phone penetration has contributed significantly to the GDP per capita of the region after controlling for a number of other variables. A 10% increase in mobile phone penetration results in a 1.2% change in GDP per capita. Therefore, improving access to mobile phones plays a positive role in reducing the poverty level of the region through raising the per capita income of the population. However, the Internet has not contributed to the per capita GDP during the study period. The insignificant impact of the Internet could be due to low penetration of the technology, low ICT skill of Internet users, lack of or insufficient local content on the global network, the relatively immature state of the technology in the region, and a possible misuse of it. Therefore, governments and other stakeholders should design policies that encourage expansion of the Internet until a critical mass of users is achieved. In addition to improving Internet access, policies which focus on ICT skill development and local content creation should also be designed and implemented.

Keywords: Sub-Saharan Africa; Mobile; Internet; GDP per capita; system GMM.

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1. Introduction

Countries around the world have given a special attention to the development of telecommunications infrastructure. Roller and Waverman (2001) explained that telecommunications infrastructure can bring economic growth because it increases the demand for inputs which are used in its production and can reduce the transaction cost of firms. It can also have a positive impact because it can improve the production techniques of productive units. Other writers (e.g. Pohjola 2002) have also expressed the dual role of information communication technologies (ICT) in the new economy. ICT influences growth because it is both an output of the ICT using industries and it can enter into the ICT using industries as an input. Van Zon and Muysken (2005) have also explained the influence of ICT on productivity. According to the authors ICT influences productivity through its forward and backward linkages with the rest of the economy, through improving the production processes of the non-ICT sector, improving market processes, and facilitating the creation of new knowledge that enhances productivity. Some authors (e.g. Ding and Haynes 2006) argued that “unlike the traditional infrastructures, telecommunication infrastructure has a potential to lead “leapfrogging” development in developing countries (p. 281-282). Many international organizations including the United Nations also advice developing countries to deploy and use ICT in various sectors including health, agriculture, transport, education, government agencies, etc. Generally, it is believed that ICT has the potential to improve the living standards of society. It generates revenue and creates employment opportunities; it improves productivity of inputs, lowers transaction costs, facilitates the creation of knowledge; it reduces price dispersions and price fluctuations; it makes markets more efficient and promotes investment.

Due to these and other potential benefits of ICT, adoption of telecommunications services, especially mobile phone and the Internet is rising. A report by the African Development Bank released in 2011 shows that from 2000-2010 the private sector alone in Africa has spent a total of US 28 billion Dollars on new mobile networks. As a result of this and other public investment in the technology, the penetration rate in mobile phones is rising. The International Telecommunications Union (ITU) reported that in

2015 about 87.29% of Africa's population had access to mobile phones. The mobile subscription rate for Sub-Saharan Africa for the same period was 83.11%. Unlike the mobile subscription rate, the penetration rate for the Internet in the region is; however, low -only 17% of the population had access to the internet in 2015.

ICT has increasingly attracted the attention of many researchers in recent times. Roller and Waverman (2001) have studied the impact of telecommunications infrastructure on economic growth of 21 OECD countries over the period of 1970-1990. In investigating the impact they jointly estimate a micro model for telecommunications investment with a macro production function. They found that telecommunications infrastructure affects economic growth positively. Ding and Hynes (2006) have also studied the impact of telecommunications infrastructure on regional economic growth in China. They used a panel data set of 29 regions over the period of 1986-2007. Using the dynamic fixed effects model they found that telecommunications infrastructure had a positive and significant impact on real GDP per capita. Gruber and Koutroumpis (2011) have assessed the impact of mobile phones on GDP growth of 192 countries over the period 1990-1997. They found that mobile adoption had a positive impact on the annual GDP growth.

In the literature we find few empirical studies that investigated the impact of ICTs on economic growth of Sub-Saharan Africa. Most recently, Donou-Adonsou, Lim and Mathey (2016) studied the impact of telecommunications infrastructure in Sub-Saharan Africa over the period of 1993-2012. Applying the instrumental variable generalized method of moments (IV-GMM) they found that mobile and Internet have a positive significant impact on economic growth. Chavula (2013) has also studied the impact of telecommunications on economic growth on Africa between 1990 and 2007. Using the OLS method the study revealed that fixed telephone and mobile telephone had positive and significant impact. However Internet penetration was found to have insignificant impact.

Although far behind the developed region, countries in Sub-Saharan Africa have given a special priority to the development of telecommunications infrastructure. As a result, adoption of mobile and Internet technologies is

increasing. However, the impact of these technologies on economic growth has not been studied adequately. Therefore, it is imperative to ask whether ICT is helping people in Sub-Saharan Africa in increasing their income or not. Understanding the impact of mobile phones and the Internet in the region will help governments and other stakeholders design policies, strategies, programs, and projects which could maximize the benefits from ICTs.

Using data from the World Bank and the International Telecommunication Union this paper examined the impact of telecommunication infrastructure for the period of 2006-2015 over a panel data of 40 Sub-Saharan Africa countries. Results showed that growth in mobile phone penetration has contributed significantly to the GDP per capita of the region after controlling for a number of other macroeconomic variables. However, the Internet has not contributed to the per capita GDP during the study period. The rest of the paper is organized as follows: Section 2 reviews literatures related to ICT and economic growth. Section 3 presents the methodological approach. Findings of the study and discussion of results are presented in section 4. Finally, section 5 concludes the study.

2. Literature Review

2.1 Theoretical literature

2.1.1 Growth theories

In order to explain growth differences across countries and over time economists have suggested a number of growth models. However, the two dominant growth models are the neoclassical growth model (also commonly known as the Solow model) and the endogenous growth model.

According to the neoclassical growth model, long-run economic growth is determined by exogenous factors such as population growth and technological change. It assumes variable factor proportions (there is possibility of substituting labor for capital in production), constant returns to labor and reproducible capital, closed economy, diminishing returns to the accumulation of capital, competitive markets, exogenous rate of saving, exogenous rate of capital depreciation, exogenous technological change, two factors (labor and capital), one commodity and exogenous population growth. Neoclassical

growth models (Like Solow's 1957 growth model) assume technology to be exogenous, meaning it is publicly available. In Acemoglu's (2009) words "It is publicly available as a non-excludable, non-rival good" (p.28). According to him the implication of this assumption is that firms can get technology from the market without incurring any cost.

In this model production depends on the level of capital and labor. In addition to these inputs it also depends on the level of exogenously determined technology. According to Lucas (1988) the model predicts that countries with the same preferences and technology will converge to identical levels of income and asymptotic rates of growth. That is, countries which have the same levels of technology, saving rates, depreciation rate and population growth rates will eventually converge to the same level of output per capita. Therefore, the country with the lower level of output per capita will have a higher growth rate of output per capita. Thus, poorer countries grow faster than wealthy countries.

Although the model is considered to be a useful tool in understanding sources of economic growth it has attracted a number of criticisms. Especially its assumption on the exogenous technological change and its prediction are the main targets. Many scholars including Rosenberg (1974), Romer (1986), Lucas(1988), Aghion & Howitt (1999), and Acemoglu (2009) have challenged the exogenous assumption of technology made by Solow(1956). They argued that technological progress(or accumulation of knowledge) is obtained because of decision of firms or individuals seeking profit or achieving other objectives.

Therefore, in order to tackle the shortcomings of the neoclassical model economists have devised an alternative model commonly known as the endogenous growth model. This model endogenizes technology in the production process. It also eliminates the assumption of decreasing returns to both physical capital and human capital (knowledge capital). Many (e.g. Aghion & Howitt 1999, Fine 2000) believe that Romer's article which was published in 1986 was the benchmark for the contemporary writings on endogenous growth. Romer (1986) explained that his model can be viewed as "an equilibrium model of endogenous technological change in which long-run

growth is driven primarily by the accumulation of knowledge by forward looking profit maximizing agents” p.1003. In a later time Romer (1990) argued that technological change is mainly the result of “intentional actions taken by people who respond to market incentives” p.S72. Aghion and Howitt (1999) have stated that the ideas of endogenous growth theory can be traced back to many writers including Kuznets, Abramowitz, Griliches, Schmookler, Sherer, Rosenberge, and Schumpeter. According to the authors these writers have admitted the significance of endogenous technological progress for economic growth. According to the authors the endogenous growth theory helps us to handle the endogenous technological change and innovation. They also explained that “the purpose of endogenous growth theory is to seek some technological knowledge and various structural characteristics of the economy and the society and how such an interplay results in economic growth.”P.1.Mankiw, Phelps, & Romer (1995) have also argued that endogenous growth models can provide us a sensible description of the advances in knowledge around the world.

The theory has its earlier version commonly called the AK model. Acemoglu (2009) has stated that when the assumptions of continuity, differentiability, positive and diminishing marginal products, and constant returns to scale ;and the Inada Conditions imposed on the aggregate production function are relaxed, sustained economic growth could be achieved through capital accumulation. However this model is criticized on a number of grounds. First, its long-run equilibrium is unstable, i.e. its equilibrium is on “a knife-edge”. Second, as time passes output will almost entirely depend on capital. This implies that capital is the major factor in understanding economic growth. However, many argue that technological progress plays the key role in understanding the performance of economies (see Acemoglu 2009).

Therefore, following the popularity of the endogenous growth model and its wider application in growth related researches we have used it as a framework in our analysis.

2.1.2 ICT and economic growth

The importance of infrastructure to economic growth is well established in the literature. Especially, after the late 1980s a series of studies have been conducted showing the importance of infrastructure to economic growth (See Bougheas, Demetriades & Mamuneas, 2000). Bougheas et al. explained that infrastructure (including telecommunications infrastructure) could be considered as cost reducing technology. The importance of technological progress to economic growth is also clearly identified in both growth models. Metcalfe (2010) argued that “Technology is capable of many forms of expression, as knowledge and information, as skills and capabilities and as human built structures” (p.168). Czernich, Falck, Kretschmer and Ludger (2011) stated that ICT facilitate growth by enhancing distribution of ideas and information, competition, entrepreneurial activities and job search. According to the authors ICT can also affect economic growth through knowledge spillovers across firms.

Roller and Waverman (2001) explained that telecommunications infrastructure can bring economic growth because it increases the demand for inputs which are used in its production and can reduce the transaction cost of firms. It can also have a positive impact because it can improve the production techniques of productive units.

Pohjola (2002) stated that “Given that ICT is generally regarded as the current manifestation of the ongoing sequence of technological revolutions, it can be seen as the key factor driving economic growth in present-day societies”p.381. He also explained that “ICT plays a dual role in the modern economy” as both an input and output. Dutta (2001) has also explained that telecommunications improvement leads to wider dissemination of market information, more timely market information, lower coordination costs in markets, and improved public services such as health and education.

In another study Van Zon and Muysken (2005) have stated the influence of ICT on productivity. According to the authors ICT influences productivity through a number of ways. First, it can affect productivity through its forward and backward linkages with the rest of the economy. Second, since the non-

ICT sector uses ICT goods and services in its production processes it can improve its productivity. Third, market processes will be improved leading to productivity improvement. Forth, because of its network externalities features it can be more productive the more people use it. Finally, ICT catalyzes the creation of new knowledge that enhances productivity. They concluded that the use of ICT in the final output sector can lead to improvement in growth performance. Ding and Haynes (2006) have also explained the various ways in which telecommunications infrastructure could enhance economic performance. According to the authors the telecommunications sector itself serves as a source of revenue and employment. It also reduces transaction costs, provides market information, and facilitates information diffusion. It may also affect economic growth positively by encouraging domestic investment and foreign direct investment.

ICTs can play a significant role in the accumulation and dissemination of knowledge which could in turn lead to long-term economic growth. Jacobson (2003) argued that faster knowledge accumulation stimulates economic growth. Macdouglass (2011) has also argued that ICT (particularly the Internet) reduces search and transaction costs. It also provides new ways for information acquisition and exchange. “This information exchange leads to knowledge, which is fundamental to technological progress.”p.30. Technological progress in turn leads to economic growth. ICT can expand market boundaries and improves information flows (see, Waverman, Meschi, and Fuss, 2005 and Andrianaivo & Kpodar, 2010).

2.2 Empirical evidence

This section provides some empirical evidence on the relationship between ICT (including mobile phone and the Internet) and economic growth.

Bougheas et al. (2000) have studied the impact of infrastructure (including telecommunications) on economic growth of 119 countries over the period of 1960-1989. Extending Romer’s (1987) endogenous growth framework and applying various cross country regression models they showed that telecommunications infrastructure, as measured by telephone lines per thousand inhabitants, has a positive impact on long-run economic growth.

Pohjola (2002) has studied the impact of ICT on growth. Using the neoclassical growth model and taking a sample of 42 countries over the period of 1985-1999 he found no significant correlation between ICT investment and economic growth. Jacobson (2003) investigated the impact of telecommunications on economic growth of 61 developing and 23 developed countries using the seemingly unrelated regression technique (SUR) over the period of 1990-1999. The author has adopted the simultaneous equations models of Roller and Waverman (2001). The study showed that a positive relationship between economic growth and telecommunications exist. Furthermore, it was found that the growth effect from telecommunications expansion in developing countries exceeds that of developed countries. Choi and Yi (2003) have studied the impact of the Internet on economic growth of 207 economies over the period 1991-2000. Using the endogenous growth models they found a positive and significant impact of the Internet on the growth rate of GDP per capita. Similar results have also been obtained by the same authors in 2009. Gruber and Koutroumpis (2010) assessed the impact of mobile telecommunications on economic development of 192 countries over the period 1990-2007. Using similar structural equations to Roller and Waverman (2001) and estimating it with 3SLS technique they found a positive and significant impact of mobile phones. Macdougald (2011) has studied the impact of Internet use on four measures of economic development-per capita GDP, per capita export revenues, per capita market capitalization, and societal wellbeing covering 202 countries over the period 1996-2007 using dynamic panel data and finite mixture model estimation techniques. Results show that in low income countries (30 SSA countries included) Internet has a positive and significant impact on per capita GDP and overall welfare. Meah (2012) has studied the impact of the Internet on 244 countries over the period 1990-2011 using the framework used by Barro (1996). Fixed effects model is used. Although a positive and significant effect is registered for the world as a whole the result for South Asian countries only shows unfavorable impact. A 10% increase in internet users decreases GDP per capita by -4.65% at the 5% significance level.

Roller and Waverman (2001) have also investigated the impact of telecommunications infrastructure (as measured by telephone penetration rate) on economic development of a sample of 21 OECD countries over the 1970-

1990 period. They jointly estimate a micro model for telecommunication investment with a macro production function. They found that telecommunications infrastructure affects output positively and significantly especially this impact is higher when a universal access is obtained (critical mass is achieved). Based on their findings they concluded that a convergent in telecommunications infrastructure (above the critical mass) would offset divergence in economic performance. Datta and Agarwal (2004) investigated the long-run relationship between telecommunications infrastructure and economic growth in 22 OECD countries over 1980-1992. Following the cross-country framework of Barro (1990) and Levine and Renelt (1992) they formulate a dynamic panel data model which includes telecommunications infrastructure (which is measured in access per 100 inhabitants) as its explanatory variable. They found a positive and significant correlation between telecommunications infrastructure and economic growth. They also found that the positive impact of telecommunications infrastructure on GDP growth is largest for countries with the smallest telecommunications infrastructure. Czernich et al. (2011) have investigated the impact of broadband infrastructure (as measured by broadband penetration rate) on per capita growth using IV-estimation technique. Their sample includes 25 OECD countries over the period 1996-2007. They found that a 10 percentage point broadband penetration raised annual per capita growth by 0.9-1.5 percentage points.

Ding and Haynes (2006) studied the role of telecommunications infrastructure on regional economic growth of China comprising 29 regions for the 1986-2002 period. Employing a dynamic panel data model similar to Datta and Agarwal (2004) they found that China's growth rates are positively related to telecommunications infrastructure (especially mobile phone and fixed line). Most recently, Feng (2016) has studied the impact of the Internet on economic growth of Chinese provinces within the Cobb-Douglas production function under the Solow model over the 2000-2014 period. Results show that Internet development (as measured by the number of Internet users, websites and domain names) has a positive and significant role on Chinese economic growth. A panel data approach of fixed effects and random effects models were used.

Ghosh and Prasad (2012) assessed the impact of telephone on India's economic growth on a panel of states in India. They used annual data for the time span of 1980/81-2006/2007. Though a short term positive relationship was observed, this relationship could not be established in the long-run. Mehmood and Siddiqui (2013) studied the long-run relationship between telecommunications investment and economic growth in 23 selected Asian countries over the 1990-2010 periods. Applying Pedroni (1999) panel cointegration technique they found a positive impact of telecommunications investment on GDP per capita of Asian countries.

Chavula (2013) has investigated the impact of mobile phone, fixed telephone, and the Internet on per capita income of 49 African countries over the periods of 1990-2007. They found that fixed telephone and mobile telephone have a positive and significant impact. A 1% increase in fixed telephone results in 0.15% increase in per capita GDP while a 1% increase in mobile leads to a 0.22 percentage point increase in per capita GDP growth. However, Internet usage did not have a significant contribution towards economic growth. Lee et.al (2009) has studied the impact of mobile phones on economic growth of 44 Sub-Saharan Africa countries over the 1975-2006 periods. Using the cross-country growth framework of Datta and Agarwal (2004) and applying the two-step GMM estimator of Arellano-Bover (1995) /Blundell-Bond (1998), they found a positive impact of mobile phone on economic growth. Most recently, Donou-Adonsou et al. (2016) have investigated the relation between economic growth and telecommunications infrastructure with a special focus on mobile phone and the Internet in a panel of 47 Sub-Saharan Africa countries over the period 1993-2012. Applying the IV-GMM they found that the Internet and mobile phones have contributed to economic growth. A 1% increase in both technologies results in 0.12 and 0.03 percentage point improvement in per capita GDP growth respectively.

Most of the reviewed empirical studies confirmed that ICT has a positive and significant impact on economic growth of individual countries. However in some instances its impact was found to be negligible and even growth retarding.

3. Empirical Analysis

3.1 Econometric methods

In order to investigate the impact of mobile phones and the Internet on GDP per capita we have applied Datta and Agarwal's (2004) model with a slight modification. This approach used a dynamic panel data model with telecommunications infrastructure included as one of its explanatory variable.

The model is specified as follows:

$$lngdppc_{it} = a + \beta_1 lngdppc_{i,t-1} + \beta_2 lngovcon_{it} + \beta_3 lnmercha_{it} + \beta_4 lngcf_{it} + \beta_5 internet_{it} + \beta_6 mob_{it} + \beta_7 inf_{it} + \beta_8 popg_{it} + \gamma r_i + v_i + \epsilon_{it} \quad (1)$$

$$E(v_i) = E(\epsilon_{it}) = E(v_i \epsilon_{it}) = 0$$

$$\beta_1 < 1$$

$$i = 1, 2, \dots, N; t = 2, 3, \dots, T.$$

Where

$lmgdppc_{it}$ is the logarithm of GDP per capita of individual countries at time t ;

a is a constant term;

$lmgdppc_{i,t-1}$ is the one period lagged logarithm of GDP per capita of individual countries. It is assumed to be endogenous, hence we have used lags 2 and above as instruments for the differenced equation and lag 1 for the equation in levels.

β_1 is a measure of the speed of mean reversion (the tendency of GDP per capita to converge (revert) slowly to its equilibrium or long run level, i.e. the mean, after a shock) and we expect β_1 to be positively related with $lmgdppc$;

$lngovcon_{it}$ is general government final consumption expenditure as a percentage of GDP (in log form). It includes all government current expenditures for purchases of goods and services including most expenditures on national defense and security. In the literature the effect of government consumption on GDP per capita is mixed so we have to determine it in our estimation;

$lnmercha_{it}$ is merchandise trade as a percentage of GDP (in log form). It is the sum of merchandise exports and imports divided by the value of GDP in current US dollars. It is a measure of trade openness and its expected sign is positive;

$lngcf_{it}$ is gross capital formation as a percentage of GDP (in log form). It is the summation of expenditures on additions to the fixed assets of the economy and net changes in the level of inventories. We expect it to have a positive impact on GDP per capita;

$internet_{it}$ is the percentage of individuals using the Internet in each country and we expect it to have a positive contribution on growth;

mob_{it} is cellular telephone subscription per 100 inhabitants in each country and its expected sign is positive. Both Internet usage and mobile subscription rates are assumed to be endogenous, hence we have used lags 2 and above as instruments for the differenced equation and lag 1 for the equation in levels;

inf_{it} is annual inflation rate of each country. Based on various literatures its expected sign is negative;

$popg_{it}$ is annual population growth rate of individual country. We expect population growth to have a negative impact on economic growth;

v_i is the unobserved country specific effects. It is the “permanent” effect associated with individual country which captures unobserved individual heterogeneity. It captures the impact of time-invariant individual characteristics such as geographical area.

ϵ_{it} is the time variant error term. The β s are parameters to be estimated. Finally, time dummies (yr_t) are included in the regression in order to prevent any possible cross-individual correlation that results from temporary shocks common across countries (e.g. the 2008 financial crisis).

In order to investigate the relation between economic growth and telecommunications infrastructure we have deployed the Windmeijer corrected two-step system GMM. According to Roodman (2006) the System GMM is used to improve efficiency of estimators as well as to avoid finite sample biases that result from weak instruments. Furthermore, he explained that System GMM is used in situations where we have few time periods and large number of samples, distributed fixed individual effects, endogenous regressors, and heteroskedasticity and serial correlation of idiosyncratic disturbances. The estimator uses lagged first differences as instruments for the level equations in addition to lagged levels as instruments for the differenced equation.

Thus, the following systems of equations are solved simultaneously.

$$\begin{aligned} \ln g d p p c_{i t} &= \beta_1 \ln g d p p c_{i, t-1} + \beta_2 \ln g o v c o n_{i t} + \beta_3 \ln m e r c h a_{i t} + \beta_4 \ln g c f_{i t} + \\ &\beta_5 \ln i n t e r n e t_{i t} + \beta_6 m o b_{i t} + \beta_7 \ln i f_{i t} + \beta_8 p o p g_{i t} + v_{i t} \end{aligned} \quad (2)$$

$$\begin{aligned} \ln g d p p c_{i t} &= \alpha + \beta_1 \ln r g d p p c_{i, t-1} + \beta_2 \ln g o v c o n_{i t} + \beta_3 \ln m e r c h a_{i t} + \beta_4 \ln g c f_{i t} + \\ &\beta_5 \ln i n t e r n e t_{i t} + \beta_6 m o b_{i t} + \beta_7 \ln i f_{i t} + \beta_8 p o p g_{i t} + \gamma r_i + v_{i t} \end{aligned} \quad (3)$$

In the literature it is shown that most macroeconomic variables, including the per capita GDP, are persistent (see Nelson and Plosser (1982), Stock and Watson (1986), Caporale and Gil-Alana (2004), and LoFaso (2012)). Hence, per capita GDP of individual countries may be dynamic i.e. current per capita GDP of countries may depend on past GDP per capita. Thus, if we have persistent variables system GMM could give us better results.

Blundell and Bond (1998) have shown that compared to the usual first-differenced GMM estimator and the non-linear GMM estimators, the estimators from system GMM perform well in terms of their asymptotic efficiency for the simple AR(1) model. In their simulation they showed that the linear generalized method of moments (GMM) estimator of Arellano and Bond (1995) has large finite sample bias and poor precision.

Using data from Arellano and Bond (1991) and Blundell and Bond(2000) Windmeijer (2005) found that estimated standard errors of the two step GMM estimator are downward biased in small samples and concluded that this phenomenon could lead to a very poor performance of the Wald test. He stated that the usual standard errors for the two step estimator are much smaller than the standard errors for the one step estimator. However, he argued that this perceived increase in precision is due to downward bias of the estimates of standard error and he devised a mechanism to correct this problem. He showed that in a Monte Carlo study of a panel data the corrected variance leads to more accurate inference.

Despite the above benefits the methodology has some limitations. First, the System GMM can generate too many instruments. Roodman (2006) has expressed his concern about the proliferation of instruments in the GMM. Second, according to Roodman (2009) this instrument proliferation could weaken the Hansen test. He indicated that in finite samples, like in our case,

the sample may lack enough information to estimate the large matrix well. This could affect the efficiency of our estimates. However, he argued that there is no consensus on the limit of the instrument count because even we have few instruments our estimators may be still biased. Third, as our instrument count rises the bias of the estimates would also increase leading to a failure to eliminate the endogenous components of our endogenous variables.

3.2 Data

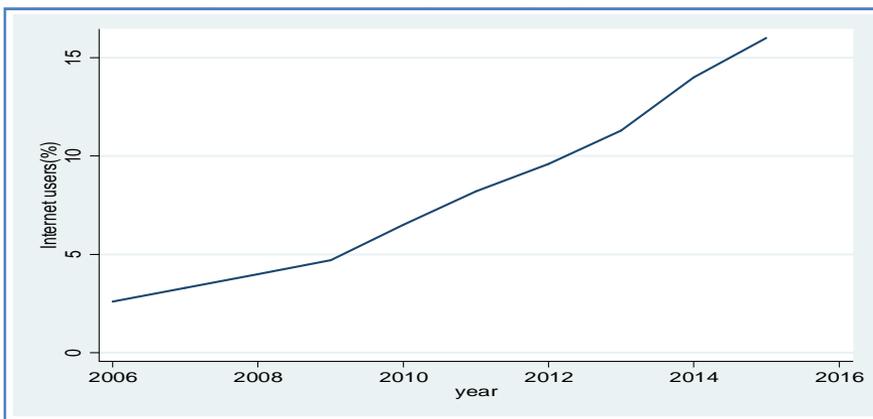
The research is based on data from 40 sub-Saharan African countries for the period of 2006-2015. Due to incomplete data Cape Verde, Djibouti, Eritrea, Sao Tome and Principe, Seychelles, Somalia, South Sudan, and Zambia are not included in the study. Macroeconomic data and telecommunications data are taken from the World Bank and the International Telecommunication Union respectively.

4. Findings of the Study and Discussion of Results

4.1 Descriptive statistics

As we can see from the summary statistics in appendix 1, the mean natural logarithm of GDP per capita for all countries in the study is 6.9 with a standard deviation of 1.1, a maximum amount of 9.97 and a minimum amount of 5.04. The mean individual Internet usage for all countries is about 8.1 with a standard deviation of 9.8. The maximum amount of Internet usage is 51.9%. Although the Internet penetration is low in the region mobile subscriber's number is growing rapidly. The mean subscriber's number for the whole group is 54.33 with a standard deviation of 36.75. In some countries the mobile subscriber's rate has surpassed their population reaching up to 171%.

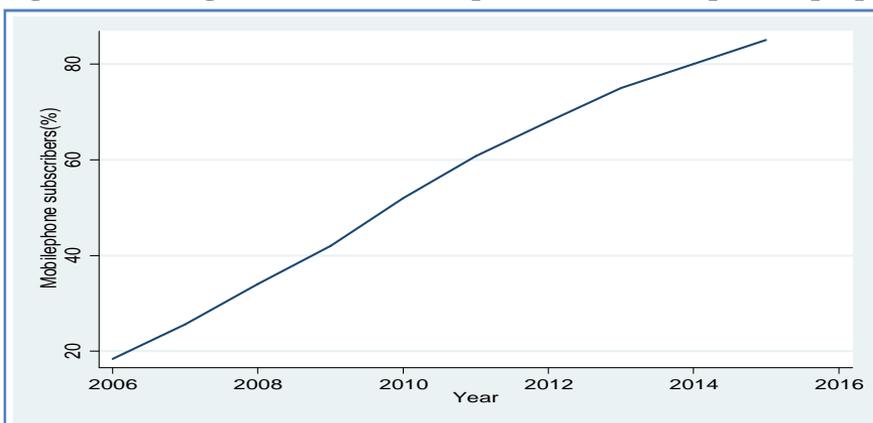
Figure 2: Average Internet users per 100 people



Source: Own computation (based on data from International Telecommunication Union)

From Figures 2 we observe that the average number of Internet users is increasing steadily for the last decade indicating the importance of Internet in people's lives.

Figure 3: Average number of mobile phone subscribers per 100 people



Source: Own computation (based on data from the International Telecommunication Union)

Figure 3 also indicates that the average number of mobile phone subscribers is increasing rapidly for the last decade indicating the importance of ICTs in people's lives.

4.2 Regression results

Table 1: Dynamic panel-data estimation, two step system GMM (with full Instruments)

Variables	Coef.	Corrected Std. Err.	z	P>z	[95% Conf.	Interval]
Ingdppc L1.	0.9227605	0.0735915	12.54	0.000*	0.778524	1.066997
Ingovcon	-0.0156519	0.0499125	-0.31	0.754	-0.113479	0.082175
Inmercha	0.0264935	0.0478069	0.55	0.579	-0.067206	0.120193
Ingcf	0.0805538	0.0625194	1.29	0.198	-0.041982	0.203090
internet	0.0032648	0.0032589	1.00	0.316	-0.003123	0.009652
mob	0.0013865	0.0014469	0.96	0.338	-0.001449	0.004222
inf	-0.0000050	0.0000045	-1.09	0.275	-0.000014	0.000004
popg	0.0196037	0.0430766	0.46	0.649	-0.064825	0.104032
Wald			chi2(18) = 35516.85 Pr > chi2 = 0.000			
Arellano-Bond test for AR(1) :			z = -1.12 Pr > z = 0.264			
Arellano-Bond test for AR(2) :			z = 0.95 Pr > z = 0.340			
Sargan test of overid. Restrictions:			chi2(127) = 118.31 Pr > chi2 = 0.697			
Hansen test of overid. Restrictions:			chi2(127) = 25.59 Pr > chi2 = 1.000			
Difference-in-Hansen tests of exogeneity of instrument subsets						
GMM instruments for levels						
Hansen test excluding group			chi2(103) = 24.41 Pr > chi2 = 1.000			
Difference(Null H=exogenous)			chi2(24) = 1.18 Pr > chi2 = 1.000			
iv (exogenous regressors)						
Hansen test excluding group			chi2(114) = 24.12 Pr > chi2 = 1.000			
Difference(Null H=exogenous)			chi2(13) = 1.47 Pr > chi2 = 1.000			
Number of observations					340	
Number of groups					40	
Number of instruments					146	

Note: The variable with "*" is significant at p<1%.

Year dummies are also included in the estimation.

In the regression with full instrument sets (Table 1) although all the tests perform well, instrument proliferation has been observed. There are 146 instruments for 40 groups. In the literature (see Roodman 2009) it is well documented as our instrument count rises the bias of the estimates also increases leading to a failure to eliminate the

endogenous components of our endogenous variables i.e. the instruments for the Internet and mobile subscribers. High instrument count has also made our Hansen test to be extremely good which has p- values of 1.000. Hence following the literature we have collapsed our instruments. Results are presented in table 2.

Table 2: Dynamic panel-data estimation, two step system GMM(Instruments are collapsed)

Dependent variable: GDP per capita(lngdppc)

Variable	Coef.	Corrected Std. Err.	z	P>z	[95% Conf. Interval]
lngdppc L.1	0.9060462	0.0584609	15.5	0.000*	0.791465 1.020628
Ingovcon	-0.0745640	0.0277070	-2.69	0.007*	-0.128869 -0.020259
lnmercha	0.0346075	0.0616460	0.56	0.575	-0.086216 0.155431
lngcf	0.0491633	0.0232818	2.11	0.035**	0.003532 0.094795
internet	0.0033255	0.0029750	1.12	0.264	-0.002506 0.009156
mob	0.0012131	0.0006973	1.74	0.082***	-0.000154 0.002580
inf	-0.0000136	0.0000041	-3.31	0.001*	-0.000022 -0.000006
popg	-0.0306409	0.0190808	-1.61	0.108	-0.068039 0.006757
Wald			chi2(18) = 3.73e+07 Pr > chi2 = 0.000		
Arellano-Bond test for AR(1):			z = -1.1 Pr > z = 0.268		
Arellano-Bond test for AR(2):			z = 0.95 Pr > z = 0.340		
Sargan test of overid. Restrictions:			chi2(21) = 8.39 Pr > chi2 = 0.993		
Hansen test of overid. Restrictions:			chi2(21) = 22.26 Pr > chi2 = 0.385		
Difference-in-Hansen tests of exogeneity of instrument subsets					
GMM instruments for levels					
Hansen test excluding group			chi2(18) = 19.58 Pr > chi2 = 0.357		
Difference(Null H=exogenous)			chi2(3) = 2.68 Pr > chi2 = 0.444		
iv(exogenous regressors)					
Hansen test excluding group			chi2(7) = 10.90 Pr > chi2 = 0.143		
Difference(Null H=exogenous)			chi2(14) = 11.36 Pr > chi2 = 0.657		
Number of observations					340
Number of groups					40
Number of instruments					40

Note: Variables with "*", "**", and "***" are significant at p<1%, p<5%, and p<10% respectively.

Year dummies are also included in the estimation.

Results from the estimation procedure with collapsed instruments show that the null hypothesis of joint insignificance of the coefficient of all independent variables is rejected. This is confirmed by the Wald- test. This shows that variables selected for the estimation procedure are valid jointly i.e. Internet penetration; number of mobile subscribers; lagged GDP per capita, government consumption, gross capital formation, trade openness, inflation, and population growth are relevant in explaining the change in the GDP per capita income of Sub-Sahara Africa jointly. The Arellano-Bond test for zero autocorrelation in first differenced errors at order 1 and order 2 shows that errors are not serially correlated implying consistency of the parameters. Hence, our instruments are valid in predicting current levels of GDP per capita. The Hansen test of over identifying restrictions also shows that we fail to reject the null hypothesis of joint instrument validity implying that our instruments are indeed jointly valid. The difference-in-Hansen test for GMM instruments for levels show that the instruments (lagged differences) are exogenous to the error term in the level equations. Based on this test we can conclude that our system GMM is working well and results are reliable. Therefore, the assumptions needed for the system GMM estimator to be valid are not ruled out. The two Hansen tests for excluding group for both instruments in levels in the GMM and the IV instruments have p-values of 0.357 and 0.143 respectively. This implies that we cannot reject the null hypothesis that the instruments are correctly excluded. Since these values are far below 1.000, instrument proliferation may not be a problem in our case. The test also fails to reject the hypothesis of instrument exogeneity in both the GMM instruments for levels and the IV. Based on the diagnostic tests we conclude that our system GMM is working well and results are reliable. Therefore, the assumptions needed for the system GMM estimator to be valid and consistent are not ruled out.

Results also show that all variables have their expected sign. The coefficient on the lagged value of the GDP is 0.906042 and it is significant at $p < 1\%$ level. From the estimation results we observe that past GDP per capita in the region affects current GDP per capita income positively, showing persistence of the macroeconomic variable. The variable's coefficient indicates that our model is indeed dynamic showing a convergence towards equilibrium values in the region.

From Table 2 we can also see that both mobile telephone and the Internet contributed to the GDP per capita of people living in Sub-Saharan Africa. The result is in line with previous studies conducted by Lee et al. (2009), Chavula (2013), and Donou-Adonsou et al. (2016). Especially, the contribution of mobile telephone is positive and significant at the 10% significance level. A 10% increase in mobile phone subscribers raises GDP per capita income by 1.2%. Although Internet's contribution is positive it is statistically insignificant at all commonly used significance levels. The insignificant impact of the Internet could be due to low penetration of the technology in most of this region. As Roller and Waverman (2001) have explained telecommunications infrastructure is characterized by *network externalities*. The implication of such externalities is that the growth impact of telecommunications might not be observed unless a significant network size is achieved. In other words a *critical mass* is needed to have a significant impact from telecommunications, like the Internet (see p. 911). The other explanation could be related to the lack of ICT skill of Internet users. In order to fully realize the potential of the Internet individual users must have appropriate ICT skills. Studies show that ICT skills are crucial for economic growth and development. This implies that a low level of ICT skill will have an insignificant impact on economic activities. The other reason could be related to the adoption time of the technology. The development of ICT, especially, the Internet is a recent phenomenon in SSA. Therefore, although the Internet has an insignificant impact on the GDP per capita income change it has the potential to affect income of the people of the region significantly through time. The other factor to the insignificant impact of the Internet could be related to the unavailability of local content on the global network. It is known that SSA is rich in cultural and linguistic diversity. However, it is underrepresented on the global network. In other words, local content is scant. This might have prevented users from exploiting the full potential of the Internet and hence affecting their income significantly.

The other commonly used variables which determine economic growth such as government consumption, and annual inflation rate affect per capita income negatively and significantly at $p < 1\%$ significance level. Annual population growth was also found to affect per capita income negatively, though insignificantly at any of the commonly used significance levels. Total

expenditures on additions to the fixed assets of individual country (gross capital formation) affects per capita income positively and significantly at $p < 5\%$ significance level. Furthermore, each country's openness to the global economy has contributed to the region's economic activity positively, although the impact was insignificant at any of the conventional significance levels.

5. Conclusion and Recommendation

Conclusion

Many people in sub-Saharan Africa are suffering from lack of food, clean water, improved health services, electricity, shelter, education and other basic services such as telecommunications. In order to reduce such problems, African governments and the international community have been engaged in various poverty reduction programs. Among those efforts the commitment to expand ICT access is worth mentioning. A number of ICT policies have been designed and implemented during the last decade. As a result, the number of mobile subscribers and Internet users has increased. As our estimated results showed this ICT expansion in the form of increasing mobile phone subscribers and rising Internet users has impacted the per capita income of the people in the region in a favorable way. During the last ten years the expansion in mobile phones has improved the per capita income of the region. Therefore, promoting mobile phone usage will play a critical role in reducing the poverty level of the region through raising the per capita income of the population. Our results imply that a "critical mass" of users of mobile phones has been achieved in SSA. Thus, in addition to improving access to mobile phones in the region all stakeholders should look for ways which could maximize the potential benefits of mobile phones. For instance, developing mobile applications tailored to the local needs would further enhance growth. Hence, governments should design and implement policies which promote the expansion of mobile phones. Telecommunications companies should also play their role in making mobile telecom services affordable and accessible to both rural and urban population. Donors and the international community should also support local start-ups which specialize in mobile applications developments.

As our results show the Internet has not been a critical contributor to the per capita GDP during the study period. Despite the steady rise in the number of Internet users in the region its positive impact is statistically not notable. This could be due to low penetration of the technology in most of the region. The other explanation could be related to the lack of ICT skill. In order to fully realize the potential of the Internet individual users must have appropriate ICT skills. Furthermore, the development of the Internet is a recent phenomenon in SSA. As a result any significant impact would take time to show up. Scarcity of local content on the Internet could also be one of the reasons preventing the technology to have any notable impact on the income of people in SSA.

Recommendations

Therefore, governments and other stakeholders should design policies that encourage expansion of the Internet until a critical mass of users is achieved. In addition to improving Internet access, policies which focus on ICT skill development should be designed and implemented. It is also widely known that SSA is rich in cultural and linguistic diversity. However, it is underrepresented on the global network. This might have prevented users from exploiting the full potential of the Internet in enhancing economic growth.

Therefore, governments should design policies which encourage the presence of local contents, preferably produced in local languages, on the Internet.

Telecommunications companies should also revise their Internet access prices in order to increase the number of Internet users.

Donors and the international community should also give their support directly to those startups which focus on local content production and distribution.

Appendix 1: Summary statistics

Variable		Mean	Std. Dev.	Min	Max	Observations
lngdppc	overall	6.938206	1.095849	5.04278	9.966791	N = 400
	between		1.083739	5.375732	9.728726	n = 40
	within		0.2299707	6.272862	9.025262	T = 10
lngovcon	overall	2.58731	0.4228531	0.6931472	3.678829	N = 395
	between		0.3780397	1.548057	3.600212	n = 40
	within		0.2066524	0.8571699	3.38689	T-bar=9.875
lnmercha	overall	4.009908	0.4463769	2.624669	5.103518	N = 398
	between		0.4196297	3.173401	4.982807	n = 40
	within		0.1633689	3.313155	4.520981	T = 9.95
lngcf	overall	3.027383	0.4526481	0.4700036	4.238445	N = 396
	between		0.3813701	1.866687	3.957047	n = 40
	within		0.2493689	1.157726	4.032548	T = 9.9
internet	overall	8.060354	9.763988	0	51.9	N = 396
	between		7.779102	1.01	31.49	n = 40
	within		6.049863	-12.58965	31.91035	T-bar = 9.9
mob	overall	54.33568	36.75265	1.1	171.4	N = 398
	between		27.55801	15.76	124.1	n = 40
	within		24.5986	-21.56432	129.8557	T-bar= 9.95
inf	overall	73.03005	1243.244	-35.8	24411	N = 386
	between		503.2076	1.73	3189.487	n = 40
	within		1157.389	-3118.857	21294.54	T-bar= 9.65
popg	overall	2.57175	0.7139687	0.1	4.2	N = 400
	between		0.6973021	0.29	3.88	n = 40
	within		0.1857114	1.76175	3.56175	T = 10

List of countries included in the study

Angola
Benin
Botswana
Burkina Faso
Burundi
Cameroon
Central African Republic
Chad
Comoros
Congo (Brazzaville)
Congo (Democratic Republic)
Cote d'Ivoire
Equatorial Guinea
Ethiopia
Gabon
Gambia
Ghana
Guinea
Guinea-Bissau
Kenya
Lesotho
Liberia
Madagascar
Malawi
Mali
Mauritius
Mozambique
Namibia
Niger
Nigeria
Rwanda
Senegal
Sierra Leon
South Africa
Sudan
Swaziland
Tanzania
Togo
Uganda
Zimbabwe

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