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and

Ethiopian Strategy Support Program (ESSP) of IFPRI

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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).

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FOREWORD

The Ethiopian Economics Association (EEA) is happy to issue two volumes of the proceedings of the 16th International Conference (the 27th Annual Conference) on the Ethiopian Economy that was held from July 19 – 21, 2018 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 (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 and the Friedrich Ebert Stiftung of Germany is also critical for the organization of this important conference and other activities of the Association.

This year's conference, as was last eight years, has been 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, and European Union (EU), Awash International Bank and United Bank S.C. The contribution of EEA's partners that includes the 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. The Association well recognized the support of sponsors and partners institutions during the opening and closing time of the conference and by displaying the support at the conference program, which has been distributed to all participants and medias; and banners at different corners of the venue.

At the conference about 69 presentations were made in four plenary and four parallel sessions with the attendance of about 938 persons in three days (480, 239 and 219 participants in the first, second and third days, respectively). In addition, two panel discussions and one key note speech were also organized. Out of the total 69 presentations, about 42 were presented by partner institutions like (IFPRI-ESSP), International Growth Centre (IGC), United Nation Economic Commotion for Africa (UNECA), the World Bank, EDRI, AKLDP Ethiopia/Tufts University, Gonder University and Addis Ababa University etc. The rest 27 papers were presented by individual researchers.
The conference was opened by H.E. Ato Demeke Mekonnen, Deputy Prime Minster of the Federal Democratic Republic of Ethiopia, at the presence of higher dignitaries and invited guests. The presence of H.E. Ato Demeke Mekonnen, Deputy Prime Minster of the Federal Democratic Republic of Ethiopia who greatly honored us by opening officially the conference demonstrate the value of the conference to the economic policy making process of the country. H.E. Ato Demeke Mekonnen not only graced the conference by officially opened the conference, but also by attending the first key Note speech on Inclusive Growth in Ethiopia by Professor Stefan Dercon.

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 14 papers to be included in the proceedings. All these papers are organized into two volumes. Volume I consists of Macroeconomics, Industry and Social Sector Related Topics 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. The staffs of the EEA and Executive Committee of the Ethiopian Economics Association deserve a special recognition for their enthusiasm and perseverance in managing the conference from inception to completion.

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, 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 Demeke Mekonnen, Deputy Prime Minster 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 strengthen its capacity and 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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Macroeconomics, Industry and Social Sector Related Topics

Dynamics of Technology Gap between OECD and African Nations: Structural Estimation

Samson Gebresilasie Gebrerufael[1]

Abstract

Like other technology gap models applied in the North and the South, application of the Latin American Structuralists (LAS) technology gap model in OECD &African nations reveals that technology spillovers due to the technology gap is not as easy task as presupposed. Using the per capita GDP difference between OECD and sample African nations (including Ethiopia) as a proxy for technology gap, this study indicates that the per capita GDP gap significantly and positively affects the per capita GDP gap growth rate (proxy for technology gap growth rates). This implies that the "weak" efforts African nations exerted so far to benefit from the technology gap and absence of "automatic catch up tendency" between the heterogeneous technology producing and technology extracting nations. Moreover, the result could indicate absence of equilibrium in the global economic system (instability of the global economic system). However, the sectoral growth contributions (of agriculture, manufacturing and service sectors) in Africa significantly and negatively affect the per capita GDP gap growth rate. Even if the relative sectoral growth contributions themselves are found to be in favor of the North (OECD nations), the finding indicates that African sectors are playing crucial role in reducing the technology gap growth rate. The largest contribution of the service sector, however, in reducing the technology gap growth rate could command long run structural transformation of African economies to manufacturing dominant one as manufacturing sector is the most dynamic sector of all sectors. Overall, the technological asymmetry between OECD and Africa is found to be further soaring. The linear panel data regression is conducted on 34 sample African nations and OECD member nations for the period 1991-2014 using the World Bank Database (WDI database).

Key Words: Technology, Technology gap, Technology gap growth rate, Relative sectoral growth contributions, OECD nations, Africa, North, South, LAS technology gap model

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1. Introduction

Both the mainstream and heterodox schools widely advocate immense role of technological capabilities in the international level of development differentials. One of the heterodox schools of thoughts that deal with the technology gap is the Latin American Structuralism (LAS) School. Even if the LAS idea is significant in the long run growth theories of heterodox tradition, it is not broadly familiar to students and researchers (Cimoli and Porcile, 2011). Based on the non-linear technology gap model of Verspagen (1991), economic catch up tendencies are observed within groups of Western style economies (homogenous economies) themselves while it is missing taking groups of homogenous and heterogeneous economies (advanced and poor nations). This argument could lead us to articulate catch up is not "manna from the heaven" that every poor nation enjoys it due to a mere existence of technology gap and spillovers without any deliberate efforts ("automatic catch up") to exploit the spillovers that come up from the technology pap. Since what the LAS technology gap model would articulate about the idea of "automatic catch up" tendencies (of the mainstream school) is not yet empirically tested between advanced and developing nations (such as African nations) so far, this study therefore would be instrumental to add to the ongoing theoretical and empirical debates (between the mainstream and heterodox schools).

The purpose of this paper is, therefore, to empirically present how the LAS technology gap model is relevant to explain the position of African nations in terms of the extent they are benefiting from spillovers that come up from the prevailing positive technology gap between the OECD and African nations. The study could also benefits both the internal and external actors. The internal actors (African policy makers and the governments) could get direction of structural transformation and particularly the roles the governments could play in the economic transformation efforts. The external actors (the North) could also benefit from this paper as it points their roles and gains in helping the better performing African economies.

The paper is organized in 6 sections. Section 2 presents state of science, technology and innovation in Africa; Section 3 presents' theoretical and empirical literatures; section4 presents' methods; section 5 presents results and section 6 concludes.

2. State of Science, Technology and Innovation in Africa

General observation of African state of science, technology and innovation seems to be at its lowest level. Among others, the indicators are the very small share of Africa`s modern knowledge base, very small application of technology to development challenges and very small trade in technology assets and products (UNECA, 2013).

However, education as a weapon to ensure long run technological catch up, encouraging results have been registered over the past decade. For instance, even if African overall enrollment rate in tertiary institutions in Sub-Saharan Africa is much lower than Asia and Latin America and the Caribbean, the enrollment rate have been soaring at annual rate of 15% from the year 1999 to 2008 (ibid.).

Based on survey conducted by ASTII[2] on 13 African nations, the number of researchers per 1 million inhabitants is lower than 1000 for more than 50% of the surveyed countries. This figure is much lower than the innovative economies like Republic of South Korea which has around 4627 researchers per 1 million inhabitants. However, the number of African researchers is comparable with Brazil which has 500 researchers per 1 million inhabitants (AU-NEPAD, 2010). With regards to R&D expenditure it is less than 1% of GDP of the surveyed counties (ibid.)[3]. However, considering the trend, the publications of the prevailing few African researchers' scientific works in internationally accepted peer reviewed journals are soaring from year to year (UNECA, 2013).

Intellectual property rights as a good indicator of innovativeness, there is lack of intellectual property right data in African. That is, only nine African countries seems to have somehow organized office that grant intellectual

[2] ASTII is abbreviation of African science technology innovation indicators.
[3] South Africa, Malawi and Uganda have R&D expenditure equivalent to 1% of their respective GDP (AU-NEPAD, 2010).

property right and have data for 10 or more years[4]. This makes it somehow difficult to talk about the state of Africa in intellectual property right (ibid.).

3. Theoretical and Empirical Literatures

Basic Concepts: Technology and Knowledge

In dealing with technology dynamics the concepts of knowledge and technology are worth notice. Knowledge is "knowing thing" which could be theoretical (basic)[5] and practical (applied). Theoretical knowledge is detailed understanding of the thing being searched. Practical knowledge is about knowing cause-effect relationships that are expected to happen in practice (Fagerberg, Srholec and Verspagen, 2009). However, since the knowledge might not be easily found and incompletely available, to search for it for the first time or investment in education or training that allow successfully imitation of what others already have been doing is recommended (ibid.). For economists, technology is the concern of how economic agents produce and distribute goods and services. In this sense, technology is a subset of knowledge which represents the practical (applied) component of knowledge (ibid).

Catch-up Debates: Theory and Empirics

The "old" neoclassical growth theories of the 1950s advocate the possibility of technological catch-up based on the heroic assumption that technology is public good and therefore freely available to everybody. Technological catch-up based on the assumption of public good nature of technologies implies that there will be equilibrium in the global economic system. Moreover, the public good nature of technologies is supposed to let all nations to grow by the same rate of the exogenous global technological growth rate in the long run. However, in the move towards the long run growth rate, economies are

[4] South Africa, Morocco and Egypt could be mentioned among others.

[5] Basic knowledge is to know new ideas, principles, theories which may not be immediately utilized but it is a basis of progress and development for all fields of studies and productive activities.

supposed to have different growth rate due to differences in the initial condition[6] (ibid.).

The "old" neoclassical growth theories expect poor economies to grow at fastest rates than the rich nations. The rationale for the expected fastest growth rates in poor economies is due to high marginal productivity of capital as marginal productivity of capital is higher in the nations where there is lower employment of capital compared to labor. The higher rate of return on capital results in higher accumulation of capital and therefore higher per capita income growth rate (ibid.).

However, studies conducted on determinants of long run growth evidenced that factor growth (capital accumulation and labor) could not explain well being as a long run growth source. More precisely, based on some empirical findings such as Abramovitz (1956), Solow (1957) and Denison (1967), the economic growth of nations was found to be less explained by the difference in the growth rate of capital and labor. Considering the first empirical research (Abramovitz, 1956), the majority of the source of US per capita income growth is unexplained and categorized as total factor productivity growth ("residual" or "measure of our ignorance"). Following these findings, the new growth theories came to exist by expanding the basic production function in the manner the production function incorporate technology as an endogenous[7] and the third source of production in addition to labor and capital (Fagerberg, 1987).

With regards to the optimistic scenario of the "old" neoclassical convergence growth theory, different studies conducted on the poor economies and rich economies since the Industrial Revolution[8] indicated that the tendency is

[6] The difference in per capita income growth rate due to the difference in the initial condition is called "transitional dynamics".

[7] The endogenous growth theories (the new growth theories) could be found on Romer (1986 and 1990) and Aghion and Howitt (1992&1998). These theories advocate differences in economic development across countries are the result of differences in endogenous knowledge accumulation within nation's territory.

[8] Industrial Revolution, which is began in Great Britain, is the transition to new manufacturing process in the period from about 1760 to sometime between 1820 and 1840. The transition included going from hand production method to machine, new

towards divergence[9] than convergence in productivity and income (Fagerberg, Srholec and Verspagen, 2009).

Moreover, Pritchet (1997) also evidenced existence of large inequality and divergence since the history of modern capitalism (the late 1800s). With regards to the kind of convergence observed before and post World War II, Maddison (1991), evidenced that absolute convergence was not feature of industrial economies before the World War II. In other words, industrial economies have been experiencing absolute convergence only during the postwar (post World War II) era. However, this absolute convergence was not the feature of developing economies in the postwar era (Ros, 2000).

Among the developing nations, the only nations shifted to the high income countries in the 20th century is Japan. However, convergence to the middle income category was seen in Southern Cone Latin American Countries (in the late 19th and early 20th centuries), Latin American economies (in the inter-war period), Asian newly industrialized economies (in the postwar), China (since 1980s) and India (since 1980s). The driving force for shift to the middle income category was due to the reallocation of labor (based on increasing returns to scale) from low productivity sectors to high productivity sectors (ibid.).

The cause of the "unlevel playing field" in the international economy could be associated with prohibitive entry cost of technologically mature activities, financial asymmetries and macroeconomic asymmetries (ECLAC[10], 2003).

Technology Gap: Theories and Empirics

Posner (1961), Gomulka (1971) and Cornwall (1976, 1977) presented the role of technology in the process of economic growth and technology gaps between the rich and the poor economies could be gradually narrowed if

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chemical manufacturing and iron production processes, improved efficiency of water power, increasing use of steam power, the development of machine tools and the rise of the factory system (Landes, 1969).

9 See Islam (2003) and Landes (1998) for detail analysis on the historical divergence in productivity and income.

10 ECLAC is short form of economic commission for Latin American and the Caribbean.

radical changes in the prevailing technological, economic and social structures are observed in the poor economies. The radical changes required to narrow the technology gaps are exhaustively presented in the following paragraphs.

“Economic growth in developing countries is intrinsically tied to the dynamics of production structures and to the specific policies and institutions created to support it” (Ocampo, 2005). The dynamics of production structure refers to evolution of the sectoral composition of production, evolution of intra and inter sectoral linkages, evolution of market structures, evolution of factor markets and evolution of institutions that support all of them i.e., institutions that support intra and inter sectoral linkages, market structures and factor markets (ibid.).

The policy and institutions supposed to support economic growth are those that facilitate the diffusion of innovations generated in the industrialized world and that promote creation of linkages among domestic firms and sectors.

The level of technological and innovative activities of a nation could be measured in terms to two measures viz technological input measures and technological output measures (Soete, 1981). The technological input measures are identified as expenditure on education, R&D and employment of scientists and engineers. The technological input measures could be related to the innovative and imitation capacity of a nation (Fagerberg, 1987). The technological output measures are identified to be patenting activities which are supposed to be the direct result of technological input measure (ibid.). The technology gap theorists of the neo-technological tradition such as Kravis (1956), Posner (1961), Vernon (1966) and Hirsch (1967) relate the technology level to its level of innovative activities. A high level of the innovative activity of a nation is manifested by the share of new goods in output and the new input and a new technique employed in the production process (ibid.).

Technology gap could be positively and negatively affected by innovation and imitation respectively (Schumpeter, 1934 & 1939). This statement could be further elaborated as innovation by the North could further increase the gap (positively impact the gap) and imitation by the South could decrease the (negatively impact the gap). Simply put, if the force of innovation is greater than the force of imitation, the technology gap further increase and vice versa. This implies that the south could grow fast benefiting from the open chance of imitation possibilities and narrow the level of economic development gap. However, this chance of imitation possibilities basically depends on the imitation efforts of the South and the innovative efforts of the North in widening the gap (Fagerberg, 1987). The innovation efforts of the North are not debatable as trade between north and south basically depends on innovation efforts of the north. The northern monopoly over innovation (first hand innovation) is a must to maintain its relative position and its real income in absolute terms (Krugman, 1979).

In measuring dynamics of technology gap, preferred proxy variable for the variable technology gap is GDP per capita as the other competing proxy variables like patent and R&D based technology gap measures give close result. While the disadvantage of using patent index of nations for technology gap measure overestimates the absolute differences in technological level between countries, R&D data do not exist for several countries and periods (ibid.). Empirical findings of Parvin (1975), Cornwall (1976, 1977), Marris (1982) and Lindbeck (1983) presented that technology gap (measured by GDP per capita) and efforts to exploit the technology gap (measured by investment ratio) significantly affect economic growth.

The technology gap study conducted within the group of Northern Western style industrial economies indicated that the process of catching up is evident due to diffusion of technology. This could indicate catch-up requires being sufficiently homogenous for transferring and diffusion of existing knowledge (Singer and Reynolds, 1975)[11]. The same result is obtained by Verspagen (1991) in which he precisely indicate that while catch up between western style industrial economies is evident, the same catch up tendency failed to happen between the Western style economies and the poor nations.

Finally, among the technology gap models, the less familiar (to researchers and students) technology gap model is the Latin American Structuralism

[11] Per capita GNP was taken as a proxy to measure the technology gap among the then OECD economies.

(LAS) model which is a significant part of the heterodox tradition in the theory of long run growth. The LAS model focuses on the problems of developing economies which started their industrialization process when other regions had already accumulated substantial technological capabilities (Cimoli and Porcile, 2011). This paper, therefore, presented the dynamics of technology gaps between OECD and African nations. Specification of the model is exhaustively presented in the next (methodology) part of this paper.

4. Methodology

4.1 Data

The paper employs secondary data from World Bank`s database (WDI database, Feb, 2016). The variables taken from the WDI database are per capita GDP (at market price in constant 2005 USD) for both African and OECD member countries and sectoral[12] value added (at market price in constant 2005 USD) of the 34 sample African nations for the period of 1991-2014.

4.2 Method of Analysis

The linear panel data regression method is applied to test the LAS technology gap model. The commonly used linear panel data regression methods are the pooled OLS, the fixed effect (FE) and the random effects (RE) regression methods. However, since pooled OLS is assumed to suffer from time-constant unobserved effects that can vary with explanatory variables (i.e., suffer from endogenity), the FE and the RE regression methods are standard and preferable in a sense that they can control for drawbacks of the pooled OLS method. Therefore, one of the estimates of FE and RE regression methods will be taken and analyzed based on the Hausman specification test (Wooldridge, 2002 and Guajarati, 2004).

[12] They are agriculture, manufacturing and service sectors.

4.3 The Model: The Linear LAS Technology Gap Model

The specification of the linear LAS technology gap model would be based on the following structuralists toolbox (economic behaviors from structuralists point of view) provided by Cimoli and Porcile (Cimoli and Porcile, 2011).

Dynamics of the Technology Gap

$$G = \ln\left(\frac{T_n}{T_s}\right) = \ln(T_n) - \ln(T_s) \qquad .(1)$$

Where G= technology gap, Tn= technology in the North (per capita GDP in the North is considered proxy for Tn) and Ts= technology in the South (per capita GDP in the South is considered proxy for Ts). "G" is constrained to be greater than 1 because of the fact that current technological capability in the North is much better than the South. The technology gap is based on the idea that international diffusion of technology is slow and irregular (Prebisch, 1949).

Taking the time derivative of equation (1), it will be:

$$\dot{G} = \frac{dG}{dt} = \frac{d}{dt}\ln\frac{T_n}{T_s} = \frac{\dot{T}_n}{T_n} - \frac{\dot{T}_s}{T_s} \qquad (2)$$

Equation (2) is time derivative of the technology stock gap (technology stock gap growth rate). Based on the LAS toolbox, the technology stock gap growth rate ($\dot{G}$) could be influenced negatively by the technology stock gap (G) itself and the relative growth of the South. The aggregate relative growth of the South is decomposed to the relative sectoral growth contributions as it could allow presenting sectors that are contributing more to technical progress in the South. In other words, no all sectors have the same capacity to make the economy more dynamic or propagate technical progress (Prebisch, 1964).

The technology gap (G) is supposed to have negative effect on the technology stock gap growth rate ($\dot{G}$). This is because the higher the technology gap (G), the South will have opportunity to imitate and benefit from international technology spillovers which gradually supposed to narrow the technology stock gap growth rate ($\dot{G}$) and then catching up in the South[13]. In other words, it is believed that the technology gap offers the possibility of using existing foreign technology to build up indigenous capabilities.

Higher relative sectoral growth contributions of the South are also supposed to narrow the technology stock gap growth rate as higher relative sectoral growth contributions of the South are positively related with higher labor productivity which could in turn negatively affects the technology gap. This argument is based on the idea that "the international system is formed by two poles, the North (Centre) and the South (Periphery), whose economies are structurally different. While the North is diversified and shows levels of labor productivity relatively homogeneous across sectors, the South specializes in a narrow set of commodities with large differences in labor productivity within and between sectors. The existence of such differences in productivity and the fact that a significant part of the labor force in the South is allocated in the subsistence sector and/or in the informal labor market is called structural heterogeneity" (Cimoli and Porcile, 2011).

The idea of focusing on structure of the economy in the efforts to bring higher per capita GDP growth is also supported by Chenery, Robinson and Syrquin (1986) and Balassa (1989). They state that the tendency of per capita income growth should be accompanied by regular changes in the sectoral composition of output and in the pattern of international specialization. The same idea is also delivered by Kaldor-Verdoorn Law[14].As it is already stated, Prebisch (1964) also argues that no all sectors have the same capacity to make the economy more dynamic or propagate technical progress. This argument could lead us examine which sector/s is/are playing crucial role in the efforts to ensure technical progress in the South and lowering the technology gap growth rate.

[13] Catch up tendency will be there when the technology gap growth rate dies out ($\dot{G}$=dG/dt=0).

[14] Based on Kaldor-Verdoorn Law (1966 &1949 respectively): $P=\alpha+\beta Q+\varepsilon$; where $\beta>0$, P=labor productivity, Q= output. The law states strong positive relationship between labor productivity and output. Therefore, the implication we could derive from this is that as sectoral outputs in the South grows, the labor productivity of sectors grow and then the technology gap between the nations in the South and the North get narrow gradually.

Therefore, based on the aforementioned arguments, the determinants of the technology stock gap growth rate could be symbolically stated as:

$$\dot{G} = f(\underset{(-)}{G}, \underset{(-)}{y_a}, \underset{(-)}{y_m}, \underset{(-)}{y_s}) \tag{3}$$

From equation (3), ya=gas/gan[15] (relative growth contribution of the agricultural sector in the South), ym=gms/gmn(relative growth contribution of manufacturing sector in the South) and ys=gss/gsn(relative growth contribution of the service sector in the South).

The growth contributions of sectors are constructed for both the African and the OECD nations (to derive the relative growth contribution of sectors in the South) based on the following simple GDP identity:

$$Y = Y_A + Y_M + Y_S \tag{4}$$

$Y = GDP$

$Y_A = Agriculture\ Value\ added$

$Y_M = Manufacturing\ Value\ added$

$Y_S = Service\ Value\ added$

$$\Delta Y = \Delta Y_A + \Delta Y_M + \Delta Y_S \tag{5}$$

$$\frac{\Delta Y}{Y} = \frac{\Delta Y_A}{Y} + \frac{\Delta Y_M}{Y} + \frac{\Delta Y_S}{Y} \tag{6}$$

$$\frac{\Delta Y}{Y} = \frac{\Delta Y_A}{Y_A} * \frac{Y_A}{Y} + \frac{\Delta Y_M}{Y_M} * \frac{Y_M}{Y} + \frac{\Delta Y_S}{Y_S} * \frac{Y_S}{Y} \tag{7}$$

$$g = g_a + g_m + g_s, where\ g = \frac{\Delta Y}{Y}, g_a = \frac{\Delta Y_A}{Y_A} * \frac{Y_A}{Y}, g_m = \frac{\Delta Y_M}{Y_M} * \frac{Y_M}{Y}, g_s = \frac{\Delta Y_S}{Y_S} * \frac{Y_S}{Y} \tag{8}$$

[15] g_{as}=growth contribution of agriculture sector in South, g_{an}=growth contribution of agriculture sector in North, g_{ms}=growth contribution of manufacturing sector in South, g_{mn}=growth contribution of manufacturing sector in North, g_{ss}=growth contribution of service sector in South, g_{sn}=growth contribution of service sector in North.

From equation (8), g is GDP growth, ga is growth contribution of agriculture, gm growth contribution of manufacturing sector and gs is growth contribution of the service sector.

Based on equation (3 to 8), equation (2) could be rewritten more explicitly as:

$$\dot{G} = \alpha + \beta G + \chi y_a + \delta y_m + \varepsilon y_s \qquad (9)$$

While the parameters α is constrained to be positive, the parameters (β,χ,δ and ε) are constrained to be less than zero (negative) due to the aforementioned theoretical reasons.

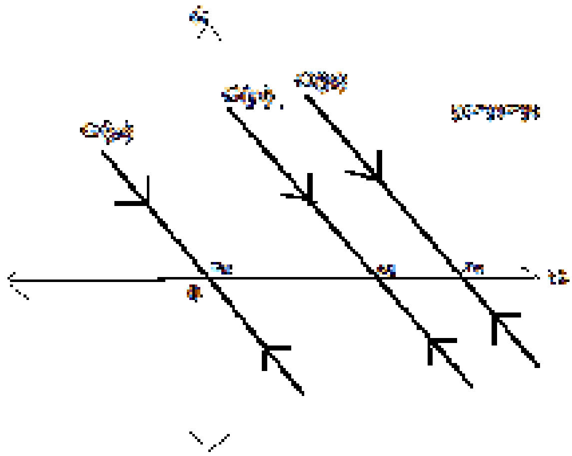
Equation (9) is stable differential equation which implies that the technology stock gap growth rate ($\dot{G}$) inversely related with the technology gap itself (G). At equilibrium, the technology stock gap growth rate dies out ($\dot{G}$=0) which implies the stability of the technology gap model. The equilibrium value of G when $\dot{G}$=0 is:

$$G = \frac{-\alpha - \chi y_a - \delta y_m - \varepsilon y_s}{\beta} \qquad (10)$$

Equation (10) implies that, the parameter β must be less than zero to benefit from the technology gap in the form of spillovers. This condition is basically needed because as the values of "ya, ym and ys" increase, the equilibrium level of "G" decreases as numerator of equation (10) become higher positive number (since α>0 while χ, δ, ε and β are < 0). In other words, sectoral growth contributions are meaningful for catch-up in case the coefficient of G is less than zero, ceteris paribus. In contrary, if β> 0, nations will have higher positive value of equilibrium G following higher values of ya, ym and ys which is against catch up tendency of nations. Simply put, if β is greater than zero (positive), it implies that the efforts of nations (in the South) for catching up are too weak and hence there is no room for international spillovers of technology. In this case, the equilibrium technology gap is a saddle point (unstable equilibrium) and the relative higher growth in the South will be pushing factor for the North to innovate more, export and widen the equilibrium technology gap further.

The theoretical stability of the LAS technology gap model could be presented using the following phase diagrams.

Figure 1: Theoretical Stability of the Linear LAS technology gap Model



Source: Based on of LAS technology gap model (Equation 10)

From Figure (1), the phase diagrams are down ward sloping lines which indicate the theoretical stability of the LAS technology gap model. The stability implies promise of catch up if economies in the South exert their level best to imitate technologies of the North. Point e0 (on the G(y0) phase diagram) represents the initial equilibrium level of G that makes $\dot{G}$ =0 and ensures catch up tendency in the South. If the relative sectoral growth contributions of the South (y or ya, ym and ys) increase, the equilibrium technology gap decreases to the level corresponding to point e1 (on the G(y1) phase diagram). The persistent increase in the relative sectoral growth contributions of the South would ultimately makes the equilibrium technology gap to be the level corresponding to point e2 (on the G(y2) phase diagram). At point e2 full catch up is supposed to be realized as the technology gap at this point is equal to zero. Thus, as long as $\beta<0$ (the coefficient of the variable G), the persistent increase in the relative sectoral growth contributions of the South allows the South to persistently decrease the level of equilibrium technology gap[16], ceteris paribus. However, if $\beta>0$, the persistent increase in

[16] See Equation 10.

the relative sectoral growth contributions of the South allows the equilibrium technology gap to further soar and therefore no promise of catch up at all.

Since we are going to deal with dynamics of technology gap in more than one nation, the panel data regression form of equation (9) would be:

$$\dot{G}_{it} = \alpha + \beta G_{it} + \chi y_{ait} + \delta y_{mit} + \varepsilon y_{sit} + u_{it} \tag{11}$$

Where, $\frac{dG_{it}}{dt} = \dot{G}_{it}$ = the technology stock gap growth rate of a given nation in Africa, say it "i", at time "t" and uit=the error term[17].

Therefore, based on the LAS technology gap model, we would have the following two hypotheses.

i. Per capita GDP gap (proxy for technology gap) negatively influences the per capita GDP gap growth rate (proxy for the technology stock gap growth rate)[18].
ii. The sectoral growth contributions of the South (ya, ym and ys) negatively influence the per capita GDP gap growth rate (Verdoorn,1949; Kaldor, 1966[19]; Prebisch, 1964; Chenery, Robinson and Syrquin, 1986 and Balassa, 1989).

[17] Based on the FE panel data method, coefficients of equation (11) indicate a percentage deviation of the explained variable (technology gap growth rate) of a nation from its own mean due to a percentage deviation of an explanatory variable from its own mean. For instance, the coefficient "β" indicates when technology gap of a nation deviate from the average technology gap by one percent, technology gap growth rate (the explained variable) of the nation deviate from the average technology gap growth rate by "β" percent. Moreover, the estimators are fixed effect estimators (within estimators) as the OLS based on fixed effect panel data method uses the time variations in explained and explanatory variables within each cross-sectional observations.

[18] Based on Kravis (1956), Posner (1961), Vernon (1966) and Hirsch (1967), GDP per capital differences are basically associated with differences in innovative activities. Innovative activities are defined as share of new products out of the total output, application of new inputs and technique in the production process. The rationale for this explanation is new goods bring higher returns and the new technique enhances the level of productivity. This is part of the analysis of neo-technological tradition.

[19] Verdoorn's law postulates the existence of a significant positive relationship between the growth rate of labour productivity and that of output.

4.4 Econometrics Procedures and Diagnostic Tests

To choose one of the potential estimation results of FE or RE, Hausman specification test would be consulted. What is central in choosing between the two regression results is that whether the time constant unobserved effects are correlating with explanatory variables or not. If there are time constant unobserved effects in the panel data set, FE could handle the case and avoid the problem of endogenity that arise from it. Therefore, estimates of the FE regression result would be relevant in case the Hausman specification test is significant as they are supposed to be consistent estimates and vice versa (Hausman, 1978).

Next, to test the possible autocorrelation in the panel data, Wooldridge Test will be conducted. Significant value of the F-statistics (of Wooldridge Test) implies that existence of first order autocorrelation in the data set as the null hypothesis of the test represents "no first order autocorrelation". The possible remedy for mal-effects of the first order autocorrelation is to have the robust standard errors of Driscoll-Kraay. The robust standard errors of Driscoll-Kraay could be used in case the Hausman specification test is in favor of FE estimates. Therefore, since the Hausman specification test in this study is in favor of FE estimates, the FE regression with robust standard errors of Driscoll-Kraay will be run to control the mal-effects of the first order autocorrelation observed in the data set.

5. Results

5.1 More on Variables and Sample Economies

Once again the five variables employed to test the LAS technology gap model are the per capita GDP gap growth rate (the explained variable), per capita GDP gap, growth contribution of the agricultural sector, growth contribution of manufacturing sector and growth contribution of service sector (the explanatory variables) of each sample African nation.

This paper uses sample of 34 African[20] nations (based on availability of data for the period 1991-2014) to represent the South while the North are

[20] See Appendix 8

represented by OECD nations. Therefore the yearly per capital GDP of OECD member nations (regional per capital GDP) is compared against per capital GDP of each sample African nation to calculate the technology gap of each Sample African nations for the period (1991-2014).

5.2 Descriptive Statistics

To present the directions and magnitudes of correlations between the explained variable and the explanatory variables, analysis of pair-wise correlation coefficients are conducted. Based on examination of the pair-wise correlation coefficients, the correlation coefficient between per capita GDP gap growth rate and the per capita GDP gap is found to be 0.05 which indicates existence of a weak positive relationship between the two variables. The correlation coefficients of the remaining variables are found to be negative with varying magnitudes. More specifically, the pair-wise correlation coefficients between per capita GDP gap growth rate and the relative growth contribution of agriculture is found to be -0.1753 while the per capita GDP gap growth rate and the relative growth contribution of manufacturing is -0.1306. Based on these magnitudes of the correlations coefficients, it could be possible to claim existence of weak and negative relationships between the variables. However, the relatively moderate correlation coefficient is found to be in favor of the relationship between per capita GDP gap growth rate and the relative growth contribution of the service sector (which is -0.4103)[21]. The directions of influence of all the correlation coefficients are consistent with the econometrics results (that we are going to see next). If need be, summery statistics with regards to number of observations, mean, standard-deviation, maximum and minimum of the five variables are also presented[22].

5.3 Regression Result

To start with some preliminary tests, Hausman specification test and Wooldridge test (to test autocorrelation in the panel data set) are conducted. The Hausman specification (Appendix 3) is found to be significant which

[21] See Appendix 6
[22] See Appendix 7

indicate evidence against accepting the estimates of the RE estimates. The Wooldridge test for autocorrelation is found to be significant which indicates existence of autocorrelation in the data set[23]. To tackle this problem of autocorrelation, the regression with Driscoll-Kraay standard errors is conducted which is supposed to provide robust standard errors of FE regression results[24]. Given these preliminary tests, our next concern will be to deal with estimates of the regression result based on the FE results (with robust SE).

Table 1: Regression with Driscoll-Kraay standard errors, Fixed Effect (FE)

Explanatory variables and the constant	Coefficients	t-value	P-value	Significance
g	0.0403231	2.24	0.032	**
ya	-0.00000187	-1.91	0.065	*
ym	-0.0000148	-2.45	0.020	**
ys	-0.0001884	-1.88	0.069	*
_cons	-0.1359026	-2.07	0.046	**

** and * represent less than 5% and 10% level of significance respectively.
g = per capita GDP gap (between OECD and Africa in logarithm)
ya= relative growth contribution of the agricultural sector in Africa
ym= relative growth contribution of the manufacturing sector in Africa
ys= relative growth contribution of the service in Africa
Source: Based on WDI data base (2016) for the period from 1991-2014.

Based on Table (1) the negative signs of the coefficients of the explanatory variables such as the relative growth contribution of sectors (ya, ym and ys) are found to be consistent with the theory (LAS technology gap model). However, the positive coefficient of the explanatory variable per capita GDP gap (g) is found to be against the LAS technology gap model. With regards to the statistical significances, all the explanatory variables are found to be statistically significant.

[23] see Appendix 4
[24] see Appendix 5

The statistically significant and positive relationship between per capita GDP gap growth rate and the per capita GDP gap might imply that Africa is not benefiting well from the technology gap. In other words, the condition implies that African nations are not benefiting well from the international technological spillovers in terms of learning and producing the more technologically complex commodities which could possibly allows them ensuring technological catch up tendency. Moreover, it might also indicate that the technology gap is helping the North itself to further innovate and widen the technology gap more.

The finding is consistent with the finding of Bart Verspagen (Verspagen, 1991). In his empirical findings related to catch up, Verspagen stated that catching up tendency does not hold automatically between developed and less developed countries (based on the non-linear model of catch he developed). To assimilate knowledge from abroad, a country must be able to apply the knowledge in its own economic system (ibid.). This explanation of Verspagen seems working in Africa as UNECA put the same suggestion about the technological position of Africa. That is, Africa's share of the global modern knowledge base, technology application to development challenges and trade in technology assets and products remains very small (UNECA, 2013).

Fagerberg (1987) and Schumpeter (1934 and 1939) also pointed out that technology gap decline as long as the imitation efforts of the South exceed the innovation efforts of the North. From this we cannot boldly say that Africa is not totally imitating rather the rates of imitation of Africa could be lower than the rates of innovation of the North (OECD) and therefore more gaps.

The statistically significant and negative relationship between the per capita GDP gap growth rate and sectoral growth contributions of sectors in Africa might imply that African sectoral growth contributions are playing a significant role in terms of reducing the per capital GDP gap growth rates (which is consistent with the LAS technology gap model and the Kaldor-Verdoorn law).

In terms of the role African sectors play, the best performing sector in reducing per capita GDP gap growth rate is the service sector. This is because the magnitude of the coefficient of growth contribution of the service sector is found to be relatively higher than the coefficients of the remaining relative sectoral growth contributions. The coefficient could be interpreted as, if the relative growth contribution of the service sector positively deviates from the average relative growth contribution of the service sector by 1%, the per capita GDP gap growth rate negatively deviates from the average per capita GDP gap growth rate by 0.019%. By analogy, the second and the third best performing sector in reducing per capita GDP gap growth rate are the manufacturing and the agricultural sectors relative growth contributions as their coefficients are found to be 0.0015% and 0.00019% respectively.

With regards to the value of the constant, it is found to be negative (-0.14) unlike what is supposed to be in the theory (the normal condition of the LAS technology gap model). As it is known, the negative value of the constant could be interpreted as, given all explanatory variables (the values of the relative sectoral growth contributions and the per capita GDP gap) unchanged the level per capita GDP gap growth rate negatively deviates (decreases) from the average per capita GDP gap growth rate by 14%.

Here we can also discuss the dynamics of the equilibrium technology gap using a phase diagram. The differential equation of the LAS technology gap model based on the parameters we find empirically could be stated symbolically as:

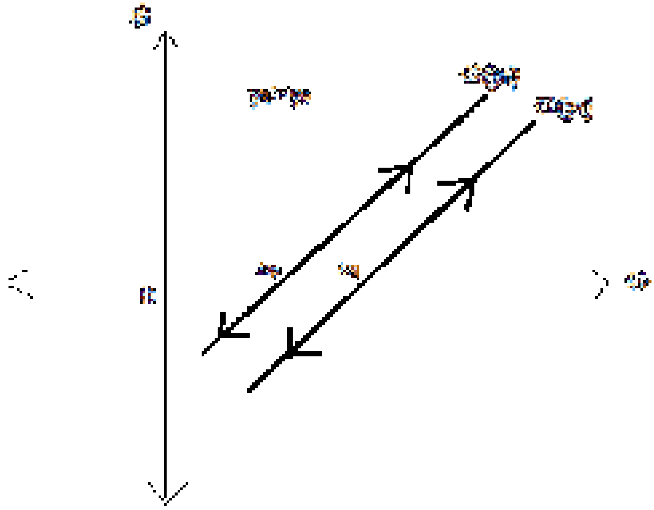
$$\dot{G}_{it} = -0.14 + 0.04 g_{it} - 0.0000019 y_{a\,it} - 0.00015 y_{m\,it} - 0.00019 y_{s\,it} \ldots \quad \textbf{(12)}$$

Given equation (12), equilibrium technology gap (g) is there where Ġ=0. That is, solving (12) for "g" while Ġ=0 is:

$$g_{it} = \frac{0.14 + 0.0000019 y_{a\,it} + 0.00015 y_{m\,it} + 0.00019 y_{s\,it}}{0.04} \ldots. \quad \textbf{(13)}$$

Equation (13) is a saddle point equilibrium level of technology gap (or equilibrium per capita GDP gap) corresponding to zero technology gap growth rate (zero per capita GDP gap growth rate). Since the coefficient of the technology gap (or per capita GDP gap) is positive ($\partial\dot{G}/\partial G > 0$), the equilibrium will be a saddle point (unstable) as stability requires ($\partial\dot{G}/\partial G < 0$). The following phase diagrams present the instability of the LAS technology gap model in OECD and African nations.

Figure 2: Phase diagram (of the linear LAS technology gap model in OECD and Africa)



Source: Regression result based on WDI database, 2016 (equation 13)

These upward sloping phase diagrams indicate the instability of the LAS technology gap model (in Africa and OECD nations) due to the positive coefficient of the per capita GDP gap. Point e0 and e1 are the saddle point equilibrium points on the phase diagrams G(y0) and G(y1) respectively. The phase diagram is constructed based on Equations (12 and 13). Corresponding to Point e0 there is supposed to be the initial equilibrium level of G (given the initial level of the relative sectoral growth contributions of Africa are represented by y0). If the initial levels of the relative sectoral growth contributions (y0) of Africa increase to y1, the equilibrium technology gap will increase and the level of the new equilibrium technology gap (per capita GDP gap) will be the amount corresponding to point e1. This implies that economic growth that could not tend to narrow the long run per capita GDP gap will worsen the international development differential (or worsen the income inequality). As it is already said, this condition commands African nations to enhance their current weak efforts to learn, apply and produce high tech goods in the long run. This is from the common sense that high tech goods are more valuable than the less complex commodities (on which Africa is already specialized) in the international markets. Moreover, it could be claimed that the past growth (the sectoral growth contributions) experience in Africa was not meaningful enough for catch up as the growths were not contributing to decreasing the technology gap. That is, growth is necessarily condition for catch up but not be sufficient condition for catch up as catch up requires a persistently falling technology gap and technology gap growth rate following a persistent higher relative growths.

To sum up, in the absence of negative coefficient of the per capita GDP gap (or in the absence of gradually joining the high tech goods markets), solely raising the relative sectoral growth contributions of the less complex outputs of Africa could not allow African nations to exhibit catch up tendency. This might be because the North could be motivated by access to markets for their complex commodities in Africa and produce more (in both quantity and quality) following the increase in the relative sectoral growth contributions in Africa. In other words, an ever growing technology gap between the North and the South (absence of global equilibrium) given the current aggressive innovativeness persists in the North and the current weak effort of imitation persists in Africa.

6. Conclusions

This paper surveys the efforts of African nations to benefit from technology spillovers that could arise from the existing technology gap. To meet the purpose the LAS technology gap model is consulted. Panel data regression method is employed on 34 sample African economies and OECD nations using WDI database for the period from 1991-2014.

The regression result presents a significant positive relationship between per capita GDP gap growth rate (proxy for technology gap growth rate) and the per capita GDP gap (proxy for technology gap) in the OECD and sample African nations. This finding is against the expected relationship under normal condition of the LAS technology gap model in which the South (or Africa) is presupposed to exert their possible maximum efforts to benefit from imitation and gradually narrow the technology gap growth rate.

The positive relationship between the two variables indicates “weak” efforts African nations exerted so far to benefit from the technology gap and absence of equilibrium in the global economic system (instability of the global economic system). As Verspagen (1991) indicated, the possibility of catch up is not manna from the heaven if not deliberate and all rounded efforts are not put in place. It is also advisable to share the idea of UNECA (2013) which proposes Africa should have a dynamic science, technology and innovation (STI) policy. The dynamic STI policy commands continuous development (based on the context at hand), implementation, monitoring and evaluation of performances (which could be an input for future plan and implementation).

The other explanatory variables, the relative growth contributions of sectors, are found to have a negative influence on the explained variable (per capita GDP gap growth rate). This indicates African sectors relative growth contributions are playing constructive role in terms of lowering the over time technology gap growth rates. Based on the relative importance of sectors the service sector is found to be the best sector in terms of reducing the per capita GDP gap growth rate. It is followed by the manufacturing and agricultural sectors respectively. However, since the coefficient of technology gap is found to be greater than zero, the observed growth in the sectors was found to be less meaningful for catch up as the growth could not brought the tendency of falling technology gap between the North and the South. Even if the sectors relative growth contributions of Africa have been playing crucial role to decrease the per capita GDP gap growth rate, the relative sectors growth contributions have been benefiting back the North in terms of being motivated to produce more (both in quantity and quality) and widen the equilibrium technology gap (equilibrium per capita GDP gap). This is implies that tiny growth in per capita GDP that arise from production of “less complex commodities” in Africa could worsen the international development differential (income inequality).

Observing this status of sectors in Africa, it could be possible to argue that structural transformation is crucial in Africa. The structural transformation this paper is proposing is in terms of enhancing the role of the manufacturing sector activities that could foster composition of African products and improve their pattern of international specialization that could allow a sustainable higher per capita GDP. Focusing more on the manufacturing sector in Africa is suggested because it is practically a dynamic sector of all sectors in the manner that could bring a sustainable higher per capita GDP growth. This allows the coefficient of the technology gap (in equation 10) to be negative in the long run as the soaring technology gap is mainly the result of the inability of African nations to apply the existing advanced nations knowledge to their respective activities in the manufacturing sector and boost their per capita GDP. In addition to improving the existing activities in the manufacturing sector, African nations should strive to import activities in the manufacturing sectors which are new to their respective nations. This is not by any means to say that African nations should give less emphasis to the agricultural and the service sectors as they are playing significant role in reducing the technology gap growth rate. In other words, African nations could use agriculture and the service sectors as a spring board to transform their economies to the manufacturing sector dominant economy for the reason stated above. This could require strong governments that could mobilize resources for the construction of physical infrastructures (road, telecommunication, electricity, water, working amenities such as construction of industrial parks and so on) and non-physical infrastructures (working amenities such as peace, attractive industrial policies, provision of required knowledge and skill trainings for domestic workers and so on) are crucial for the development of the manufacturing sector. The other meaning of strong governments is that African all level leaders are required to be less corrupted and should have strong policy advisors (among others) that could help in prioritizing resource allocation among the needy activities and sectors, ceteris paribus. In other words, given the role of the local and international private investors to develop the manufacturing sector, African governments should also act as social entrepreneurs as the case is somehow observed in some East Asian economies at their early stage of development.

Apart from the domestic efforts of the African economies, supports from the international community to the best performing African economies seem to be crucial. This is because supporting the less complex products producing South (or African economies) could benefit the North (or OECD nations) in return as it allows them increase their per capita GDP.

Finally, to consolidate the weak efforts of African nations to benefit from the technology gap, it will be good idea to deal with dynamics of product complexity of African economies and technical efficiency of African sectors which I am currently doing towards them.

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Appendix: Description of Data and Sample Economies

Appendix 1: Regression Result, FE

```
. xtset id year, yearly
      panel variable:  id (strongly balanced)
      time variable:  year, 1991 to 2014
              delta:  1 year
. xtreg dgdt g ya ym ys, fe
Fixed-effects (within) regression            Number of obs      =     816
Group variable: id                           Number of groups   =      34
R-sq:   within  = 0.1923                     Obs per group: min =      24
        between = 0.0286                                    avg =    24.0
        overall = 0.0519                                    max =      24
                                F(4,778)          =    46.32
corr(u_i, Xb)  = -0.8446                 Prob > F          =    0.0000
```

dgdt |	Coef.	Std. Err.	t	P>|t	[95% Conf.	Interval]
g|	.0403231	.0108812	3.71	0.000	.0189632	.061683
ya |	-1.87e-06	3.89e-07	-4.82	0.000	-2.64e-06	-1.11e-06
ym |	-.0000148	6.23e-06	-2.37	0.018	-.000027	-2.53e-06
ys |	-.0001884	.0000176	-10.70	0.000	-.000223	-.0001538
_cons |	-.1359026	.0385284	-3.53	0.000	-.2115345	-.0602708
sigma_u |	.04542918					
sigma_e |	.04509024					
rho |	.50374442 (fraction of variance due to u_i)					

F test that all u_i=0:   F(33, 778) =   2.22   Prob > F = 0.0001

Source: Regression result based on WDI database (2016)

Appendix 2: Regression Result, RE

```
. xtreg dgdt g ya ym ys, re
Random-effects GLS regression                Number of obs      =     816
Group variable: id                           Number of groups   =      34
R-sq:  within  = 0.1795                      Obs per group: min =      24
       between = 0.5700                                     avg =    24.0
       overall = 0.1998                                     max =      24
                                Wald chi2(4)      =   198.51
corr(u_i, X)   = 0 (assumed)              Prob > chi2       =    0.0000
```

dgdt |	Coef.	Std. Err.	t	P>|t	[95% Conf.	Interval]
g|	.002311	.0015687	1.47	0.141	-.0007636	.0053856
ya |	-1.99e-06	3.88e-07	-5.14	0.000	-2.75e-06	-1.23e-06
ym |	-.0000129	6.29e-06	-2.05	0.040	-.0000252	-5.78e-07
ys |	-.0002114	.0000175	-12.11	0.000	-.0002457	-.0001772
_cons |	-.0007524	.005866	-0.13	0.898	-.0122496	.0107448
sigma_u |	| .00401751					
sigma_e |	| .04509024					
rho |	00787615 (fraction of variance due to u_i)					

Source: Regression result based on WDI database (2016)

Appendix 3: Hausman Specification Test

. hausman fixed . , sigmamore

	(b) fixed	(B) .	(b-B) Difference	sqrt(diag(V_b-V_B)) S.E.
g |	.0403231	.002311	.0380121	.0109726
ya |	-1.87e-06	-1.99e-06	1.19e-07	8.22e-08
ym |	-.0000148	-.0000129	-1.87e-06	8.94e-07
ys |	-.0001884	-.0002114	.000023	4.11e-06

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(3) = (b-B)'[(V_b-V_B)^(-1)](b-B)

= 32.37

Prob>chi2 = 0.0000

Source: Regression result based on WDI database (2016)

Appendix 4: Wooldridge Test for Autocorrelation in Panel Data

. xtserial dgdt g ya ym ys

Wooldridge test for autocorrelation in panel data

. xtserial dgdt g ya ym ys

Wooldridge test for autocorrelation in panel data

H0: no first-order autocorrelation

F(1,33) = 34.454

Prob > F = 0.0000

Source: Regression result based on WDI database (2016)

Appendix 5: FE Regression Result with the robust Driscoll-Kraay standard errors

. xtscc dgdt g ya ym ys, fe

Regression with Driscoll-Kraay standard errors Number of obs = 816
Method: Fixed-effects regression Number of groups = 34
Group variable (i): id F(4, 33) = 5.93
maximum lag: 2 Prob > F = 0.0010
within R-squared = 0.1923

		Drisc/Kraay				
dgdt |	**Coef.**	**Std. Err.**	**t**	**P>|t**	**[95% Conf.**	**Interval]**
g|	.0403231	.0180268	2.24	0.032	.0036474	.0769988
ya |	-1.87e-06	9.81e-07	-1.91	0.065	-3.87e-06	1.22e-07
ym |	-.0000148	6.03e-06	-2.45	0.020	-.000027	-2.50e-06
ys |	-.0001884	.0001002	-1.88	0.069	-.0003923	.0000155
_cons |	-.1359026	.0656116	-2.07	0.046	-.2693904	-.0024148

Source: Regression result based on WDI database (2016)

Appendix 6: Pair wise correlation coefficients

. pwcorr dgdt g

	dgdt |	**g**
dgdt |	1.0000	
g|	0.0476	1.0000

. pwcorr dgdt ya

	dgdt |	**ya**
dgdt |	1.0000	
ya |	-0.1752	1.0000

. pwcorr dgdt ym

	dgdt |	**ym**
dgdt |	1.0000	
ym |	-0.1306	1.0000

. pwcorr dgdt ys

	dgdt |	**ys**
dgdt |	1.0000	
ys |	-0.4103	1.0000

Source: Regression result based on WDI database (2016)

Appendix 7: Summery Statistics

summarize dgdt g ya ym ys

Variable ||	Obs	Mean	Std. Dev.	Min	Max
dgdt |	816	-.0031069	.05151	-.3516472	.4999331
g|	816	3.529954	1.118614	.728778	5.390858
ya |	816	450.9659	4173.367	38365.89	-33536.37
ym |	816	40.173	260.4902	-1414.118	3403.36
ys |	816	43.0179	94.06292	-895.1852	726.4178

Source: Regression result based on WDI database (2016)

Appendix 8: List of the Sample African Nations

Benin	Kenya	Sierra Leon
Botswana	Lesotho	South Africa
Burkina Faso	Malawi	Sudan
Cameroon	Mauritania	Swaziland
Central Africa	Mauritius	Tanzania
Congo Dem	Morocco	Togo
Congo Rep.	Mozambique	Tunisia
Egypt	Namibia	Uganda
Ethiopia	Nigeria	Zambia
Gabon	Rwanda	Zimbabwe
Gambia	Senegal	Swaziland
Guinea	Seychelles	

Determinants of Private Saving in Ethiopia (Johansen Co-Integration Approach)

Tizita Gebeyehu[1]

Abstract

The main objective of this research is to empirically examine the main determinants of private saving in Ethiopia for the period ranging from 1971-2015 by using Johansen maximum likelihood co-integration approach. The result shows that level of real per capital income, inflation, urbanization ratio, bank branch and the dummy variable for political instability are significant variables to determine private saving of Ethiopia in the long run. Moreover, level of per capital income, urbanization ratio, bank branch and the dummy variable for political instability have significant positive effect on private saving of Ethiopia. However, inflation rate influencing private saving negatively and significantly. In addition, in the short run only level of per capital income, Urbanization ratio and bank branch at their difference are statistically significant in determining private saving. Gross domestic product per capital income and urbanization ratio have positive effect on private saving whereas Bank branch has negative effect on private saving of Ethiopia in the short run. Since the effects of a change in a given saving determinant are fully utilized both in the long term and short term, measures such as bank branch expansions, creating awareness among public and improving both the quality and the quantity of export have to be considered by the concerned authorities.

Key Words: Private saving, Ethiopia, Johansen Co-integration, Endogenity problem and Granger causality

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1. Introduction

An economic system must be able to produce capital if it is to satisfy the want and needs of its people. To produce capital people must be willing and able to save, which release produce for use elsewhere. When people save, they make funds available to others. When business borrows these savings, new business and services are created, plants and equipment's are produced and new jobs become available (William, 2003).

In Ethiopia, private saving does not have a deep-rooted history because of frequent policy changes following the changes of government. The general trend of private saving as a percentage of GDP was falling after the year 1972/73. Ethiopia's private saving was lower in the Derg regime than the imperial era since it was above 10 percent before 1974 as compared to below 4 percent for the years 1973/74-1990/91. Despite its recovery in 1989/90, it fell again consistently and became negative for the year 1992/93. This is in spite of the introduction of a new interest rate structure which resulted in positive real interest rate (WB, 2013).

Even in the present, EPRDF government there is still a fluctuation over time though there exist a significant change in private saving as compared to past times. And according to statistical reports a considerable proportion of total approved saving projects fail to be implemented due to several reasons in which many of them and attributed to the negative effects of determinants of private saving. Technology, higher employment, low level of poverty and others, which are the most common indicators of growth and development, are not yet attained in Ethiopian economy. And all these factors are related to saving where their long-term solutions can be reached through investment (Zewdu, 2006).

Economic growth is the main target of all countries all over the world including both developed and developing countries. Among other things, rise in Gross Domestic Product (GDP) is a good indicator of economic growth; higher GDP implies higher income and thus higher standard of living. One of the important ingredients of GDP is saving. Therefore, most efforts to increase GDP and thus increase economic growth relay on saving.

Private saving is a very important factor in bringing economic development, its working or efficiency is determined by different socio economic and political factors. Moreover, these different factors have different effects on private saving either in the negative or positive sense. Therefore, in order to study the effects of private saving on the performance of an economy, one needs to identify first, the factors that are affecting it. By doing so, the researcher could understand why and how changes in private saving occurred and pose possible remedies to correct prevailing problems of private saving by looking at the current situation of the determinants.

Previous studies in case of Ethiopia i.e. Ayalew (1995) and Hadush (2012)did not use important variables in the saving model, which may have significant effect on private saving. There are a number of determinants of private saving which are not still well explained. This paper tries to fill this variable gap by incorporating important variables such as Urbanization ratio, bank branch and political instability. Besides to above variable gap, studies on determinants of private saving on others (not Ethiopia) country cases have been carried out during 1990s and early 2000s. Furthermore, Ayalew's study on the determinants of private saving in Ethiopia has been carried out before the world 2007 financial crisis. These imply there is the time gap in these areas. Therefore, this paper is also significant by filling the time gap using data's ranging from the year 1971-2015. As a result, the study is motivated by the basic questions raised in the following section to partially fill in the existing literature, time and variable gap by examining the determinants of private saving from the context of Ethiopia. Therefore, the central task of this paper is to analyze factors determining the private saving in Ethiopia for the period between 1971and 2015 with methodology at hand.

The main objective of this study is to identify the major factors that determine private saving in Ethiopian context from 1971to 2015. In addition to this, the specific objectives of the paper are to:

- Show trends and performance of private saving during the period under consideration.
- Determine the effects of bank branch, urbanization ratio and political instability on private saving.

- Empirically examine the short run and long run effect of determinants of private saving in Ethiopia.

Based on the determinants of private saving conducted in different parts of the world the researcher can hypothesize that political instability and bank branch will positively and significantly affect private saving. Whereas urbanization rate will negatively and significantly affect private saving.

The remaining part of the paper is organized as follows: The next section looks into methodological issues. The third section provides discussion of results and the final section deals with a brief concluding remarks.

2. Methodology of the Study

2.1 Source and Type of Data

Secondary data were employed in this study for time series data running from 1971 to 2015. This is because most of the data's used for this study are available after the year 1970s and issues related to determinants of private saving gained a great interest of researchers and decision makers in both developing and developed countries after the 1970s.The sources of the data were from different domestic and international bureaus and organizations. The domestic sources are a variety of organizations and ministries like National Bank of Ethiopia (NBE), Ministry of Finance and Economic Development (MoFED), Ethiopian Economic Association (EEA) and also the researcher used data's from international sources like the World Bank (WB).

2.2 Model-Specification

In developing a saving model, it is difficult to include all the determinants of private saving because of unavailability of all the data required, unquantifiability of some determinants and small observation. Considering this, the following explanatory variables are used: Level of real per capital income, Terms of Trade, interest rate, inflation, urbanization ratio, number of bank branch and political instability measured by dummy variable.

Using the literatures on the determinants of private saving and following the works of previous researchers such as Tochukwu and Fetu (2007), Said Hallaq (2003), Ayalew (1995) and Hadush (2012) the model employed in this study is expressed in the following manner:

$$Y_t = \alpha + \beta X_t + \varepsilon_t .. \quad \textbf{(1)}$$

Where Y_t - is private saving (PS) at period t.

X_t - is a vector of explanatory variables included in the model at period t.

ε_t - is the error terms at period t.

More specifically, the following model is fitted to analyze the impacts of explanatory variables on private saving.

LnPSt = β0+ β1LnRGDPPCt+ β2LnTOTt+ β3LnIRt +β4LNCPI t + β5LnURt + β6LnBBt + β7Dt + εt - (2)

Where; β0 is an intercept term and β1, β2, β3, β4, β5, β6 and β7 are the long run coefficients

LnPS = Natural logarithm of Private savings at period t

LnGDPPCt = Natural logarithm of level of real per capital income at period t (+)

LnTOTt= Natural logarithm of Terms of Trade at period t (- or +);

LnIRt = Natural logarithm of interest rate at period t (+)

LnCPIt= Natural logarithm of consumer price index (-) at period t (proxy for inflation), measured as aproxy of macroeconomic uncertainty,

LnURt= Natural logarithm of Urbanization ratio at period t (- or +)

LnBBt = Natural logarithm of Bank branch at period t (+)

Dummy= is the dummy variable taken for political instability. Setting 1 for the stable period and 0 otherwise.

εt= Stochastic error term

In addition, all variables are expressed in log form and hence log linear form of the model is used for private saving model as opposed to linear model. As Gebeyehu (2010) pointed out that results obtained from linear form of the model are not significant and consistent; thus, in order to control the size of data and obtain consistent and reliable estimates log linear model is superior to linear model. Additionally, as Fredric (2003) suggests that log linear model produces better results than linear form of the model.

Variable Description

Level of Real per Capital Income (RGDPPC): An increase in GDPPC has a positive effect on private saving. This is due to the fact that an increase in GDPPC means an increase in income. It is known from economic theories that as income increase the marginal propensity to consume out of the additional income decreases. Thus the higher the per capital income gets the share of consumption decreases and more out of the income will be saving. As a result, this increase in saving makes a lot of finance to be available to private investors. RGDPPC is measured by RGDP/ total population.

Terms of trade: Equals PX/PM, where PX and PM are the price index of exports and imports price index respectively (both in domestic currency), the expected sign of TOT is either negative or positive. Deterioration in the terms of trade, that is, duction in the price of domestically produced goods relative to that of foreign goods, reduces real income and hence saving. By contrast, a term of trade deterioration that is perceived to permanent may induce domestic residents to increase their savings at the current period in order to sustain their real standard of living in the future.

Interest rate: implies that when there is deposit money at the bank, the bank may earn interest on that money especially in savings accounts or certificates of deposit. In a sense, you are lending money to the bank so they can use it elsewhere. In return, you get interest income. The interest rate is generally quoted as annual percentage yield. As a result, interest rate and private saving move in the same direction, which leads to an expectation of a positive sign on saving interest rate in the regression.

Inflation: A fourth issue relates to the role of inflation in determining saving. Inflation is defined as a sustained increase in the general level of prices for goods and services. It is measured as an annual percentage increase. When inflation goes up, there is a decline in the purchasing power of money (Aberu, 2010), so we expect a negative sign for inflation in the regression because, as inflation exists the ability to save will decrease.

Urbanization ratio: Urbanization ratio is compiled under the heading of demographic variables. Demographic variables are sometimes termed as life-cycle variables, as they operate under the predictions of the life-cycle and precautionary saving theories. In their seminal article Ando and Modigliani (1963), show that demographic variables negatively affect savings rates. Urbanization ratio, defined as the percentage of the total population living in urban areas. This variable is also expected to have a negative impact on saving, as increased urbanization reduces the need for precautionary saving, which is high in rural societies with greater volatility in income. In the empirical work, the signs of the demographic variables have usually been found negative. However, as in the case of many other variables, the empirical significance varies a lot across studies.

Bank branch: Bank branch is measured by number of banks available for users. Researchers like Athukorala and Sen (2004), Johnson (2011) also used number of banks to measure bank branches to conduct investigation. As number of bank branch increase all the society will have accesses for banking services, one of which is saving. We expect positive sign for bank branch in the regression because as a branch of bank increases private saving will increase.

Political instability: The variables that capture the effects of uncertainty about the future bear on saving rates primarily via their impact on precautionary savings. These variables can be termed broadly as macroeconomic uncertainty (proxies by inflation) and political instability. Political instability, which creates an uncertain economic environment for agents, would be expected to act positively on savings. Political instability brings about uncertainty in future income streams and can thus lead to higher saving on precautionary grounds. This may be particularly true for households in developing countries whose income prospects are much more uncertain than their counterparts in developed countries. It is also possible to consider uncertainty at the individual level by the extent and coverage of government-run social security and insurance programs and/ or the urbanization ratio–

implying decreased volatility of income, which had been discussed under different headings. Asmelash (2009) also used 1 for political stability for period 1991 up to date and zero for instability for period 1971 -1991 to conduct his study.

3. Discussion and Estimation of Results

3.1 Results of Unit Root Test

Testing for the existence of unit roots is of major interest in the study of time series Models and co-integration. In this study, the Augmented Dickey Fuller (ADF) test is employed to test the stationary of the variables and the test result is given in Table 3.1.

Table3.1: Result of test of stationarity

Unit Roots
ADF Unit-Root Test Results

Variable ADF	Test Statistic	Critical Value	Order of Integration
LNPS	-3.424343	-2.938987	I(1)**
LNRGDPPC	-5.197052	- 3.610453I	(1)***
LNTOT	-4.390098	-3.610453I	(1)***
LNSIR	-2.958534	-2.936942	I(1)**
LNCPI	-2.847738	-2.606857	I(1)*
LNBB	-5.729183	-3.605593	I(1)***
LNUR	-2.753151	-2.607932I	(1)*
Residual	-6.034188	-3.632900	I(0)***

*, ** and *** shows 10%, 5% and 1% level of significance respectively; the null hypothesis is that there is a unit root.
Source: Eviews version 6 outputs

The test has shown that all variables are non-stationary in level (and they become stationary at first difference). Thus the researcher can conclude that all variables included in the private saving model are I (1). Hence, it is possible to employ Johansen procedure to test cointegration.

The result of the ADF stationary tests for the residuals indicates that the residual is stationary at 1% level of significance (i.e. I (0)) showing that there is a long run relationship between the explanatory variable and private saving. In other words, the linear combination of the variables of the model is stationary and they are co-integrated.

Johansen co-integration analysis is very sensitive to the number of lags included in the model. The selected lag length is one. This is because both AIC and SC of optimal lag selection suggest an optimal lag of one at 5% level of significance.

Johansen co integration test result clearly shows that the null hypothesis of no co-integration is rejected by both the λmax and the λtrace statistics.

Table 3.2: Johansen co integration test result

Hypothesized No. of co-integration eqn(s)	**Trace statistic**	**0.05 critical value**	**0.01 critical value**	**P-value**	**Max Eigen statistic**	**0.05 critical value**	**0.001 critical value**	**p-value**
None	215.12	159.53***	171.10***	0.0000	69.16	52.36***	58.67**	0.0005
At most 1	145.96	125.62***	135.97***	0.0016	43.33	46.23	52.31	0.0992
At most 2	102.63	95.75	104.96	0.0155	33.56	40.10	45.87	0.2254
At most 3	69.10	69.82	77.82	0.0573	21.44	33.88	39.37	0.6508
At most 4	47.63	47.86	54.68	0.0525	18.31	27.58	32.72	0.4697
At most 5	29.32	29.80	35.48	0.0567	16.43	21.13	25.86	0.2008
At most 6	12.90	15.50	19.94	0.1188	12.86	14.26	18.52	0.0822
At most 7	0.03	3.84	6.63	0.1600	0.87	3.84	6.63	0.8665

** and *** shows rejection of null hypothesis at 5% and 1% level of significance respectively

Source: Eviews version 6 outputs

Table 3.2 clearly shows that the null hypothesis of no co-integration is rejected by both the λmax and the λtrace statistics. While the trace statistics shows two co-integration equations at 1% level of significance, maximum Eigen value statistics shows 1 co-integration equations at 1% level of significance. According to Harris (1995) in Johansen approach to co-integration trace statistics rejects null hypothesis whenever it is true because of small sample size of the data. Thus, the rejection of one co-integration approach by trace statistics may be due to small sample size. Hence, taking the major objective of investigating the determinants of private saving into consideration, the researcher use only one co integrating vector that relates private saving which is the dependent variable to its determinants.

After establishing the existence of one co-integrating relationship between the variables in the private saving model, the next step is to test for the existence of weak exogeneity. The test for zero restrictions on adjustment coefficient is referred to as the test for exogeneity. The results, using the likelihood ratio (LR) test confirm that dependent variable rejects weak exogeneity at 1% level of significance.

3.2 The long run equation

Finally, the structural long run relationship derived from the co-integrating vector normalized with respect to LNPS can be represented as:

$$
\begin{aligned}
LNPS = {} & \underset{(0.096^{*})}{1.40LNGDPPC} + \underset{(0.451)}{0.10LNTOT} + \underset{(0.186)}{0.53LNIR} - \underset{(0.004^{***})}{1.17LNCPI} + \underset{(0.047^{**})}{1.40LNUR} + \underset{(0.040^{**})}{1.89LNBB} \\
& - \underset{(0.011^{**})}{1.10DUMMY} + 7.42 \qquad \textbf{(3)}
\end{aligned}
$$

Having identified the co integrating vector using Johansen, the next step is to proceed investigates the long run dynamics of the saving process. The long run equation suggested that level of per capital income; Terms of trade, interest rate, urbanization ratio, bank branch and the dummy variable for political instability are positively affecting private Savings in the long run. Whereas inflation has negative influence on private saving in the long run. The results are statistically significant for all variables except for Terms of trade and interest rate.

The long run relationship between private saving and level of per capital income has a positive coefficient and statistically significant. Thus the Ethiopian experience provides support for the argument that, private saving highly responds to changes in RGDPPC. Out of 1 percent increase in level of per capital income 1.40 percentage points being saved. A one percent increase in urbanization ratio increases private saving by 1.40 percent over the long run period. As bank branch increase by one percent private saving will increase by 1.89 percent which proves that the expansion of bank branches will result in reducing the cost of banking transactions and thus motivate private sector to save. The dummy variable to capture political instability shows that positive and significant coefficient. Individuals increase precautionary saving in the face of increased uncertainty in the economic environment. An increase of one percent in inflation decreases private Savings by 1.17 percent over the long run period holding others constant.

However, Terms of trade (LNTOT) and Interest rate (LNIR) have positive and insignificant impact on private saving.

3.3 Vector error correction model (short run equation)

After determining the long run model and its coefficients, the next step is the determination of short run dynamics. The coefficient of difference represents the coefficients of short run dynamics whereas the coefficient of lagged error correction term ECM (-1) captures the speed of adjustment towards the long run equilibrium relationship.

Table 3.2 indicates that only Level of per capital income, urbanization rate and Bank branch at their difference are statistically significant in determining private saving in the short run at 1%, 10% and 1% level of significance respectively.

The short run result of BB contradicts with the view that the expansion of banking facilities since the 1970s seems to have contributed significantly to improvements in saving propensity in the economy of Ethiopia.

The result shows that the coefficient of the error-term (or the Speed of adjustment term) for the estimated private saving equation is statistically significant and negative as expected. The Coefficient -0.151013shows that 15.10 percentage points' adjustments take place each year towards long run equilibrium.

Table 3.3: The result of short run model

Variable	Coefficient	Std. error	t- statistic	Prob.
DLNPS(-1)	-0.622807	0.262136	-2.375895	0.0235**
DLNRGDPPC(-1)	1.353512	0.245654	5.509829	0.0000***
DLNUR(-1)	5.768000	3.287088	1.754745	0.0886*
DLNBB(-1)	-2.656391	0.610239	-4.353034	0.0001***
DDUMMY(-1)	0.204002	0.164818	1.237741	0.2245
C	0.182390	0.061803	2.951156	0.0058***
ECM(-1)	-0.151013	0.058386	-2.586447	0.0143**

R-squared	0.941570	Mean dependent variable	0.036250
Adjusted R- squared	0.930947	S.D dependent variable	0.564849
S. E of regression	0.148431	Akaike information	-0.819767
Sum squared resid.	0.727047	criterion	-0.524213
Log likelihood	23.39534	Schwarz criterion	88.63049
Durbin – Watson test	2.035176	F-statistic Prob (F- statistic)	0.000000***

Source: Eviews version 6 output Note: ***, ** and * shows significance level at1%, 5% and 10% level respectively.

The model passed all the diagnostic tests. The model and parameters of the model are stable as the stability test reported.

4. Conclusion and Policy Implications

4.1 Conclusion

The study analyzed the determinants of private saving in Ethiopia during the period 1971 – 2015.The researcher established the relationship of variables in the long run as well as in the short run.

In the long run, the study concludes that Level of real per capital income, Terms of trade, Interest rate, urbanization ratio, bank branch and the dummy variable for political instability are positively affecting private Savings. Whereas inflation rate has negative influence on private saving.

In the short run only Level of per capital income, Urbanization ratio and bank branch at their difference are statistically significant in determining private saving.

4.2 Policy Implication

Based on the result found from the descriptive and econometric analysis, the following policy implications are forwarded as alternatives to enhance the performance of the private sector and of course to increase its level, having in mind the contributions it makes to the development of the economy.

- Core efforts may be taken to improve economic activity and accelerate per capita GDP through creating conducive investment to the private sector.
- Controlling birth is also vital to achieve high level of real per capital income.
- Promote the export of industrial products and reduce excessive dependency on the export of primary agricultural products.
- The government of Ethiopia should work to create awareness in the reduction of extravagant activities.
- Increase number and services of banks to meet the demands of people for saving.
- Overall, improve the skill, knowledge and training levels of labors through establishing training and skill formation institution that helps for job creation efforts.
- In addition, expand small scale enterprises so that unemployed youths and women participate in income generation activities.

The present study tried to meet gap between the existing literatures by examining the determinant of private saving from the context of Ethiopia but it also has its own limitations and those limitations can be addressed by researchers in future. Hence the researcher suggests future researcher's to change their attention to study determinants of saving in the household level (helps to fully understand the behavior of saving in Ethiopia).

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Capital Flight and Fiscal Policy in Developing Country: Evidence from Ethiopia[1]

Kumadebis Tamiru Gemechu[2]

Abstract

This study examined the effect of fiscal policy on capital flight in Ethiopia using time series data from 1970 to 2012 by employing ARDL model. The results establish that past capital flight, change in debt, and government expenditure have no significant impact on capital flight in Ethiopia. However, external debt, taxation, and expenditure practices under different political regimes have significant effects on capital flight. The study provided policy implications emerging from the empirical results.

Key words: Fiscal Policy, Capital Flight, Autoregressive Distribute Lag Model, Ethiopia

1. Introduction

Capital flight refers to a wealth that is earned, transferred or used by breaking a country's laws (illegal or illicit). It also refers to wealth whose origin is connected with illegal activity, such as corruption, the illicit production of goods, other forms of crime, or the concealment of a company's wealth from a country's tax authorities (The Service Centre for Development Cooperation,

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2010). Capital flows are illicit if they involve illicitly acquired funds, or are transferred abroad and held there without full disclosure to national authorities, or both (Leonce Ndikumana, 2015).

During the past decades, many countries experienced considerable capital flight. Residents moved their wealth abroad; using different ways to accumulate foreign assets (Niels Hermes and Robert Lensink, 2014).Since the emergence of the Asian financial crisis of 1997–98, Fiscal policy has gained considerable attention in the literature. At the center of this discussion is how fiscal policy influences economic variables, specifically the flow of funds across borders. While tax rates can be used to attract foreign capital and government spending can be used as a stabilizer and booster of economic growth, the extent of fiscal policy's impact on economic variables is still an open empirical question (Dianah Ngui Muchai and Joseph Muchai, 2016). The past decades have witnessed growing attention in academia and in policy circles to the issue of capital flight from developing countries in general and from African countries in particular. Researchers are intrigued by the stunning paradox posed by large-scale capital flows both to and from Africa. While the continent receives a substantial amount of capital inflows in the form of official development assistance, external borrowing and foreign direct investment, it also suffers a heavy financial hemorrhage through capital flight (Léonce Ndikumana, James K. Boyce and Ameth Saloum Ndiaye, 2014).Hence, capital flight has been an issue of concern for Africa because it reduces the continent's much needed investible funds.

In Ethiopia, capital flight is estimated at $31 billion over the 1970–2012 periods. On average, the country has lost around half a billion dollars annually under the 'Derg' regime. This amount more than doubled to over 1 billion per annum during the EPRDF regime. The empirical evidence suggests that macroeconomic instability, the degree of financial market deepening, exports, interest rate differentials, political instability, corruption, and debt-creating flows are the most important determinants of capital flight from Ethiopia. The political environment is also found to be crucial. Generally, capital flight was high before violent regime changes and low in the subsequent periods, when regimes were in the process of establishing a firmer grip on power; after this point, however, capital flight began to rise significantly again. The historical analysis points to potential causality running from political factors to capital flight. A strong improvement in economic and political governance will be key to abating the problems of capital flight in Ethiopia (Alemayehu and Addis, 2016).

Despite the serious capital flight problem in Ethiopia, few country specific studies have investigated the size and determinants of capital flight in the country. The few that exist generally focus on the economic determinants of capital flight (see Alemayehu et al., 2016), and While a number of studies have explored the relationship between fiscal policy and capital flight in Africa (see for example., Muchai., et al 2016), no paper examined how fiscal decisions influence capital flight systematically. Hence, the issue at hand is whether these fiscal decisions influence capital flight or not.

This study defines fiscal policy as the combined government decisions regarding a country's revenue and spending. Fiscal policy therefore relates to government taxation and expenditure decisions that lead to budget deficits or surpluses. In this context, this study addresses the following questions as they pertain to the case of Ethiopia: what is the effect of government consumption on capital flight? Do taxation practices influence capital flight? How do political regimes affect capital flight?

2. Capital Flight and Fiscal Policy

There are scanty studies in developing countries which analyze the relationship between capital flight and Fiscal Policy variables such as taxation, government expenditure and debt. For instance, Alesina and Tabellini (1989) state that uncertainty about which group will be in control in the future and thus uncertainty about future fiscal policies is one of the main reasons for the over-accumulation of public debt and private capital flight.

Boyce (1992) finds evidence for debt-motivated capital flight by using the time series data from the Philippines between 1962 and 1986 and suggests that foreign borrowing causes capital flight by contributing to an increased likelihood of debt crisis, worsening macroeconomic condition and the deterioration of general investment conditions.

Eaton (1987) argues that the expectation of increased tax obligations created by the potential nationalization of private debt generates capital flight. Ize and Ortis (1987) also show that when fiscal rigidities create difficulties for servicing foreign debt, private capital flight is encouraged by foreign borrowing since there is an expectation of higher domestic asset taxation in order to service future debt. Foreign borrowing provides the resources for channeling private capital abroad as well.

Boyce and Ndikumana (2001) examine 30 sub-Saharan African countries and show that funds borrowed abroad are re-exported as private assets. By comparing cumulative capital flight with private net external assets, they conclude that Sub-Saharan African countries are net creditor vis-a-vis the rest of the world. In the case of capital flight driven debt, capital flight forces governments to borrow from abroad since capital flight decreases national resources by lowering domestic saving and investment. In this case, capital flight provides the resources to finance loans to the same residents who export their capital, which leads to a situation called round tripping or back-to-back loan, motivated by the desire to obtain government guarantees on foreign borrowing.

2.1 Capital Flight from Ethiopia

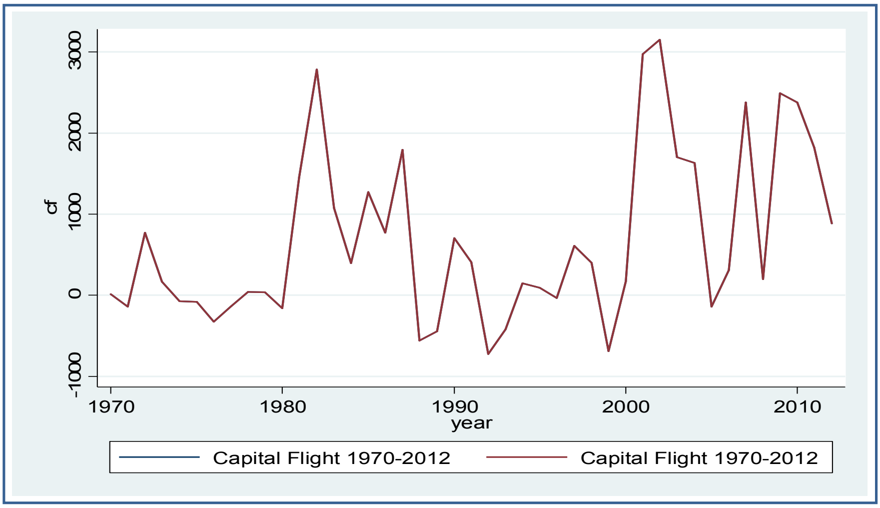
Using this method, the capital flight from Ethiopian for the last 42 years is estimated. Table 2 summarizes the results. We have found the total real capital flight during the period 1970 to 2012 to be USD 31 billion. On average, the country has lost around half a billion dollar annually in the 'Derg' regime. This amount has more than doubled to over one billion per annum during the EPRDF regime (then you should probably recommend to other researchers to know the reasons why capital flight accumulated more in the current regime than the former while it seems to be more stable and use IMF and World bank advice on more liberal market economy that are assumed to be pro private sector promotion. Capital flight amounts to about 50 per cent of the country's average annual export during the period.

Table 1: Capital flight from Ethiopia (1970-2012): in millions of real constant US Dollar (2012)

Year	Capital Flight 1970-90 The Derg Regime*	Year	Capital Flight (1991-2012) The EPRDF Regime
1970	10.7	1991	410.6
1971	-140.9	1992	-725.6
1972	771.6	1993	-420.5
1973	163.9	1994	145.6
1974*	-72.4	1995	91.9
1975	-84.5	1996	-33.3
1976	-324.7	1997	605.7
1977	-138.4	1998	398.3
1978	41.0	1999	-689.5
1979	37.6	2000	170.8
1980	-160.8	2001	2969.6
1981	1457.5	2002	3148.6
1982	2784.0	2003	1700.8
1983	1072.0	2004	1631.3
1984	392.1	2005	-144.5
1985	1272.1	2006	309.6
1986	771.4	2007	2376.2
1987	1794.8	2008	198.4
1988	-561.0	2009	2491.2
1989	-445.9	2007	2376.2
1990	702.2	2008	198.4
		2010	4096.3
		2011	1818.7
		2012	886.7
Total Capital Flight		9342.4	21437.1
Average Annual Capital flight		444.9	974.4
Grand Total (1970-2012) = USD 30779.5			
Average Annual Capital Flight (1970-2012) = USD 715.8			

Source: Alemayehu and Addis, 2017

Figure 1: Capital flight from Ethiopia (1970-2012)



Source: Own computation

As shown on the above figure, the average annual capital flight during the Derg regime was half the amount in the EPRDF regime. Moreover, the EPRDF regime also accounts for about the 70 percent of the stock of capital flight during the entire period under analysis. The highest level of capital flight was registered during EPRDF in 2003. However, during Derg regimes the capital flight has reached its maximum point in 1980's. Then, it was declining continuously up to 2000 when it becomes low level. The pattern of capital flight is showing cyclical pattern during period under consideration.

2.1 Empirical Evidence on Fiscal Policy and Capital Flight

Alemayehu et al. (2017) in their study attempts to estimate the volume of capital flight and its impact on growth and poverty reduction in Ethiopia. Over the period 1970 to 2012, the total capital flight from the country is estimated at USD 31 billion. Based on a simple ICOR based growth model simulation, the average growth lost owing to the capital flight is found to be about 2.2 percentage points per annum, between 2000/01-2012/13. Using an elasticity of poverty to income and inequality, we have also found the effect of capital flight on total poverty. Had it not been for capital flight, poverty would have been reduced by about 2.5 percentage points in the last decade. This is, however, owing to the nature of growth in Ethiopia in the last decade which was accompanied by rising inequality that wiped out the positive effect of growth on poverty reduction. Had it not been for this inequality that accompanied growth, the lost resource through capital flight would have led to a decline in poverty of about 5 percentage points in the last decade, instead.

Dianah Muchai and Joseph Muchai (2016) stated that Capital flight has been an issue of concern for Africa because it reduces the continent's much needed investible funds. In Kenya, the country lost US$ 4.9 billion in real terms from 1970 to 2010 through capital flight. This study seeks to provide fiscal evidence of capital flight in Kenya. The results establish that past capital flight, change in debt, and government expenditure have no significant impact on capital flight in Kenya. However, external debt, taxation, and expenditure practices under different political regimes have significant effects on capital flight. The study discusses policy implications emerging from the empirical results.

On the other hand, much of contemporary literature on African capital flight has focused on inter alia, lessons from case studies on the causes and effects of capital flight (Ndikumana, 2016) notably: the nexus between fiscal policy and capital flight in Kenya (Muchai & Muchai, 2016), determinants of capital flight in Madagascar (Ramiandrisoa & Rakotomanana, 2016) and Ethiopia (Geda & Yimer, 2016), capital flight and trade mis-invoicing in Zimbabwe (Kwaramba et al., 2016) and capital flight in Cameroon; connections between tax revenue and capital flight in Burkina Faso (Ndiaye & Siri, 2016) and the effect of capital flight on public social spending in Congro-Brazzaville (Moulemvo, 2016).

Alemayehu and Yimer (2016) in their study attempts to estimate the volume of capital flight from Ethiopia and its determinants, focusing on economic, institutional, and political determinants. Capital flight is estimated at $31 billion over the 1970–2012 periods. On average, the country has lost around half a billion dollars annually under the 'Derg' regime. This amount more than doubled to over 1 billion per annum during the EPRDF regime. The empirical evidence suggests that macroeconomic instability, the degree of financial market deepening, exports, interest rate differentials, political instability, corruption, and debt-creating flows are the most important determinants of capital flight from Ethiopia. The political environment is also found to be crucial. Generally, capital flight was high before violent regime changes and low in the subsequent periods, when regimes were in the process of establishing a firmer grip on power; after this point, however, capital flight began to rise significantly again. The historical analysis points to potential causality running from political factors to capital flight. A strong improvement in economic and political governance will be key to abating the problems of capital flight in Ethiopia.

3. Data and Methodology

The annual time series data for fiscal and control variables covering the period of 1970–2012 obtained from Ministry of finance and economic cooperation, National bank of Ethiopia and (KNBS) and the World Bank's World Development Indicators.

Capital flight is computed using the extended Balance of Payments residual method (see Ndikumana and Boyce, 2010 and 2012). For this study, capital flight data are used from Boyce and Ndikumana (2012).The analysis in the previous sections has revealed a qualitative relationship between fiscal policy variables and capital flight in Ethiopia. This section undertakes a quantitative analysis of the relationship between fiscal policy and capital flight. Fiscal policy variables included in the analysis are: government expenditure, taxation, change in the stock of debt, and external debt. For proper specification of our model, control variables presented in the literature were included. These variables are: the exchange rate, which captures risk and return to investment; political regimes; previous capital flight; financial deepening; and inflation, which captures the macroeconomic environment.

To analyze empirically the fiscal policy variables that could induce capital flight in Ethiopia, we employed a regression model of the following form:

$$\boldsymbol{KF_t = \alpha_0 + \alpha_1 KF_{t-1} + \alpha_2 CD_t + \alpha_3 ED_t + \alpha_4 T_t + \acute{a}_5 EXP_t + \alpha_6 P_t + \alpha_7 FD_t + \alpha_8 INF_t + \alpha_9 ER_t + \varepsilon_t} \quad \textbf{(1)}$$

Where α1 to α9 are parameters to be estimated, t is time and e is the error term

Capital Flight (KF): Capital flight/GDP. Change in the Stock of Debt (CD): CD /GDP. Financial Deepening (FD): M2/GDP. Inflation (INF): Annual average inflation rate (consumer price index). External Debt (ED): Total external debt/GDP. Exchange Rate (ER): Annual average exchange rate; Ethiopian Birr against the US dollar. Tax rate (T): Total taxes/GDP. Expenditure (EXP): Government Expenditure/GDP. Political Regimes (P): Dummy variable: 1 in regimes that demonstrated fiscal discipline relatively (EPRDF), 0 otherwise (Derg regime).

4. Results and Discussion

Since we are using time series data, the stationarity of the time series is important. Traditionally, the augmented Dickey–Fuller (ADF) has been used to test for the stationarity of macroeconomic variables and results are presented on Table 1 below. However, this test does not consider the fact that the data in question could have structural breaks. To take into account the existence of structural breaks, the Clemente-Montanes-Reyes (1998) test was applied in this study. The Clemente-Montanes-Reyes (CMR) approach has two models: an additive outlier model (AO) which captures a sudden change in the mean of a time series, and an innovative outlier model (IO) which allows for a gradual shift in the mean of the series of the model. We employed the CMR-IO test, which is considered superior to the AO model since it can identify the long-run impact of changes (Kinuthia and Murshed, 2015). Stationarity test results that consider structural break is presented in Appendix A3.

The diagnostic test run on the residuals of the long-run equation presented on appendix 6 indicates no evidence of Serial Autocorrelation, the Breusch-Godfrey with the null hypothesis of no serial Autocorrelation is accepted, while the white test for Hetroskedasticity also indicates no evidence of Hetroskedasticity. The test for checking the model specification i.e. the Ramsey RESET for model specification was conducted and the result indicated that the model has no evidence of any misspecification.

4.1 Unit root test

Determining the stationarity of a time series is a key step before go on board on any analysis. Customarily, the augmented Dickey–Fuller (ADF) has been used to test for the stationarity of macroeconomic variables. Consequently, capital flight, external debt, change in debt, tax rate, government expenditure, exchange rate, and financial deepening are integrated of order (1)while inflation is integrated of order (0). Since seven (of eight) of the variables are I(1) processes, it is possible to run a long-run equation with our stationary variables.

Table 1: Stationarity result

Variables	Without constant and trend	With constant only	With constant and trend	Order of integration
DLNKF	-5.240*	-5.180*	-5.115*	I(1)
DLNCD	-4.323*	-4.246*	-4.219**	I(1)
DLNFD	-4.499*	-4.485*	-5.203*	I(1)
LNINF	3.026*	0.406	-1.269	I(0)
DLNED	-3.680*	-3.638**	-3.580**	I(1)
DLNER	-2.729*	-3.319**	-3.511***	I(1)
DLNT	-3.991*	-3.978*	-4.831*	I(1)
DLNEXP	-3.730*	-3.697*	-4.372*	I(1)

*- significant at 1%, **- significant at 5% and ***- significant at 10%

4.2 Bound test for co-integration

Our estimated F-statistics is outside their critical value bounds at 90, 95 and 99 percent. We therefore reject the null hypothesis of no co-integration and no long-run capital flight equation. The ARDL bounds test therefore confirms the existence of a long-run capital flight equation presented on Table 2 below. The regression results are presented in Table 3.

The finding that previous capital flight has no significant effect on the current capital flight implies that there is no habit formation. The change in the stock of debt was also found to have no significant effect on capital flight in Ethiopia and the result confirm with Dianah Ngui Muchai and Joseph (2016) for Kenya, Nyoni (2000), who focused on Tanzania and inconsistent with the findings of other studies such as Hermes and Lensink (1992), Lensink et al.

(1998), and Ndikumana and Boyce (2003). Financial deepening has a positive and significant influence on capital flight.

Table 2: Bound co-integration result

Test Statistics	Value	lag	Level of significance	I0 Bound	I1 Bound
F-statistic	5.352466	2	10%	1.95	3.06
			5%	2.22	3.39
			2.5%	2.48	3.7
			1%	2.79	4.1

Table 3: Long Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNT	-13.987043	3.297720	-4.241429	0.0003
P	-15.464325	4.581440	-3.375429	0.0027
LNINF	-1.162713	0.935439	-1.242960	0.2270
LNFD	8.921147	3.557880	2.507434	0.0200
LNEXP	3.616109	3.830957	0.943918	0.3555
LNER	8.932589	3.266884	2.734285	0.0121
LNED	-0.016644	0.479176	-0.034735	0.9726
LNCD	-0.079615	0.128959	-0.617371	0.5433
C	-16.019901	9.374833	-1.708820	0.1016

External debt has no positive and significant influence on capital flight. This finding is inconsistent with the findings of Muchai and Joseph (2016) for Kenya, Hermes and Lensink (1992), Lensink et al. (1998), and Ndikumana and Boyce (2003), but consistent with the finding of Nyoni (2000).

Tax has a significant coefficient, implying that taxation significantly influenced capital flight. This finding is consistent with the study of Muchai and Joseph (2016), Alam and Quazi (2003) but inconsistent with Pastor (1990), Vos (1992), Schineller (1997), and Ndikumana and Boyce (2003). The political regimes variable had a significant effect on capital flight. However, government expenditure had an insignificant impact on capital flight.

Table 4: ARDL Co-integrating and Long Run Form

ARDL Co-integrating and Long Run Form
Dependent Variable: Log of capital flight
Selected Model: ARDL(2, 1, 1, 0, 2, 2, 2, 0, 0)
Co-integrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNKF(-1))	0.476432	0.186824	2.550164	0.0182
D(LNT)	-10.446250	5.011589	-2.084419	0.0489
D(P)	-3.530503	3.751813	-0.941013	0.3569
D(LNINF)	-1.988996	1.655245	-1.201632	0.2423
D(LNFD)	-7.208446	5.969921	-1.207461	0.2401
D(LNFD(-1))	-8.754956	3.528175	-2.481440	0.0212
D(LNEXP)	15.816610	5.087023	3.109208	0.0051
D(LNEXP(-1))	10.367885	3.739880	2.772251	0.0111
D(LNER)	27.958649	8.282047	3.375814	0.0027
D(LNER(-1))	-10.208636	4.565486	-2.236046	0.0358
D(LNED)	-0.028472	0.821374	-0.034664	0.9727
D(LNCD)	-0.136194	0.214934	-0.633656	0.5328
ECM	-0.710650	0.287751	-5.944904	0.0000

Cointeq = LNKF - (-13.9870*LNT -15.4643*P -1.1627*LNINF + 8.9211 *LNFD + 3.6161*LNEXP + 8.9326*LNER -0.0166*LNED -0.0796*LNCD -16.0199)

5. Conclusion and Policy Implication

This study examined how fiscal policy affects capital flight in Ethiopia using time series data from1970 to 2012. The study defined fiscal policy as decisions taken by government regarding the country's revenue and spending. Econometric analysis was done to ascertain the effect of tax and public expenditure on capital flight. The econometric analysis revealed that taxes had a negative and significant on capital flight in Ethiopia. External debt was found to have a negative and insignificant effect on capital flight, which invalidates the revolving door phenomenon for Ethiopia. Fiscal policy regimes were also considered in the study to explore the effect of political regimes on capital flight and the result established that political regimes that exercised some form of budgetary discipline experienced less capital flight. Furthermore, financial deepening and exchange rate have a significant and positive effect on Capital flight where as Government expenditure and change in the stock of debt had an insignificant impact on capital flight. In addition, previous capital flight has significant effect on the current capital flight implies that there is habit formation. At last, there is no evidence of debt-fueled capital flight in Ethiopia. The inflation rate has always been within tolerable levels for economic players. This could probably explain its insignificance in the econometric results.

Based on the findings from this study some policy implications are derived. Government should be prudent in managing public resources as fiscal discipline is shown to be a significant factor in deterring capital flight. Taxation policies in Ethiopia should be implemented cautiously. The government should therefore cease from a directed focus on tax incentives, but rather focus on the general tax rate in the economy.

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Appendix

Appendix A1: ARDL Estimation Result

Selected Model: ARDL (2, 1, 1, 0, 2, 2, 2, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKF(-1)	-0.234219	0.179499	-1.304846	0.2054
LNKF(-2)	-0.476432	0.186824	-2.550164	0.0182
LNT	-10.44625	5.011589	-2.084419	0.0489
LNT(-1)	-13.48069	5.208154	-2.588382	0.0168
P	-3.530503	3.751813	-0.941013	0.3569
P(-1)	-22.92355	7.412287	-3.092642	0.0053
LNINF	-1.988996	1.655245	-1.201632	0.2423
LNFD	-7.208446	5.969921	-1.207461	0.2401
LNFD(-1)	13.71445	6.423568	2.135021	0.0441
LNFD(-2)	8.754956	3.528175	2.481440	0.0212
LNEXP	15.81661	5.087023	3.109208	0.0051
LNEXP(-1)	0.737173	4.990640	0.147711	0.8839
LNEXP(-2)	-10.36788	3.739880	-2.772251	0.0111
LNER	27.95865	8.282047	3.375814	0.0027
LNER(-1)	-22.88675	6.796683	-3.367340	0.0028
LNER(-2)	10.20864	4.565486	2.236046	0.0358
LNED	-0.028472	0.821374	-0.034664	0.9727
LNCD	-0.136194	0.214934	-0.633656	0.5328
C	-27.40445	15.54777	-1.762597	0.0919

R-squared	0.656537	Mean dependent var	-3.994351
Adjusted R-squared	0.375522	S.D. dependent var	2.821711
S.E. of regression	2.229827	Akaike info criterion	4.746025
Sum squared resid	109.3868	Schwarz criterion	5.540119
Log likelihood	-78.29351	Hannan-Quinn criter.	5.035190
F-statistic	2.336304	Durbin-Watson stat	2.355482
Prob(F-statistic)	0.030165		

Appendix A2: Lag length selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-78.66520	NA	8.876170	5.009440	5.409387	5.147501
1	-78.06862	0.852260	9.124594	5.032492	5.476877	5.185894
2	-72.96474	6.999607*	7.258143*	4.797985*	5.286809*	4.966727*
3	-72.78957	0.230216	7.661290	4.845118	5.378381	5.029200
4	-72.63322	0.196552	8.107191	4.893327	5.471028	5.092749
5	-72.60237	0.037029	8.654916	4.948707	5.570846	5.163469
6	-71.63651	1.103839	8.775189	4.950658	5.617235	5.180760
7	-70.70298	1.013544	8.932353	4.954456	5.665472	5.199899
8	-70.54661	0.160836	9.527952	5.002663	5.758118	5.263446

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)

FPE: Final prediction error

AIC: Akaike information criterion

SC: Schwarz information criterion

HQ: Hannan-Quinn information criterion

Appendix A3: Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.714259	Prob. F(2,20)	0.2055
Obs*R-squared	5.999919	Prob. Chi-Square(2)	0.0498

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNKF(-1)	0.179249	0.276551	0.648159	0.5243
LNKF(-2)	0.217664	0.222101	0.980023	0.3388
LNT	1.085257	5.106510	0.212524	0.8338
LNT(-1)	2.167350	5.234542	0.414048	0.6832
P	0.087684	3.715660	0.023598	0.9814
P(-1)	1.173019	7.308620	0.160498	0.8741
LNINF	0.196869	1.678308	0.117302	0.9078
LNFD	0.610024	5.915828	0.103117	0.9189
LNFD(-1)	0.910243	6.477481	0.140524	0.8897
LNFD(-2)	-1.053817	3.624339	-0.290761	0.7742
LNEXP	-1.156514	5.011650	-0.230765	0.8198
LNEXP(-1)	-3.101341	5.180925	-0.598608	0.5562
LNEXP(-2)	1.048366	3.790487	0.276578	0.7849
LNER	-2.307302	8.180237	-0.282058	0.7808
LNER(-1)	0.080981	6.606914	0.012257	0.9903
LNER(-2)	1.229632	4.673768	0.263092	0.7952
LNED	0.170081	0.831144	0.204635	0.8399
LNCD	-0.111616	0.232346	-0.480388	0.6362
C	2.976128	15.55519	0.191327	0.8502
RESID(-1)	-0.478782	0.351707	-1.361309	0.1886
RESID(-2)	-0.359583	0.321579	-1.118179	0.2767

R-squared	0.146339	Mean dependent var	1.55E-14
Adjusted R-squared	-0.707321	S.D. dependent var	1.653684
S.E. of regression	2.160778	Akaike info criterion	4.685364
Sum squared resid	93.37923	Schwarz criterion	5.563047
Log likelihood	-75.04997	Hannan-Quinn criter.	5.004968
F-statistic	0.171426	Durbin-Watson stat	2.158257
Prob(F-statistic)	0.999884		

Appendix A4: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.410749	Prob. F(18,22)	0.9701
Obs*R-squared	10.31292	Prob. Chi-Square(18)	0.9212
Scaled explained SS	4.294299	Prob. Chi-Square(18)	0.9996

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-17.81438	37.36595	-0.476755	0.6382
LNKF(-1)	-0.170420	0.431390	-0.395048	0.6966
LNKF(-2)	-0.430487	0.448994	-0.958781	0.3481
LNT	-8.229395	12.04435	-0.683258	0.5016
LNT(-1)	-2.004187	12.51675	-0.160120	0.8742
P	-5.547786	9.016729	-0.615277	0.5447
P(-1)	-14.90422	17.81394	-0.836660	0.4118
LNINF	-2.138080	3.978049	-0.537469	0.5963
LNFD	-0.573779	14.34751	-0.039992	0.9685
LNFD(-1)	11.00610	15.43776	0.712934	0.4834
LNFD(-2)	9.000142	8.479261	1.061430	0.3000
LNEXP	8.573388	12.22564	0.701263	0.4905
LNEXP(-1)	-7.810517	11.99400	-0.651202	0.5217
LNEXP(-2)	-13.41368	8.988051	-1.492390	0.1498
LNER	10.50339	19.90424	0.527696	0.6030
LNER(-1)	-7.704293	16.33447	-0.471659	0.6418
LNER(-2)	10.22373	10.97223	0.931783	0.3616
LNED	-0.092985	1.974007	-0.047105	0.9629
LNCD	0.175977	0.516550	0.340678	0.7366

R-squared	0.251535	Mean dependent var	2.667972
Adjusted R-squared	-0.360846	S.D. dependent var	4.593827
S.E. of regression	5.358942	Akaike info criterion	6.499710
Sum squared resid	631.8018	Schwarz criterion	7.293804
Log likelihood	-114.2441	Hannan-Quinn criter.	6.788875
F-statistic	0.410749	Durbin-Watson stat	2.246464
Prob(F-statistic)	0.970140		

Appendix A5: Functional form

Ramsey RESET Test

	Value	df	Probability
t-statistic	1.395729	21	0.1774
F-statistic	1.948060	(1, 21)	0.1774

F-test summary:	Sum of Sq.	df	Mean Squares
Test SSR	9.285845	1	9.285845
Restricted SSR	109.3868	22	4.972129
Unrestricted SSR	100.1010	21	4.766714

Unrestricted Test Equation:
Dependent Variable: LNKF
Method: ARDL
Date: 06/20/18 Time: 11:11
Sample: 1972 2012
Included observations: 41
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (2 lags, automatic):
Fixed regressors: C

Variable	Coefficient	Std. Error	t-Statistic
LNKF(-1)	-0.453513	0.235744	-1.923758
LNKF(-2)	-1.041138	0.444026	-2.344769
LNT	-25.84933	12.07761	-2.140268
LNT(-1)	-27.13816	11.03422	-2.459453
P	-7.535996	4.661592	-1.616614
P(-1)	-49.96695	20.69045	-2.414977
LNINF	-4.279794	2.306617	-1.855442
LNFD	-12.89054	7.123278	-1.809636
LNFD(-1)	27.11312	11.47663	2.362464
LNFD(-2)	18.17432	7.581473	2.397201
LNEXP	35.54378	14.98590	2.371814
LNEXP(-1)	2.030143	4.973499	0.408192
LNEXP(-2)	-22.30722	9.305005	-2.397336
LNER	59.74629	24.17553	2.471354
LNER(-1)	-47.00820	18.51933	-2.538332
LNER(-2)	20.49197	8.617761	2.377877
LNED	-0.277127	0.823724	-0.336431
LNCD	-0.164502	0.211422	-0.778072
C	-55.95215	25.49699	-2.194461
FITTED^2	0.140520	0.100679	1.395729

R-squared	0.685694	Mean dependent var	
Adjusted R-squared	0.401321	S.D. dependent var	
S.E. of regression	2.183281	Akaike info criterion	
Sum squared resid	100.1010	Schwarz criterion	
Log likelihood	-76.47494	Hannan-Quinn criter.	
F-statistic	2.411251	Durbin-Watson stat	
Prob(F-statistic)	0.026646		

*Note: p-values and any subsequent tests do not account for model selection.

Appendix A6:

Diagnostic tests: The diagnostic test run on the residuals of the long-run equation presented in the table below indicates no evidence of Serial Autocorrelation, the Breusch-Godfrey with the null hypothesis of no serial Autocorrelation is accepted, while the white test for Hetroskedasticity also indicates no evidence of Hetroskedasticity.

Breusch-Godfrey Serial Correlation LM Test: Serial Autocorrelation			
F-statistic	1.714259	probability	0.2055
Obs*R-squared	5.999919	probability	0.0498
White Heteroskedasticity Test			
F-statistic	0.410749	probability	0.9701
Obs*R-squared	10.31292	probability	0.9212
Ramsey RESET Test: Model Misspecification			
F-statistic	1.948060	probability	0.1774
Log likelihood ratio	-76.47494	Probability	5.010479

As shown on the above table the test for checking the model specification i.e. the Ramsey RESET for model specification also indicates that the model has no evidence of any misspecification.

The Macroeconomic Determinants of Multidimensional Poverty: Evidence from East Africa[1]

Kumadebis Tamiru Gemechu[2]

Abstract

This paper investigated the macroeconomic determinants of multidimensional poverty in east Africa using a panel data span from 1990 to 2016. The fixed effect model was employed to analyses the effects of each variable considered. A set of models has been developed to measure the response of consumption expenditure and human poverty index to changes in economic growth as well as human capabilities. All models are estimated using fixed effect techniques. Inconsistent with the theory, household expenditure appears to be insignificantly and positively related to changes in gross domestic product (GDP) per capita. However, when the HPI is regressed on GDP per capita, statistically significant relationship is observed, calling into policy intervention on the relationship between economic growth and well-being in much of east African Countries sampled. This finding suggests that development policies that focus primarily on economic growth as a means to addressing multidimensional deprivation may be used well.

Key words: Macro drivers, multidimensional poverty, East Africa

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[1] The original version of this paper was presented at the 16th International Conference on the Ethiopian Economy, Ethiopian Economics Association, from July 19 -20, Addis Ababa, Ethiopia. The author has benefited a lot from the comments of the conference participants and examiners.

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1. Introduction

In the international development field's history, poverty has been expressed and measured in monetary terms, such as gross domestic product (GDP) per capita, when discussed at a national or global scale, or the $1.25 (plus periodic adjustments) per day standard commonly cited in the development literature, when discussed at the individual level. Because poverty is conceptualized as primarily a function of control over monetary resources, policies designed to reduce poverty and improve well-being have tended to focus primarily on economic growth and the expansion of monetary wealth in the developing world (Prince, H., 2014).

Over the last ten years or so, interest in multidimensional poverty measurement has been growing steadily. Multidimensional poverty analysis has also ventured forth from purely academic discussion and into the broader policy debate, both within a number of countries and internationally (Francisco H., Maria A., 2012). The driving force behind this rising popularity is the broad acknowledgment that poverty is about more than just low incomes. Low consumption and inadequate living standards lie at the heart of what most people understand by the word “poverty”, to be sure. But the associations conjured up by that term also include aspects of poor health, a shortened lifespan, limited access to education, knowledge and information, and powerlessness in various domains. Poor people themselves will often allude to non-income dimensions as crucial to their perception of their own hardships.

Both human development and human poverty3 are defined in terms of the ability of the population to acquire and use capabilities. The Human Development Index measures deprivation in terms of the absence/prevalence of the capabilities to acquire and use three essential elements of human life:

[3] The HPI is a broad, aggregate measure of how well the poorest of the poor are faring in a given country. Whilst it can be argued that the selection of indicators that comprise the HPI (or any similar multidimensional index) is arbitrary (Alkire & Santos 2009; Basarir 2011; Berenger & Verdier-Chouchane 2007; Ravallion 1992), it would be difficult to argue that these indicators are not metrics of deprivation, or that they are not indicators that are typically used to characterise extreme poverty.

longevity, knowledge and a decent standard of living (UNDP, 2008). Furthermore, this study intends to know for poverty reduction or increase in Eastern Africa, as measured by the United Nation Development Program's (UNDP) former metric for aggregate and, national-level deprivation, the Human Poverty Index (HPI). The HPI value reflects the proportion of people affected by any one of three key deprivations adult illiteracy, death before age 40 and a composite measure of the percentage of children underweight for their age and the percentage of a population who lack access to clean water providing a comparative, multidimensional measure of the prevalence of human poverty. The HDI measures human development and examines the progress of a society whereas the HPI measures deprivation and the percentage of people left out of this progress.

Dollar et al. (2003) argued that growth-enhancing policies and institutions 'tend to benefit the poor and everyone else in society equi proportionately', and that 'pro-poor' policy interventions, such as those related to primary school attainment, public expenditure on health and education and labour productivity in agriculture, have little to no effect in terms of raising the share of income for the poorest. They claimed on the 1:1 ratio in Dollar and Kraay's examination of income poverty of the poorest quintile.

From the outset, the intent of this study has been to determine whether those factors that drive change in an income-based metric of poverty are the same as or different from those that drive change in a multidimensional metric. This is important because, presumably, policy and investment decisions are made based on the evidence of what does and does not work. It is an exploration of those factors that appear to contribute to changes in the HPI and will be primarily concerned with policies and activities that relate to, or are explicitly meant to encourage, economic growth, increased literacy and improved health. In order to draw out the distinctions between factors that drive change in a measure of multidimensional deprivation and those that drive change in unidimensional and income-based metrics of poverty, I will use fixed effects panel models that regress the HPI on various factors reported to reduce income poverty and compare these findings to similar models that regress final household consumption expenditure per capita on those same factors.

This study is intended to answer the following primary research questions:

1. What are the effects of economic growth-based policies on the levels of deprivation in East Africa?
2. What are the effects of human capabilities-based policies on the HPI in East Africa?
3. What are the effects of factors that drive change in consumption expenditure per capita differ from those that drive change in the HPI?

The next section explains the conceptual framework of multidimensional poverty measurements and formula.

2. Conceptual Framework of Multidimensional Poverty Measurement

There is consensus among scholars that poverty is a multidimensional concept. Even traditional monetary measures of poverty are considered as being multidimensional. Ravallion (2011) argued that besides the measures of rice consumption in countries such as Vietnam before the 1990s there have been no other attempts for uni-dimensional measures. Despite this confusion, monetary measures are often perceived as uni-dimensional when in reality, several different goods and services are used in their construction.

Furthermore, rather than viewing poverty as a result of a lack or lowness of single resource variable or trait, the multidimensional approach weighs in a more comprehensive set of information. Whereas economic well-being, capability, and social inclusion are treated as poverty indicating proxy concepts, this approach incorporates all three as separate dimensions of poverty. Although these dimensions are highly interrelated, a lack of perfect predictability indicates the urgency for using all three. The measurement outcomes from this approach would more comprehensive and accurate than those from any unidimensional approach (Udaya R., 2007). Furthermore, the 2010 HDR introduced the MPI, which identifies multiple overlapping deprivations suffered by households in 3 dimensions: education, health and living standards.

Bourguignon (2006) advocated the "income paradigm of poverty", that has been traditionally dominant in the literature. Poverty is conceptualized following the maximizing utility behavior subject to a budgetary restriction. The individual choices over a set of goods and services are conceived as an expression of the revealed preferences of the individuals, rational and autonomous with access to a full set of information. In this case tradition, poverty is defined as a standard of living below a poverty line fixed using monetary resources (income, consumption, expenditure). However, since the late 1970s different authors have identified the limitations not only in the concept of poverty but also of the indicators used.

Townsend (1979) was arguing that poverty was not a lack of income to purchase goods in the market but the lack of resources to participate in society. He also introduced different indicators, mainly focusing on the access to goods and services, to account for his concept of poverty.

In 1971(Rawls) presented his "justice as fairness" conceptual framework under the social contract tradition. It conveys the idea that the principles of justice are agreed to in an initial situation that is fair" (Rawls, 1971, p. 11). He describes his approach as based on principles of justice, using the concept of the original position of equity. For Rawls, the space of equality is the set of `primary goods' in which he positions: rights and liberties, powers and opportunities, income and wealth, and health and vigor.

The "basic needs' approach" is another area of conceptual framework in the study of poverty. Its emphasis is on the services and commodities that individuals can obtain. According to Streeten (1998, p. 26) the measurement of poverty is a process of disclosing six veils, where each veil shows a different aspect of it. In the fourth veil he refers to what is now known as the basic needs approach: Beyond the fourth veil are direct measures of physical inputs to meet basic needs, such as, calories consumed, yards of cloth bought, cubic feet at house room occupied, hospital beds available, school enrollment, letters posted, etc". He thinks that despite the fact that this veil is full of means, as in the monetary approach, those are means that move beyond the income paradigm and refer to goods and services favoring the human needs.

Also at the end of the 1970s Sen proposed the "capability approach" as a framework to understand development and specifies that poverty is a `capability deprivation'. He argues that income is not a satisfactory space to evaluate the well-being of individuals. For him, the monetary tradition is a very limited framework to understand development. Income is just one particular means among many others but not an end in itself: Aristotle had pointed out, at the very beginning of his Nicomachean Ethics, that income and wealth are only instrumentally1 valued, and we have to go deeper to understand what makes human life rich and human freedoms effective" (Sen, 2006, p. 35). The argument of Sen (1999, p. 90) is that poverty can be perceived as a capability deprivation when the focus is shifted from means (e.g. income) to ends (objectives that people want to pursue) as for instance health and education with their instrumental (indirect effects on productivity) and intrinsic (direct effect, like living a healthy life or being educated) value.

The proliferation of conceptual frameworks since the late 1970s has shifted the focus of understanding and measuring poverty from income to other dimensions of development. At the same time research on its measurement is booming. It is a complex subject to navigate and although several innovations have been proposed, the `income paradigm' is still the main framework used to understand and measure poverty. Life is richer and more complex than buying and selling goods and services, but unfortunately, this creates the need for alternative measures which are not so readily available and are likely to generate more controversy and more difficulties in measurement" (Fleurbaey, 2015, p. 201).

Poverty has different shapes and magnitudes. Poverty can be defined in terms of income, capabilities, basic needs, social exclusion, and vulnerability to risk shocks. It can be considered permanent or transitory. It can be defined in relative or absolute terms. It can be understood in objective or subjective terms.

Jenkins and Mickelwright (2007), argued that these developments respect the view that poverty is not only about having enough money, and that inequality is not just about differences in money income". The rest of this section presents a summary of the data variables and methodology used. These calls the researcher to use both growths based and capabilities based variables to draw the relationship among variables.

2.1 Measurements of Human poverty Index

As UNDP's (1997) Human Development Report stated, the Human poverty Index remained essentially true to its original formulation until 2010. Later on The Human Poverty Index was replaced by the Multidimensional Poverty Index in 2010.

The Human Poverty Index (HPI) was an indication of the standard of living in a country, developed by the United Nations (UN) to complement the Human Development Index (HDI) and was first reported as part of the Human Development Report in 1997. It was considered to better reflect the extent of deprivation in developed countries compared to the HDI. In 2010 it was supplanted by the UN's Multidimensional Poverty Index.

The HPI concentrates on the deprivation in the three essential elements of human life already reflected in the HDI: longevity, knowledge and a decent standard of living. The HPI is derived separately for developing countries (HPI-1) and a group of select high-income OECD countries (HPI-2) to better reflect socio-economic differences and also the widely different measures of deprivation in the two groups.

For developing countries (HPI-1)

The Human Development Reports summarizes this as "A composite index measuring deprivations in the three basic dimensions captured in the human development index — a long and healthy life, knowledge and a decent standard of living." The formula for calculating it is:

HPI-1 = (1/3(p1α + p2α + p3α))1/α **(1)**

p1: Probability at birth of not surviving to age 60.
P 2 {\displaystyle P_{2}}p2:Adult illiteracy rate
P 3 {\displaystyle P_{3}} p2: Unweighted average of population without sustainable access to an improved water source and children under weight for age α:3

For selected high-income OECD countries (HPI-2)
The Human Development Reports summarizes this as "A composite index measuring deprivations in the four basic dimensions captured in the human development index — a long and healthy life, knowledge and a decent standard of living — and also capturing social exclusion." The formula for calculating it is:

HPI-2= (1/3(p1α +p2 α+p3α+p4α))1/α **(2)**

p1: Probability at birth of not surviving to age 60 (times 100)
P 2 {\displaystyle P_{2}}p2: Adults lacking functional literacy skills
P 3 {\displaystyle P_{3}}p4: Population below income poverty line (50% of median adjusted household disposable income)
P 4 {\displaystyle P_{4}}p4: Rate of long-term unemployment (lasting 12 months or more) α:3

In sum up, the HPI measures deprivation in the three basic dimensions of human development:

- A long and healthy life-vulnerability to death at a relatively early age as measured by the probability at birth of not surviving to age 40;
- Knowledge-exclusion from the world of reading and communication, as measured by the adult illiteracy rate
- A decent standard of living-a lack of access to overall economic provisioning as measured by the unweighted average of two indicators, the percentage of the population not using an improved water source and the percentage of children under weight for age.α {\displaystyle \alpha }α {\displaystyle \alpha }

3. Data and Methodology

This study used a panel data set of HPI scores for a set of 7 east African countries, between 1990 and 2016. HPI is calculated using the formula above with current data for each country, and a range of indicators that the development literature and theory suggest should have an effect on poverty. Several models have been created to empirically test the relationship between both the HPI and household consumption expenditure and indicators relating to economic growth-based and capabilities-based approaches to development. Data for this study have been compiled from the World Bank's World Development Indicators.

This paper analyses the effects of economic growth and human capabilities-based policies on deprivation. In this case deprivation is measured by the HPI. To examine this question, a panel regression model is applied to measure changes in the HPI between 1990 and 2016 for selected east African countries.

Two dependent variables are used in this study. These are: Human Poverty Index and Household final consumption expenditure per capita. Human Poverty Index was created to provide an accounting of human deprivation than those based simply on measure of income. It was computed based on the HPI formula given above on Equation (1 and 2).

Independent variables are classified in to two broad categories. The first is growth-based variable considered as a potential driver of the HPI is GDP[4] per capita and as a covariates foreign direct investment, a measure of exports as a percentage of GDP, imports as a percentage of GDP, the official exchange rate and inflation.

The second is Capabilities-based[5] variables. The key indicator of interest is public health expenditure per capita. The model includes as a covariate the female

[4] Dasgupta (1993) neatly summarizes the two primary contending positions regarding the measurement of well-being and the link between national accounts, such as GDP per capita, and poverty measurement: If we wish to estimate changes in social well-being, there are two routes available. The first is the direct one. The idea is to measure changes in the constituents of well-being, such as health, longevity, basic liberties, literacy, and also real income, as indicators of the extent of commodity choice. In so doing, we measure changes in well-being itself. … The other route is roundabout. It is to measure changes in the value of the determinants of well-being. Since commodities are inputs in the production of well-being, we measure changes in the accounting (or shadow) values of goods and services. In short, the idea is to measure changes in real national income. (p. 184)

[5] Subramanian (McGillivray 2007) notes that income-based measures of poverty are often poor proxies for a capabilities-based definition of deprivation and disparity, pointing to China, Costa Rica, Kenya, Peru and the Philippines, 'which have displayed greater success in reducing human poverty than income-poverty'. The experience of these countries points 'to the possibilities of enhancing achievements in the space of human functioning's by routes different from those centered exclusively on income

secondary school enrolment rate, the percentage of women in a given country's parliament, the labour force participation rate, household consumption expenditure, livestock production index, and food production index.

Following Prince (2014) conceptual model may be presented as an equation:

$HPI_{it} = f(zg, zc, t) + Ci$+Eit Equation **(3)**

The HPI for country i at time t is explained as a function of zg, a vector of economic growth-based variables, zc, a vector of capabilities-based variables, and t. The model includes a set of indicators Ci representing the countries in the model. The variable time is key since it will show whether a change in policy contributes to a change in HPI, potentially providing the strongest evidence of 'cause'. Seven countries are selected to represent eastern African countries. These are Ethiopia, Tanzania, Madagascar, Zimbabwe, Zambia, Burundi, and Kenya.

Use fixed-effects (FE) whenever you are only interested in analyzing the impact of variables that vary over time. Fixed-effects explore the relationship between predictor and outcome variables within an entity (country, person, company, etc.). Each entity has its own individual characteristics that may or may not influence the predictor variables. When using fixed-effects we assume that something within the individual may impact or bias the predictor or outcome variables and we need to control for this. This is the rationale behind the assumption of the correlation between entity's error term and predictor variables. Fixed-effects[6] remove the effect of those time-invariant characteristics so we can assess the net effect of the predictors on the outcome variable. Another important assumption of the fixed-effects model is that

growth and the percolation of that growth to the poor'. Therefore, incorporating these variables may lead to true proxies.

[6] One limitation of using fixed effects estimators is that time-invariant variables, such as geographic characteristics, drop out of the models, making estimations of the coefficients for these variables impossible to determine. Instead, all of the effects of time-invariant factors are absorbed in the error term in fixed effects models. Random effects models are better suited to the use of time-invariant variables. However, Wooldridge (2006) notes that fixed effects models are the more appropriate models when using panel data to determine policy effects over time.

those time-invariant characteristics are unique to the individual and should not be correlated with other individual characteristics. Each entity is different therefore the entity's error term and the constant (which captures individual characteristics) should not be correlated with the others. If the error terms are not correlated, then fixed-effect is suitable since inferences may be correct.

The equation for the fixed effects model becomes:

$$Y_{it} = \beta 1 X_{it} + \alpha i + U_{it} \ldots \quad \textbf{(4)}$$

αi (i=1,2,3,....n) is the unknown intercept for each entity (n entity-specific intercepts).
Yit is the dependent variable (DV) where i= entity and t= time.
Xit represents one independent variable (IV),
$\beta 1$ is the coefficient for that IV,
uit is the error term. The log values of all variables are used in this study.

4.1 Descriptive Statistics Results

This section describes lists the 7 countries included in the analysis and provides means, standard errors, minimum, maximum, number of overall, within, and between observations for all variables.

Table 1 below presents the mean HPI, GDP per capita, household consumption expenditure, inflation, import, export, FDI and human poverty index by country over the course of this study.

Table 1: Descriptive statistics for growth based model

Variable		Mean	Std. Dev.	Min	Max	Observations
lngdpp~a	overall	2.743252	.2750842	2.213845	3.211461	N = 189
	between		.2802522	2.390494	3.059327	n = 7
	within		.0893985	2.514627	3.052489	T = 27
lnexch~e	overall	1.74498	1.60449	-2.610034	9.827566	N = 181
	between		1.384812	-.3461945	3.104128	n = 7
	within		1.017144	-.5188597	11.91874	T = 25.8571
lnfdi	overall	7.81809	1.315915	3.766356	9.600859	N = 123
	between		1.236943	4.894883	8.316478	n = 7
	within		.9250603	3.53669	9.190476	T-bar = 17.5714
lninf	overall	.9795052	.4444298	-.6847529	2.218887	N = 177
	between		.252157	.5004589	1.325487	n = 7
	within		.3877714	-.5505056	2.350024	T-bar = 25.2857
lnimp	overall	9.401594	.5496249	8.110594	10.30704	N = 150
	between		.5062929	8.549883	10.18058	n = 7
	within		.317423	8.896954	9.998884	T-bar = 21.4286
lnhpi	overall	-1.797526	.5415059	-3.878325	-1.073272	N = 189
	between		.342267	-2.25392	-1.343705	n = 7
	within		.4385009	-3.853989	-.7641272	T = 27
lnhce	overall	9.792678	.4761109	8.833504	10.75048	N = 148
	between		.4714432	9.046682	10.56081	n = 7
	within		.2465505	9.186724	10.3772	T-bar = 21.1429
lnexp	overall	9.186815	.6268607	7.587446	10.05513	N = 164
	between		.5899076	8.007542	9.771962	n = 7
	within		.2951658	8.514134	9.801832	T-bar = 23.4286

Source: Own Computation, 2018

Mean values range from, at the lower end, HPI, with a mean HPI of -1.79 , to import 9.4, over the 26-year period of this study. The observation occurred within the group were 27 observations where as between the group we have 7 observations, and overall we have 160.

Table 2 presents the mean public health expenditure per capita, secondary school enrolment rate, the percentage of women in a given country's parliament, the labour force participation rate, household consumption expenditure, livestock production index, and food production index.

Table 2: Descriptive statistics for capabilities based model

Variable		Mean	Std. Dev.	Min	Max	Observations
lnhpi	overall	-1.797526	.5415059	-3.878325	-1.073272	N = 189
	between		.342267	-2.25392	-1.343705	n = 7
	within		.4385009	-3.853989	-.7641272	T = 27
lnhce	overall	9.792678	.4761109	8.833504	10.75048	N = 148
	between		.4714432	9.046682	10.56081	n = 7
	within		.2465505	9.186724	10.3772	T-bar = 21.1429
lnhep	overall	1.282659	.3269101	.6042091	1.943658	N = 135
	between		.2551145	.9429181	1.621378	n = 7
	within		.2253726	.8327018	1.765402	T = 19.2857
lnsfe	overall	1.338666	.3108113	.6626322	1.75869	N = 71
	between		.2702001	.9157533	1.65557	n = 7
	within		.1900894	1.079302	1.924401	T = 10.1429
lnwip	overall	1.138037	.3121475	.0413927	1.588832	N = 138
	between		.2084375	.8414317	1.434555	n = 7
	within		.2463653	.317786	1.605588	T-bar = 19.7143
lnlpr	overall	.	.	.	.	N = 0
	between		.	.	.	n = 0
	within		.	.	.	T = .
lnlpi	overall	1.980914	.1084382	1.727785	2.3366	N = 172
	between		.042381	1.926716	2.028602	n = 7
	within		.1010735	1.771258	2.288912	T = 24.5714
lnfpi	overall	1.976172	.1113138	1.711301	2.268461	N = 172
	between		.026583	1.942751	2.013555	n = 7
	within		.1085244	1.730955	2.276541	T = 24.5714

Source: Own Computation, 2018

Mean values range from, at the lower end, HPI, with a mean HPI of -1.79 , to household consumption expenditure 9.79, over the 26-year period of this study. The observation occurred within the group were 27 observations where as between the group we have 7 observations, and overall we have 160.

4.2 Panel Regression Results

Economic growth-based variables and household consumption expenditure

Household final consumption per capita was used as the dependent variable against which I will compare findings from the HPI models. Therefore, economic growth based variables are regressed on household final consumption per capita.

Table 2: Economic growth models and household consumption expenditure results

Fixed-effects (within) regression		Number of obs =	101
Group variable: country1		Number of groups =	6
R-sq:		Obs per group:	
within	= 0.9258	min =	3
between	= 0.8880	avg =	16.8
overall	= 0.9385	max =	27
		F(6,89) =	185.18
corr(u_i, Xb)	= -0.4462	Prob > F =	0.0000

lnhce	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdppercapita	.3366245	.2297084	1.47	0.146	-.1198012	.7930502
lnexchangerate	-.0365456	.0669168	-0.55	0.586	-.1695078	.0964166
lnfdi	.0126601	.0138179	0.92	0.362	-.0147958	.040116
lninf	-.0749433	.0310587	-2.41	0.018	-.1366563	-.0132303
lnexp	.058523	.1238108	0.47	0.638	-.1874864	.3045324
lnimp	.760675	.0850578	8.94	0.000	.5916669	.9296831
_cons	1.26909	.4390102	2.89	0.005	.3967858	2.141394
sigma_u	.18484886					
sigma_e	.07951914					
rho	.84383997	(fraction of variance due to u_i)				

F test that all u_i=0: F(5, 89) = 6.58 Prob > F = 0.0000

Source: Own Computation, 2018

As the model result is shown on Table 2 above, with a \$1 increase in import is associated with an approximately \$0.76 increase ($p < 0.01$) in household consumption expenditure whereas a 1% increase in inflation result in \$7.4 reduction of household consumption expenditure ($p < 0.05$). None of the other indicators is statistically significant.

Economic growth-based variables and the Human Poverty Index

In this section, human poverty index is used as dependent variables and growth variables are considered as independent variables.

Table 3: Economic growth models and Human Poverty Index results

```
Fixed-effects (within) regression               Number of obs      =       103
Group variable: country1                        Number of groups   =         6

R-sq:                                           Obs per group:
     within  = 0.2087                                         min =         5
     between = 0.1221                                         avg =      17.2
     overall = 0.0023                                         max =        27

                                                F(6,91)            =      4.00
corr(u_i, Xb)  = -0.9529                        Prob > F           =    0.0013
```

lnhpi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdppercapita	-4.846078	1.169665	-4.14	0.000	-7.169474	-2.522682
lnexchangerate	-1.410121	.3439518	-4.10	0.000	-2.093339	-.7269033
lnfdi	.1156973	.0714404	1.62	0.109	-.0262104	.2576049
lninf	-.152556	.1594605	-0.96	0.341	-.4693047	.1641927
lnexp	.9595445	.63812	1.50	0.136	-.3080024	2.227091
lnimp	.2668818	.4412865	0.60	0.547	-.6096796	1.143443
_cons	2.72665	2.239603	1.22	0.227	-1.722047	7.175347
sigma_u	1.4896073					
sigma_e	.41297436					
rho	.92862548	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(5, 91) = 7.17                       Prob > F = 0.0000
```

Source: Own Computation, 2018

Table 3 presents the results of a panel regression model that regresses the HPI on the same economic growth indicators. Amongst these indicators, only GDP per capita and exchange rate are statistically significant. A $1 increase in GDP per capita resulting in a 4.84 ($p < 0.01$) decrease in the HPI. Also, exchange rate affect HPI negatively .i.e. 1% increment in the value of dollar results in decrement of HPI by 1.4. None of the other indicators is statistically significant.

Capabilities-based variables and household consumption expenditure

Table 4: Capabilities and household consumption expenditure

Fixed-effects (within) regression		Number of obs =	34
Group variable: country1		Number of groups =	6
R-sq:		Obs per group:	
within	= 0.9069	min =	2
between	= 0.0020	avg =	5.7
overall	= 0.0326	max =	11
		F(5,23) =	44.81
corr(u_i, Xb)	= -0.3527	Prob > F =	0.0000

lnhce	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnhep	.755013	.1519635	4.97	0.000	.4406526	1.069373
lnsfe	.1541345	.1773666	0.87	0.394	-.2127763	.5210453
lnwip	.4653025	.1072914	4.34	0.000	.2433534	.6872516
lnlpi	.1780492	.4684592	0.38	0.707	-.7910324	1.147131
lnfpi	-.398693	.3379511	-1.18	0.250	-1.097798	.3004122
_cons	8.581293	.6284672	13.65	0.000	7.28121	9.881377
sigma_u	.43673523					
sigma_e	.06418753					
rho	.97885617	(fraction of variance due to u_i)				

F test that all u_i=0: F(5, 23) = 134.20 Prob > F = 0.0000

Source: Own Computation, 2018

Table 4 presents the results of the panel regressions of the HPI and household consumption expenditure on the capabilities-based variables. Using the fixed effects estimator and regressing household consumption expenditure on the set of capabilities-based variables for all countries in the data set finds health expenditure per capita and women in parliament to be statistically significant. When health expenditure per capita increase by $1, then household consumption expenditure increase by $0.75 over the period of study. The percentage of women in parliament increment b y 1% percent results in $0.46 household consumption expenditure increase. None of the other indicators is statistically significant.

Capabilities-based variables and the Human Poverty Index

Table 5: Capabilities and Human Poverty Index results

```
Fixed-effects (within) regression               Number of obs      =        46
Group variable: country1                        Number of groups   =         6

R-sq:                                           Obs per group:
     within  = 0.3358                                          min =         3
     between = 0.0000                                          avg =       7.7
     overall = 0.0189                                          max =        14

                                                F(5,35)            =      3.54
corr(u_i, Xb)  = -0.5391                        Prob > F           =    0.0108
```

lnhpi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnhep	-.3774371	.3615954	-1.04	0.304	-1.111515	.3566406
lnsfe	-.0552951	.5309264	-0.10	0.918	-1.133133	1.022543
lnwip	.6200677	.2237246	2.77	0.009	.1658826	1.074253
lnlpi	.0273919	.9734653	0.03	0.978	-1.948848	2.003632
lnfpi	.6149736	1.008742	0.61	0.546	-1.432883	2.66283
_cons	-3.140772	1.464914	-2.14	0.039	-6.114706	-.1668381
sigma_u	.3747437					
sigma_e	.20261322					
rho	.77379879	(fraction of variance due to u_i)				

```
F test that all u_i=0: F(5, 35) = 6.35                      Prob > F = 0.0003
```

Source: Own Computation, 2018

However, when the HPI is considered, several of the indicators are found to be insignificant. As shown in Table 5 above, a one percent increase in women participation parliament is associated with a 0.62% reduction in the HPI ($p < 0.05$); each percentage increase in percentage of parliamentary seats held by women is associated with a 0.13% reduction in the HPI ($p < 0.01$). Curiously, neither the labour force participation rate nor the secondary school enrolment rate amongst girls is statistically significant including food production and livestock production index.

5. Conclusion

The primary aim of this study was to identify the range of potential macro-level drivers those that have an influence on multidimensional poverty in east Africa by using a panel data span from 1990 to 2016 by using fixed effect model. It has as its starting point the premise that poverty is a multidimensional phenomenon and, as a corollary premise, a better understanding of what drives change in a particular multidimensional index the HPI would help to shape policies designed to improve well-being, as measured in terms other than monetary. Continuing to conceptualize poverty as a function of income, whether national or individual, presents a misleading picture of the effect that development policy has had on the well-being of the poorest.

The result suggest that import and inflation affects the household consumption expenditure per capita when it is used as independent variable in growth based model positively and negatively correspondingly whereas GDP per capita and exchange rate resulted reduction of HPI. The other variables are insignificant

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Appendix

Robustness check

```
Fixed-effects (within) regression               Number of obs      =        101
Group variable: country1                        Number of groups   =          6

R-sq:                                           Obs per group:
     within  = 0.9258                                         min =          3
     between = 0.8880                                         avg =       16.8
     overall = 0.9385                                         max =         27

                                                F(5,5)             =          .
corr(u_i, Xb)  = -0.4462                        Prob > F           =          .

                                 (Std. Err. adjusted for 6 clusters in country1)
```

lnhce	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdppercapita	.3366245	.1740527	1.93	0.111	-.1107921	.7840411
lnexchangerate	-.0365456	.0458809	-0.80	0.462	-.1544862	.081395
lnfdi	.0126601	.0187652	0.67	0.530	-.0355775	.0608977
lninf	-.0749433	.0256816	-2.92	0.033	-.14096	-.0089266
lnexp	.058523	.1370556	0.43	0.687	-.2937897	.4108358
lnimp	.760675	.2396188	3.17	0.025	.1447154	1.376635
_cons	1.26909	1.057795	1.20	0.284	-1.450059	3.988239
sigma_u	.18484886					
sigma_e	.07951914					
rho	.84383997	(fraction of variance due to u_i)				

```
Fixed-effects (within) regression               Number of obs      =        103
Group variable: country1                        Number of groups   =          6

R-sq:                                           Obs per group:
     within  = 0.2087                                         min =          5
     between = 0.1221                                         avg =       17.2
     overall = 0.0023                                         max =         27

                                                F(5,5)             =          .
corr(u_i, Xb)  = -0.9529                        Prob > F           =          .

                                 (Std. Err. adjusted for 6 clusters in country1)
```

lnhpi	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lngdppercapita	-4.846078	1.614954	-3.00	0.030	-8.997448	-.6947069
lnexchangerate	-1.410121	.4217076	-3.34	0.020	-2.494155	-.3260874
lnfdi	.1156973	.0544269	2.13	0.087	-.0242116	.2556061
lninf	-.152556	.1207033	-1.26	0.262	-.4628337	.1577217
lnexp	.9595445	.7328163	1.31	0.247	-.9242198	2.843309
lnimp	.2668818	.3099655	0.86	0.429	-.5299099	1.063673
_cons	2.72665	3.028765	0.90	0.409	-5.059037	10.51234
sigma_u	1.4896073					
sigma_e	.41297436					
rho	.92862548	(fraction of variance due to u_i)				

```
Fixed-effects (within) regression               Number of obs      =        34
Group variable: country1                        Number of groups   =         6

R-sq:                                           Obs per group:
     within  = 0.9069                                         min =         2
     between = 0.0020                                         avg =       5.7
     overall = 0.0326                                         max =        11

                                                F(5,5)             =    271.51
corr(u_i, Xb)  = -0.3527                        Prob > F           =    0.0000

                                  (Std. Err. adjusted for 6 clusters in country1)
```

lnhce	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnhep	.755013	.2014566	3.75	0.013	.2371524	1.272874
lnsfe	.1541345	.2073702	0.74	0.491	-.3789277	.6871967
lnwip	.4653025	.0975814	4.77	0.005	.2144616	.7161434
lnlpi	.1780492	.1895838	0.94	0.391	-.3092915	.66539
lnfpi	-.398693	.3336242	-1.20	0.286	-1.256301	.4589154
_cons	8.581293	.2941195	29.18	0.000	7.825235	9.337352
sigma_u	.43673523					
sigma_e	.06418753					
rho	.97885617	(fraction of variance due to u_i)				

```
Fixed-effects (within) regression               Number of obs      =        46
Group variable: country1                        Number of groups   =         6

R-sq:                                           Obs per group:
     within  = 0.3358                                         min =         3
     between = 0.0000                                         avg =       7.7
     overall = 0.0189                                         max =        14

                                                F(5,5)             =      8.56
corr(u_i, Xb)  = -0.5391                        Prob > F           =    0.0171

                                  (Std. Err. adjusted for 6 clusters in country1)
```

lnhpi	Coef.	Robust Std. Err.	t	P>|t|	[95% Conf.	Interval]
lnhep	-.3774371	.2539648	-1.49	0.197	-1.030274	.2754003
lnsfe	-.0552951	.2559097	-0.22	0.837	-.7131318	.6025417
lnwip	.6200677	.2590755	2.39	0.062	-.0459071	1.286043
lnlpi	.0273919	.4560375	0.06	0.954	-1.14489	1.199674
lnfpi	.6149736	.7117626	0.86	0.427	-1.21467	2.444618
_cons	-3.140772	.8155383	-3.85	0.012	-5.23718	-1.044364
sigma_u	.3747437					
sigma_e	.20261322					
rho	.77379879	(fraction of variance due to u_i)				

Uncovering the Unseen Passion: A Fire to Foster Ambition towards Innovation

Abdella Kosa[1] and Idris Mohammad

Abstract

Innovativeness can contribute to the growth of enterprises by discovering and exploring new ideas and experimentation, but it cannot be successful unless the ambition is changed to the action through the individual's passion and their resources. Therefore, this study aimed to uncover the role of entrepreneurial passion and resources on innovativeness under different entrepreneurial commitment level and unpredictable environmental. A sample of 112 owners/managers were selected using two level multi-stage sampling. The data were analyzed using descriptive and hierarchical regression analysis. The finding of the study indicates that the owners/managers who are passionate and have adequate human and financial capital are involved more on innovativeness. The commitment among passionate and resourceful owners/managers raises a fire on the individuals to be more innovative, but the strong entrepreneurial passion and resources faced challenges in the unpredictable environment to change the ambition to actions. Therefore, the policy makers should develop sustainable strategies that help in discovering and exploiting business opportunities and resources to encourage passionate firms towards innovativeness. Finally, the future research should include the financial measures or financial resources and other variables such as entrepreneurial intention and entrepreneurial background in a cross country study.

Key words: Passion, Innovativeness, Resources, Commitment, Unpredictability

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1. Introduction

The most important element of an entrepreneurial personality is innovativeness (Carland et al., 1984) because innovation is not only about construct representing the creation of new ventures, but also the growth of current enterprises (Gozukara & Colakoglu, 2016). Innovativeness is the firm's propensity to engage in new idea generation, experimentation, and research and development activities(Lumpkin and Dess, 1996). Mueller and Thomas (2001) have described innovativeness as a significant precursor of entrepreneurial behavior, while Schumpeter (1990) further explains innovation as a significant entrepreneurial precursor and entrepreneur as an innovator (Gozukara & Colakoglu, 2016).

Scholars have recently focused on the role affect and emotion play in entrepreneurship (e.g. Baron, 2008), and in particular have noted that entrepreneurial passion may be an important construct in need of more careful study (Cardon, 2008; Cardon et al., 2009). A growing volume of research indicates that entrepreneurial passion – which involves intense positive emotions and a meaningful identity connection – is central to the entrepreneurial experience and venture-related outcomes (Huyghe et al., 2016). Passion research is burgeoning as more and more studies emerge that investigate the role of this construct in entrepreneurship (Murnieks et al., 2016). Murnieks et al., (2011) draw from the work of these groups to define entrepreneurial passion as a strong inclination towards enjoyable, important activities related to being an entrepreneur.

The core argument of Biraglia and Kadile, (2017) work is built on the premise that the passion for entrepreneurial activities, such as exploring new market ideas, sourcing founding capital, and establishing and developing new products (Cardon et al. 2009; Cardon et al. 2013), can lead individuals to become entrepreneurs. Therefore, Passion is important in entrepreneurship because it can "fuel motivation, enhance mental activity, and provide meaning to everyday work" (Cardon, 2008). Passion is needed as a means to achieve high levels of performance and to overcome barriers to change (Ismail et al., 2016). As a result, interest in entrepreneurial passion is growing because passion has been demonstrated to drive the tenacious pursuit of goals and to inspire stakeholders to support ventures (Murnieks et al., 2016).Moreover, Passion can foster creativity and the recognition of new information patterns critical to the discovery and exploitation of promising opportunities (Baron, 2008; Sundararajan and Peters, 2007).

Cardon et al. (2009) distinguish three different types of entrepreneurial passion. Passion for inventing reflects entrepreneurs' passion for activities related to identifying, inventing, and exploring new opportunities and includes the search for business opportunities in new markets for existed firms. Passion for developing reflects their passion for activities related to nurturing, growing, and expanding the venture after its founding, while passion for founding reflects entrepreneurs' passion for activities involved in establishing a venture for commercializing and exploiting opportunities. Since our research considers the owners/managers of established small firms, passion for founding is excluded.

The aim of this paper is to uncover the level of entrepreneurial passion influence on small firm's owners/managers innovativeness with consideration of their commitment level and unpredictable environment. It also investigates the influence of entrepreneurial resources on innovativeness under the above circumstances. Many authors (eg. Huyghe et al., 2016; Sundararajan and Peters, 2007) measured entrepreneurial passion and innovativeness for individuals who are not started their business. Therefore, this paper is among the first to measure the entrepreneurial passion and innovativeness for firm owners/managers of established firms in Ethiopia.

The study makes many contributions to the fields of innovativeness, entrepreneurial passion, and resources. By uncovering the influence of passion and resources on innovativeness, the study brings a new insight on the relationship between entrepreneurial passion, entrepreneurial resources, and innovativeness. It also aimed to advance the study towards identifying the contribution of entrepreneurial commitment and environmental unpredictability in fostering/hindering the influence of entrepreneurial passion and resources towards innovativeness. As a result, the study contributes to entrepreneurship literature by investigating the moderating role of entrepreneurial orientation and environmental unpredictability in relating entrepreneurial passion and entrepreneurial resource to innovativeness. In addition, by exploring the contribution of entrepreneurial passion and resources towards innovativeness, it helps to bring the discussion forward on the subject matter.

The rest of the study is organized as; theory and hypotheses, Methodology, Results and Analysis, Discussion and conclusions, and Implications.

2. Theory and hypotheses

2.1 Innovativeness

Entrepreneurs with high innovativeness mainly aimed at profit and development (Carland et al., 1984) because entrepreneurs have the desire to seek innovative resources, environmental changes and the signs suggestive of opportunities for innovation (Gozukara & Colakoglu, 2016). Innovation becomes increasingly important to many industries, which more and more rely on recent technological developments (Schilling, 2013). It includes the development and enhancement of products and services and new administrative techniques and technologies for performing organizational functions (Okhomina, 2010).Schumpeter (1990) explains innovation as a significant entrepreneurial precursor and entrepreneur as an innovator(Gozukara & Colakoglu, 2016), while Covin and Miles (1999) argue that without innovativeness, entrepreneurship cannot exist and that innovativeness is a crucial part of entrepreneurship survival strategies (Omisakin et al, 2016).

Innovativeness is the specific tool of entrepreneurs and the means by which they exploit change (Drucker, 1985). Covin and Slevin (1989) defined innovativeness as the firm’s propensity to engage in new idea generation, experimentation, and research and development activities. Robinson et al. (1991) describe innovation as the ability to recognize opportunities and respond to such opportunities creatively, thereby providing consumers with innovative products and services. It is the firm’s ability and attempt to engage in new ideas or to innovate and create processes that may result in new products (Rauch et al., 2009).Schilling (2013) defines innovation as the act of introducing a new device, method, or material for application to commercial or practical objectives. It is the ability to do something in a creative and improved way and the ability to exploit business opportunities (Gozukara & Colakoglu, 2016).

2.2 Entrepreneurial Passion

Scholars have recently focused on the role affect and emotion play in entrepreneurship (Cardon, 2008; Cardon et al., 2009). A number of perception-based elements may be attributed to entrepreneurs, perhaps the most widely noted and readily visible element is a passion(Davis et al., 2017) because it indicated that entrepreneurial behavior is passionate, full of emotional energy, drive, and spirit (Huyghe et al., 2016). Moreover, a growing volume of research indicates that entrepreneurial passion – which involves intense positive emotions and a meaningful identity connection – is central to the entrepreneurial experience and venture-related outcomes (Huyghe et al., 2016).

Passion was defined as a strong inclination toward an activity that people like, find important, and in which they invest significant time and energy (Vallerand et al., 2003). Chen et al. (2009) define entrepreneurial passion as "an entrepreneur's intense affective state accompanied by cognitive and behavioral manifestations of high personal value". Therefore, passion is more than the experience of strong emotions: it specifically concerns intense positive feelings for activities that are central and meaningful to an individual's self-identity (Cardon et al., 2009).

Entrepreneurial passion, acting through its components of intense positive feelings tied to salient identities, is a key motivational driver of entrepreneurial behavior (Cardon, 2009; Huyghe et al., 2016). Particularly, an entrepreneurial passion was defined as an individual's intense affective state experienced by engagement in entrepreneurial activities that are often accompanied by outwardly visible manifestations (Cardon et al., 2013; Chen et al., 2009; Davis et al., 2017). As such, we use Cardon et al., (2009)definition of Entrepreneurial Passion as "consciously accessible intense positive feelings experienced by engagement in entrepreneurial activities associated with roles that are meaningful and salient to the self-identity of the entrepreneur.

2.3 Entrepreneurial resource

Resources are defined as those tangible and intangible assets that are tied semi permanently to the firm that includes physical, human, technological or reputational (Hadjimanolis, 2000).Given the scarcity of this valuable resources, firms must find ways of acquiring and efficiently deploying such resources (Massis et al., 2017).A single resource is rarely the main success factor of the firm. It is usually the combination of assets in resource clusters, which leads to competitive advantage. Inter asset coupling and interaction with complementary assets (e.g. marketing skills complementing the technological innovation assets) contribute frequently to the uniqueness and inimitability of assets (Hadjimanolis, 2000).

Most SMEs, due to limited resources, need to access bundles of resources, including knowledge-based resources (Wiklund et al., 2009). Enterprises which wish to develop and be innovative, must increase the resources of knowledge and capabilities of their employees and, at the same time, enrich the resources of human capital. Investment in the development of employees ought to be treated by employers equally on a par with investments in research and development (Kuraś &Łęgowik-Świącik, 2014).

Lack of financial support does not seem to discourage an active involvement in entrepreneurial activity (Thurik & Grilo, 2008). The interconnectedness of household and business leads to flexibility in resource availability, as households can release resources from other household activities and make them available for business development when needed – or decided(Alsos et al., 2003).Opportunity business owners are significantly more likely to be wealthier in terms of household income and to have a higher preference for business ownership versus paid employment (Zwan et al., 2016).Multiple income sources within the household offer advantages to the business, both by relieving the pressure to generate household income and by providing a source of readily available external finance when required (Alsos et al., 2003).

2.4 Innovativeness and Entrepreneurial passion

Entrepreneurial passion has gained credence in recent years in explaining entrepreneurial efforts (Drnovsek et al., 2016) because, a burgeoning body of research is beginning to shed light on the various constructs linked to passion in entrepreneurship (Murnieks et al., 2016). They also indicate that passion plays a critical role in new venture creation processes and outcomes (Huyghe et al., 2016). In addition, passion can foster creativity and the recognition of new information patterns critical to the discovery and exploitation of promising opportunities (Baron, 2008;Sundararajan and Peters, 2007; Cardon, et al., 2013) and it is the “fire of desire” that fuels entrepreneurs' daily efforts and creativity (Cardon, 2009). Accordingly, scholars have pressed for a deeper understanding of passion as a central element of entrepreneurial efforts (Cardon et al., 2009; Chen et al., 2009;Cardonet al., 2013).

Even though the literature is unclear about the mechanisms for how passion influences outcomes (Cardon et al., 2009), Murnieks et al., (2011) define entrepreneurial passion as a strong inclination towards enjoyable, important activities related to being an entrepreneur. The core argument of Biraglia & Kadile, (2017) work is built on the premise that the passion for entrepreneurial activities, such as exploring new market ideas, sourcing founding capital, and establishing and developing new products (Cardon et al. 2009; Cardon et al. 2013), can lead individuals to become entrepreneurs.

Given the uncertain success of launching new products and services and the challenges of developing new organizations with limited resources, passion can become a key driver of entrepreneurial action (Cardon et al., 2013).The work of Ho and Pollack, (2014) portray entrepreneurial passion as a valuable characteristic that will unequivocally yield positive outcomes. Scholars suggest that entrepreneurs who experience passion benefit from its motivational energy (Cardon et al., 2009). The study by Smith & Miner (1983) determined that entrepreneurs stated a desire to produce creative and innovative solutions. More concretely, passion can fuel motivation, enhance mental activity, and provide meaning to everyday work (Cardon et al., 2013).

Senyard et al., (2014) stated that little theory or research identifies or explains the patterns of behavior that differentiate new firms that manage to innovate from those that remain largely imitative. However, Montiel-Campos and Palma-Chorres (2016) found a relationship between passion and innovation. Authors reported a positive correlation between entrepreneurial intention and innovativeness (Gozukara & Colakoglu (2016). Cardon et al. (2009) back up this relationship by proposing that if the individual's identity is dominantly the one of an inventor, his or her passion will affect the creative problem-solving and hence the effectiveness of recognizing opportunities. A similar finding was made by Baron and Tang (2011) whose study resulted in recognizing a connection between the positive effect of the entrepreneur and the radicalness of innovations.

Hypothesis 1: There is a positive influence of entrepreneurial passion on innovativeness.

2.5 Innovativeness and Entrepreneurial Resource

The absence of substantial resource endowments restricts the ability of most new firms to innovate (Senyard et al., 2014).Compared to large corporations, SMEs are generally more resource constrained in their ability to develop and commercialize new products and services. Despite such resource constraints, some special characteristics of growing firms allow leveraging their resources to innovate and to achieve a competitive advantage against larger global competitors (Massis et al., 2017).Therefore, individuals who developed sufficient human capital that helps better identify entrepreneurial opportunities and efficiently exploit them (Shirokova et al.,2016). That means individuals who have adequate human capital tend to innovate more on entrepreneurial activities comparatively.

While a growing literature has focused on innovation in the individual owner-managed and/or family-owned and managed firm, scholars still lack an integrative, theory based perspective that helps explain their ability to innovate in the face of constrained resources (Massis et al., 2017).Very little is known about the patterns of behavior that permit some resource-constrained firms to innovate (Senyard et al., 2014). Researchers still know little about how firms efficiently manage their resources to innovate (Massis et al., 2017).

Recent studies point to the importance of effective and efficient resource deployment to achieve innovation (Sirmon et al., 2011; Massis et al., 2017). Both nascent and young firms are seldom able to invest in lengthy and expensive development processes, which suggests that they may frequently rely instead on other pathways to generate innovativeness within the firm (Senyard et al., 2014).

Generally, many of the key resources needed for entrepreneurial activities, such as financial and human capital, reside with individuals (Autio & Acs, 2010; Lim et al., 2016; Shane & Venkataraman, 2000). Therefore, many entrepreneurs tend to engage on innovativeness because of the availability of entrepreneurial resources. Conversely, people with low income or limited education tend to encounter significant obstacles to identifying and seizing entrepreneurial opportunities (Lim et al., 2016). Lim et al., (2016), and Autio & Acs, (2010) focus on financial capital (household income) and human capital (level of education) as two key individual resources. Therefore, both human and financial resource contributes for the innovativeness of small firm managers/owners.

Hypothesis 2: There is a positive influence of entrepreneurial resource on innovativeness.

2.6 The Moderating Role of Entrepreneurial Commitment

Fayolle et al. (2011) define entrepreneurial commitment as the moment when the individual starts devoting most of his or her time, energy, and financial, intellectual, relational and emotional resources to his or her project. For some SME owners, this recognition led to an idea that 'something must be done', to make change happen, and it is the responsibility of businesspeople to do it – they need to be committed to driving through change (Nurse, 2014). Commitment can influence future behaviors and imply a succession of decisions and actions toward effectively carrying out the behavior (Fayolle and Linan, 2014). Individuals have to 'get off their bottoms and do something'. While it can make sense to change business practices to account for changing conditions (a discourse of competitiveness) this SME owner takes a moral position (Nurse, 2014). Commitment is what binds the individual to his or her behavioral acts (Fayolle and Linan, 2014).

An earlier study on the factors associated with entrepreneurial success revealed that high-growth-oriented entrepreneurs labeled as “ambitious” possess a strong commitment to the success of their businesses (Gundry & Welsch, 2001). In an organizational context, passion and affective commitment are both motivational constructs with emotional underpinnings, but they are distinguished on the basis of specificity and attitudinal referent (Wong and Lee, 2011). While perceptions of entrepreneurs’ passion for inventing and developing enhance commitment, passion for founding reduces it (Breugst et al., 2012). Therefore, the relationship between the entrepreneurial passion that includes a passion for inventing and developing and innovativeness is moderated by commitment.

Hypotheses 3: Entrepreneurial commitment moderates the relationship between entrepreneurial passion and innovativeness.

The role commitment plays in entrepreneurship is widely supported (Tasnim, 2016), but they need resources to improve the role they play in entrepreneurial activity. Successful entrepreneurs have a strong competency in totally committing, determining and dedicating, as well as taking proactive actions towards their responsibilities and duties (Xiang Li., 2009). The entrepreneur’s commitment and determination are critical when looking for successful entrepreneurs (Cardon et al., 2009).Successful entrepreneurs are often characterized as diligent people with a restless attitude in their work(Xiang Li., 2009). One characteristic, namely a firm's commitment to longterm objectives, might be especially important to the effectiveness of EO (Covin et al., 2006), including innovativeness (Tasnim, 2016).

Hypotheses 4: Entrepreneurial commitment moderates the relationship between entrepreneurial resources and innovativeness.

2.7 The moderating role of environmental unpredictability

The environment plays a much more prominent role in the discovery perspective: the environment is conceptualized as a given set of conditions that are objective and definable (Edelman and Yli-Renko, 2010). In the discovery perspective, cognition impacts the probability that particular people will identify and exploit an opportunity, opportunity identification depends upon an individual’s prior knowledge and exploitation depends upon an individual having the required cognitive capabilities (Shane, 2000; Shane & Venkataraman, 2000). The inherent self-organization and unpredictability mean that there is less control (Pellissier, 2012). Therefore, environmental uncertainty restricts the entrepreneurs from taking entrepreneurial actions such as new product development, entry into a new market, etc (McMullen & Shepherd, 2006).

Given the turbulence that is introduced into the environmental selection mechanisms in dynamic environments, new firms also have a greater ability to successfully challenge industry incumbents (Edelman and Yli-Renko, 2010). The discovery perspective considers entrepreneurial opportunities as existing independent of the individuals who recognize them opportunities are, in essence, a product of the environment (Edelman and Yli-Renko, 2010). Scholars suggest that highly activated and positive emotional states such as passion foster creativity and recognition of new patterns that are critical in opportunity exploration and exploitation in uncertain and risky environments (Baron, 2008).Opportunities arise in the environment under conditions of high uncertainty and turbulence (Edelman and Yli-Renko, 2010). Strambach (2002) suggests that the interdisciplinary view of innovation systems is concerned with understanding the general context of the generation, diffusion, adaptation, and evaluation of new

Hypotheses 5: Environmental unpredictability moderates the relationship between entrepreneurial passion and innovativeness.

The environmental factors such as resource pools and information sources of competitors, potential markets, and regulators provide necessary information related to their behavioral characteristics for decision making in an organization (Ghosh et al., 2014).Miller and Shamsie (1996) distinguish between property-based and knowledge-based resources, the latter is of greater utility in uncertain i.e. changing and unpredictable environments. Patterns of resource scarcity/availability are viewed as creating selection environments that impact organizational births and deaths, irrespective of whether or not the external resource conditions actually impact firm behavior (Edelman and Yli-Renko, 2010).

Small firms frequently lack critical resources. Apart from the resource gap, they may also have what has been called an innovation capability gap (Dodgson & Bessant, 1996 cited in Hadjimanolis, 2000).The extent to which objective opportunities are exploited is influenced by nascent entrepreneurs' access to resources (Brush et al., 2001). Resource scarcity thus constitutes an objective constraint on entrepreneurial action and outcomes. Complexity encourages a segmentation of the environment (Pellissier, 2012). Duncan segmented environment based on the relevance of the social and physical factors comprising it (Ghosh et al., 2014).This allows for the impact of the environmental factors on resources and resource flows to be examined, which helps determine resource predictability and the environmental locus of control with regards to resource flows (Pellissier, 2012).For example, Knowledge-based resources allow the organization to respond and adapt to challenges and are closely connected to the ability to innovate (Hadjimanolis, 2000).).
Hypotheses 6: Environmental unpredictability moderates the relationship between entrepreneurial resources and innovativeness.

2.8 Control variables

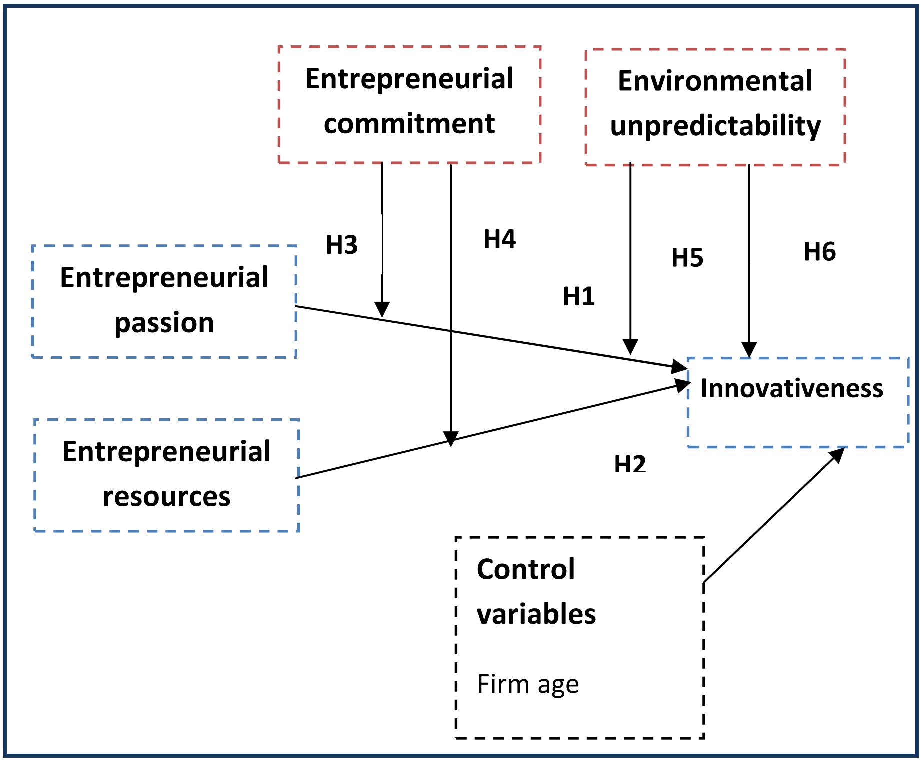
We used firms age and size as a control variable to ensure adequate validity by adding to other explanatory variables for innovativeness.

Smaller organizations are, of course, more flexible and thus more able to be innovative (Pellissier, 2012). Many small firms not only lack resources for innovation but probably also lack the relevant specialized and co-specialized assets in order to appropriate the benefits of their innovations (Hadjimanolis, 2000). Thus, the size of the organization counts because it is easier to develop relationships and creativity in a smaller group and there may be a greater willingness to release control. Larger organizations seem to become inflexible and rule-bound. Their flexibility is normally embedded in specific units, but overall, there is a notion that adaptive and resilient systems are characterized by order or disorder, or stability or flexibility (Pellissier, 2012). The size of the firm also added as a factor to test whether it has an impact on entrepreneurial engagement. Small firms are considered more entrepreneurial than large firms because of several characteristics (Kilenthong et al., 2010).

New firms simply lack the history to have developed many of the assets that older firms rely on to innovate, or the liquid resources to develop or acquire them quickly. Compared with older and resource-rich firms, most new firms face what seems a deep challenge when it comes to developing innovations (Senyard et al., 2014). Conversely, older firms may suffer from excesses of bureaucracy and from liabilities of age that can suppress innovativeness (Senyard et al., 2014).

Generally, by taking into consideration the above theoretical review and hypotheses, we developed the following conceptual model.

Figure 1: Conceptual Framework



3. Methodology

3.1 Research and Sample Design

The design of the study that was used is descriptive and explanatory in nature. The study employed descriptive research design to discover the current situation in the firm as it exists and explanatory study to discover the impact of entrepreneurial passion and entrepreneurial resource on the owners/managers innovativeness, with an aim of estimating the integrated influence of these factors. To address this, the primary data were obtained using questionnaire from selected small firm owners/managers using multi stage sampling technique. In the first stage, central part of Ethiopia is selected judgmentally since many of the small firms operated in this region. In the second stage, sample of five cities which have a large number of firms were selected. The selected owners/managers were from small enterprises that are registered, licensed formally and currently operating under Trade and Transport Bureau. A questionnaire was distributed to a total sample of 125 firms and 112 were returned. The articles published in the area were also highlighted to review theoretical issues and to look consistency in order to make the study fruitful and provide appropriate additional information.

3.2 Measures

The measure of innovativeness is mostly included as a dimension of entrepreneurial orientation. Prior research on entrepreneurship suggests that entrepreneurial orientation (includes innovativeness) is a unidimensional construct (Lyon et al, 2000). Later Lumpkin and Dess (1996) conceptualized EO as a multi-dimensional construct. Later, Hughes and Morgan (2007) improve and used three items questionnaire for innovativeness that is measured on seven point Likert scale. For this study, these three items of innovativeness is adopted to capture the measure of innovativeness

Vallerand et al., (2003) introduced the concept of The Dualistic Model of Passion (DMP) which suggested that individual may experience passion in two (2) ways: The obsessive or the harmonious passion. In their study Ismail et al., (2016) used harmonious passion to explain entrepreneurial passion which is hypothesized by Vallerand's "emerge from autonomous internalization" as compared to obsessive passion. Cardon and colleagues operationalized this construct into a passion for inventing-searching for a new business opportunity in new markets, founding-establishing a new business, and developing an already existing one (Cardon et al. 2009). Passion for founding is not included in this research because of the respondents are the owners/managers of established firms. Therefore, to measure a passion scale we adopt a nine item instrument that concerns Passion for inventing and Passion for developing from Cardon et al. (2013) and measured on seven point Likert scale.

Lim et al., (2016) and Autio & Acs (2010) focus on financial capital (household income) and human capital (level of education) as two key resources. We also employed household income and level of education to measure financial resource and human resource respectively. To measure household income we use a five point Likert scale ranging from very less (1) to substantial (5). For individuals educational level, we measure by providing five alternatives, including illiterate, primary school, secondary school, technical and vocational education, and graduated.

The commitment measure consists of four items adopted from Cardon et al., (2009) and Simon et al., (2011). The first three items are modified and presented to owners/managers of small firms from Cardon et al., 2009, while one item was modified from Simon et al., (2011) commitment to long term objectives items. To measure this item, owners/managers responded on the scale of 1 to 7 ranging from strongly disagree to strongly agree to all items. The items include (1) I am willing to do whatever it takes, (2) I have developed strong social networks based on the quality of management team and advisors, (3) I have stated he/she uses the product/service, and (4) I am absolutely committed to the achievement of our long-term objectives.

Miller and Shamsie, (1996) distinguish between property-based and knowledge-based resources, the latter is of greater utility in uncertain i.e. changing and unpredictable environments. According to Durand& Coeurderoy, (2001)Environmental unpredictability is assessed as the mean of three scale items; these include market foreseeability, strategic planning vision and the perception of skill changes. We used a 3 item scale developed by Durand & Coeurderoy, (2001) to measure environmental unpredictability.

In 2006, the Ethiopian government developed a strategy for the development of micro and small scale enterprises and many firms established after this year. Therefore, the number of firms established after 2006 were taken as younger firms, while the firms established before 2006 were categorized under older firms. In Ethiopia, the classification of firms as micro, small and large is different from the other countries. For instance, the maximum number of employees should be 30 including permanent and temporary workers. For this research, the size of the firm is determined only by the number of permanent workers. Then, we take ten workers as a baseline to state smaller and larger small firms.

3.3 Data analysis techniques

The measurement instruments are tested for validity and reliability before analysis was made for completeness and compatibility with the purpose of the study. Pre-tests of a questionnaire were conducted with twenty firms of varying sizes and belonging to different sectors for getting feedback regarding the clarity of the survey items and to evaluate new questionnaire items developed for the research. The same instrument is used for pre-test and post-test measures to ascertain the data quality and reliability. To measure the reliability Cronbach' alpha test of reliability has been used. The data gathered through questionnaires were analyzed and presented by quantitative methods of data analysis. For quantitative analysis descriptive statistics, correlation analysis and multiple linear regression analysis was applied. The results were interpreted using the values from the mean, standard deviation, and coefficients and presented quantitatively through tables and figures to give a condensed picture of the data.

4. Results and Analysis

4.1 Results of Descriptive statistics analysis

From the mean value, we identified that the firms are moderately innovative. Regarding the age and size of the firm, less than half of firm's are above 10 years in existence and less than half of firms have more than 10 workers. From this, we can understand that more firms have less experience in the market since they are recently established and these firms size is also small. Small firm's owners/managers are moderately passionate towards their job. Most of the firms faced scarcity of entrepreneurial resources that used (both financial and human capital) to run their business.

Table 1: Descriptive statistics result

Variables	Mean	Std. Deviation
Innovativeness	3.1696	1.27970
Age	.4554	.53505
Size	.4375	.49831
Passion	3.1250	1.33643
Resource	2.5268	1.01307
Commitment	3.0268	1.46712
Unpredictability	3.0714	.97458
passion_commitment	10.9911	8.90439
passion_unpredictability	8.9196	3.49037
resource_commitment	8.6339	6.21245
resource_unpredictability	7.3750	3.18817

Source: Own computation

4.2 Results of Regression Analysis

According to Cooper and Schindler (2009), multicollinearity problem should be corrected when the correlation extent to be above 0.8. In our case, there is no collinearity because there is no value that exceeds this value. The tolerance values which are not less than 0.10 also used to show the collinearity problem shows the absence of multicollinearity. As a result, collinearity is not a problem.

For this study hierarchical regression analysis was applied. In the first model, only control variables were included and the main effects are added in the second model. Later moderating variables are included and finally, the interaction variables added. Our control variables include firm age and firm size. We used entrepreneurial commitment and environmental unpredictability as moderating variables. The outcome of the analysis reveals that, our results were statistically significant because F = 5.509, p=0.005 for model 1, F = 71.350, p=0.000 for model 2, F = 71.435, p=0.000 for model 3, F = 53.845, p=0.000 for model 4. The control variables alone explain entrepreneurial engagement 9.2%, and with main effects, it explains 72.7%. In model 3 after moderators are added, it explains about 80.3% and it reaches 84.2% after interaction variables.

Table 2: Multi-level regression result

Variables	Model 1	Model 2	Model 3	Model 4
AGE	.233	.177	.056	.124
	(1.065)	(1.460)	(.531)	(1.237)
SIZE	−.726***	−.184	-.121	.007
	(-3.093)	(-1.368)	(-1.048)	(.066)
Passion	–	.568***	.252***	.572**
		(8.712)	(3.368)	(2.554)
Resource	–	.385***	.247	.578**
		(-4.549)	(3.241)	(2.280)
Commitment	–	–	.332***	.824***
			(5.031)	(5.896)
Unpredictability	–	–	-.254***	.050
			(-3.640)	(.305)
passion_commitment	–	–	–	.125***
				(3.350)
Passion_unpredictability	_	_	_	.055
				(1.221)
Resource_commitment	_	_	_	-.031
				(-.593)
Resource_unpredictability	–	–	–	-.186**
				(-2.447)
Constant	3.381***	.424*	1.559***	.272*
R2	.092	.727	.803	.842
Adjusted R2	.075	.717	.792	.826
F	5.509	71.350	71.435	53.845

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

The result of model 1 indicates firm size positively influences innovativeness in the first model only, while it's insignificant in the rest of models. The research finds a positive direct influence of passion and entrepreneurial resource on innovativeness. The moderator's entrepreneurial commitment and environmental unpredictability also moderate the relationship between entrepreneurial passion and innovativeness, as well as entrepreneurial resources and innovativeness. Regarding the interaction variable, the joint influence of entrepreneurial passion and commitment positively influences the innovativeness. The interaction of resource and unpredictability also influences innovativeness positively.

5. Discussions and Conclusions

The study highlights the current practice of innovativeness, the level of owners/manager passion, and entrepreneurial resources, as well as the influence of entrepreneurial passion and resources on innovativeness under different environment and commitment level. The finding of the study indicates that the innovativeness practice among small firm's owners/managers is moderate. The available resource is not sufficient while the entrepreneurial passion level is moderate. The model combines the dimensions of entrepreneurial passion and entrepreneurial resource in influencing innovativeness under different entrepreneurial commitment level and dynamic environment. Drawing on the previous literature, the study identified the personal drives as well as resources positively influence innovativeness. In addition, the positive influences of entrepreneurial passion and resources on innovativeness intensified by the commitment of owners/managers, while the influence of entrepreneurial passion and resources on innovativeness is weakened because of the unpredictable environment.

Since innovativeness is the engagement in new ideas, new products, new technology, new processes, and new markets that exploit business opportunities, it improves the overall performance of a given firm. But the current practice is not sufficient among small firms. That is the level of control is high, the involvement in new product and market is not sufficient. The strong desire and drive to discover new business opportunity, the existence of emotional energy and strong spirit to exploit a new opportunity, and the owners/managers intense affect contribute to the involvement in entrepreneurial activity among owners/managers is moderately practiced. In addition, the insufficiency of both human capital and financial capital hinders the innovativeness level of small firm owners/managers.

Passion is a driving force for entrepreneurial activity because small firm owners/managers who are passionate were more innovative. Passionate firms are involved more on discovering and exploitation of promising business opportunities in existed firms, which includes entering a new market, developing a new product, and introducing new technology. This is the internal driving force, emotional energy, and strong spirit that influence the owners/managers of small firms to be more innovative. When firms are enjoyable and motivated to new ideas and market need, when they are excited in scanning their environment and inventing new solutions for the problems they faced, they tend to innovate more. This is because the internal positive affective force and drive that makes them be motivated and excited in innovating new products/services, new markets, technologies, and processes by scanning their environment and searching new solutions for their problems. In general, entrepreneurial passion encourages the involvement of individuals on searching for new ideas and contributes to searching of new products/services by scanning the environment in which the firms were involved.

No firms can survive, compete against large corporations, and grow without having resources required to involve in entrepreneurial activity such as innovativeness. It's widely discussed that entrepreneurial resources are essential for managers to involve in innovativeness. That is innovativeness is dependent on the availability of both human and financial capitals since they are success factors of firms. The appropriate educational level and sufficient household income encourage individuals to involve in innovative practices. Individuals and firms who have adequate human and financial capital tend to exploit opportunities easily because they develop the required skill to identify promising business opportunities, and tends to have a financial capacity needed to exploit the discovered opportunities.

When passionate firms are devoted their time, effort, and energy, individuals become successful in innovation. That is the commitment from different factors including financial, emotional, intellectual, and behavioral acts raises a fire on the individuals to be more innovative. Therefore, commitment influences innovativeness by raising the driving internal emotions and energy towards involvement in new product/service and processes development. Directly commitment affects the individual's passion that makes them stronger in innovating new processes and products/services because their commitment leads them to change their ambition to action. Not only passion, the commitment of owners/manager also intensifies the relationship between entrepreneurial resources and innovativeness. Managers that are committed exploit their resources more effectively towards innovating new products/services and technologies. The desire and drive of innovativeness were not more successful without committed human power and sufficient capital. These are the fires that change the ambition of individuals to innovative action.

The unpredictability and uncertainty of the environment are the factor that hinders the relationship between entrepreneurial passion and innovativeness. The passion in the unpredictable environment faced a challenge in changing the desire to actions. The uncertainty in the environment increases complexity, which brings difficulty in controlling the environment. The development of new product/services and new systems are also weak when the environment is unpredictable. It's known that entrepreneurial resources encourage entrepreneurs towards innovativeness, but the unpredictable environment can bring fear and worry that hinders these entrepreneurs in engaging in the entrepreneurial activity of innovativeness. Many small firms failed at the early stage because they lack both skilled human capital and financial resource that breakthrough the unpredictable environment. In general, the environment which includes social, regulatory, and physical influences the relationship between entrepreneurial resources and innovativeness of owners/managers.

5.1 Practical implications

The owners/managers were not sufficiently positively derived towards innovativeness because of poor commitment of financial, emotional, intellectual, and behavioral acts that raises a fire on the individuals that make them more innovative. Besides, the level of innovativeness among small firms is not adequate since the firms faced a problem of internal resources that helps to break through the unpredictable environment. To reduce the level of environmental uncertainty, owners/managers should collect information's needed for decision making and they should be ready to take risks in an unpredictable environment since opportunities were better in the uncertain environment. They have also to attract both financial and human resources to break through the unpredictable environment. In support of this, the government should provide support in strengthening the existing human capital and in improving their financial capital. They have also to facilitate a good environment for small firms by providing updates on the market condition, technological upgrades, and locating funds from financial institutions. The ways of communicating market, technological, and financial updates should be included in SME's development strategies.

5.2 Limitations and future implications

This research is not exempt from some limitations. To specify the limitation that we faced, first our research concerns the subjective measure of financial capital while it has more importance when both financial and non-financial measures are combined. Therefore the future research should include the financial measures in addition to non-financial measures. Second, the study is limited to central Ethiopia, while it has a paramount importance if it covers a large geographical area that represents the continent or the world. As a result, a cross country study is recommended for future researchers for generalization. Finally, there are also other factors that influence innovativeness such as entrepreneurial intention and entrepreneurial background. Therefore, the future research may improve the relationship by adding these and other variables in the relationship between entrepreneurial passion, entrepreneurial resources, and innovativeness.

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Energy Consumption and Economic Growth in Ethiopia

Tesfaye Etensa[1] and Naol Kebede

Abstract

The study investigated the empirical relationship between economic growth and energy consumption in Ethiopia over the period 1974/75–2014/15, applying a multivariate framework that incorporates export, saving, labor, and capital as sporadic variables. In analyzing the long run and short run relationship between energy consumption and economic growth the study applied Johansen's co-integration test, VAR, VECM, and Granger causality test. Moreover, Variance decomposition and Generalised impulse response analysis were employed. Empirical findings shows there is a unidirectional causality running from economic growth to energy consumption in the long run where as in the short run, there is no causality running from economic growth to energy consumption. The study found that economic growth causes electricity consumption but not vice verse in the long run. The study investigate that there is a unidirectional running from economic growth energy import in the long run. The short run speed of adjustment coefficient of -0.7394 indicates that 73.94 % of the short run adjustment made within a year. The results of Impulse response also indicate the economic growth has a significant impact on energy consumption. The strength of causality relationship, as measured by the variance decomposition analysis, reveals that, energy has high contributing factor to output growth and certainly the most important one when compared to capital and labor. Finally, the study recommend, policy makers should consider expanding their energy-mix options, and adjust the industrial structure, development high value-added industries, promote energy conservation structures, and improve energy efficiency, enhance the level of efficiency in the energy sector for Ethiopia.

Keywords: Economic growth, Granger-Causality, Energy consumption, Impulse response, Variance decomposition analysis, Ethiopia.

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1. Introduction

Looking at developed countries, as a basic factor of production, energy is the same as the labor and capital, making an obvious influence on economic growth. Rashe and Tatom (1977), who was advanced to introduce the energy into consumption of neoclassical production function, attempted to look for the basic law of the actual process between energy use and economic growth and quantitatively explained the relationship between energy and economic development. With the impact of energy on economic development gradually expanding, the method of study from new classical economists was to exam effects of relative prices on world energy on potential GNP, income distribution, capital formation and economic welfare, and the like on the basis of a priori theory.

Looking at Ethiopia, most of the energy needs of Ethiopia are filled by bio-fuels for cooking, heating, and off-grid lighting. Petroleum, including gasoline, diesel and kerosene supply less than 7% of the country's energy supply. Ethiopia generates most of its electricity from renewable energy, mainly hydropower on the Blue Nile. In 2011, over 96% of Ethiopia's electricity was from hydropower.[1] The country began a large program to expand electricity supply in the 2010s from 2,000 MW to 10,000 MW. This was to be done mainly with renewable sources. Wind and geothermal were included to offset seasonal differences in water levels. Ethiopia plans to export electricity to neighboring countries but transmission lines will need to be upgraded and expanded (Ethiopia Resource Group, 2012). Ethiopia has small reserves of oil and natural gas, which is exploited and this is why our country is completely reliant on imports to meet its petroleum requirements. The installed electricity generating capacity in Ethiopia is about 2060 MW (88% hydro, 11% diesel and 1% thermal) and the production meets only about 10% of the national energy demand (Energy and Resources Institute, 2014).

The key indicator table by the International Energy Agency (IEA) shows that in 2014 the total energy production of Ethiopia was 34 Million Tonnes Oil Equivalent. This number is expected to grow not only in an exponential rate but with a faster rate than the GDP per Capita. The 2014 energy balance diagram shows that the energy production was 34 million tonnes of oil equivalent and the consumption was 32 million toe. The main source of energy production is from biomass which accounts for 31.6 Mtoe. The remaining energy was generated from Hydroelectric dams (0.44 million tonnes oil equivalent) and Geothermal (16 million tonnes oil equivalent). In the same year Ethiopia imported 2.32 Million tonnes of oil equivalent energy in the form of oil products (IEA, 2014).

Investments in renewable energy2 resources and hydropower in particular have been key drivers of economic growth in recent years. Ethiopia's existing generation capacity totals 2,145 MWs, up more than 200% since 2008. Projections suggest the total demand for power will grow by 30% per year. In 2012/13, hydropower comprised 90% of the electricity supplied in Ethiopia (Power Africa, 2014).

Despite strong overall growth, Ethiopia remains one of the poorest countries in Africa. To address the remaining challenges, the government has created ambitious economic development targets. The country's five-year (2010 - 2015) economic strategy, the growth and Transformation Plan (GTP), seeks to achieve the Millennium Developments Goals and middle income status by 2025.In the energy sector, the Ethiopian government's main stated objective is to use a carbon neutral growth pathway to improve the living conditions of its population.The GTP includes an aggressive energy policy framework designed to expand installed electricity capacity from approximately 2,000 MWs to 8,000 MWs, build 132,000 Kms of new distribution lines, and increase the number of customers from two million to four million by 2015. Renewable energy capacity, primarily hydro, and energy efficiency will play major roles in this growth by 2015 (World Economic Outlook, 2016).Although Ethiopia has crafted ambitious energy targets, access challenges remain. Over half of the population is located geographically close to the electricity grid, but actual interconnection rates are just 25% per capita

[2] Energy is the material basis of human progress and social development, economic growth requires energy for power. On a certain level of technological development, the greater economies of scale, the more energy demand.
Ethiopia's rapid economic growth has led to the continued growth in demand for energy. Since the total amount of energy resources is limited, following the strategy of sustainable development, energy conservation and improving the efficiency of energy use has become an inherent requirement to achieve sustained economic development.

domestic electricity consumption is less than 100KWh per year. Traditionally, biomass for household cooking also accounts for 89% of total domestic energy consumption (EEA, 2015).

A new Energy Law, Proclamation 810/2013, came into force in January 2014. The law broadly expands upon the previous policies governing the sector, including a specific focus on independent Power Purchase Agreements (PPAs), fully off grid systems, and on grid energy efficiency policies as well as standards. This new legal framework further reinforces the government's stated commitment to sustainable development practices as outlined in its Climate Resilient Green Economy Strategy and the ambitious renewable energy goals of the GTP (European Commission, 2015).

Although Ethiopia endowed by large modern energy resources, availability of modern energy resources per se is not sufficient for the social and economic problems facing the country. Ethiopia has one of the lowest rates of access to modern energy services and its energy supply is primarily based on biomass. With a share of 93% of Ethiopia's energy supply, waste and biomass are the country's primary energy sources, followed by oil (5.7%) and hydropower (1.3%) as per IEA 2011 report. Hence, the supply of modern energy is supposed to be an essential requirement for economic and social development. The power investment that is presently going on in Ethiopia is part of the process of the recognition that the quality and quantity of modern power supply can play a crucial role in the country's social and economic development. This investment process is implicitly based on the assumption that investment in modern energy sector more efficient can be the engine of the economic growth (Energy and Resources Institute, 2014).

Although energy use is a reflection of climatic, geographic and economic factors (such as the relative prices of energy), in developing economies growth in energy use is closely related to growth in the modern sectors (industry, motorized transport and urban areas). "There is a strong connection between the energy sector and a national economy. In other words, energy demand, supply and pricing have significant impact on socio-economic development and the overall quality of life of the people. On the other hand, the nature of economic structure and the change in that structure, the prevailing macroeconomic conditions are key factors of energy demand and supply" (EEA, 2015).

Based on the data Word development data for the periods 1974/75 to 2014/15 shows that RGDP per capita have strong correlation coefficient of 0.9 with energy consumption. Even though the existence of correlation between the two implies the existence of causality, on the other hand it is basis of doubt, on the part of many growth theorists. The economic growth tends to be strongly correlated with energy consumption does not a priori mean that energy consumption is the cause of the growth. Indeed, most economic models assume the opposite: that economic growth is responsible for increasing energy consumption. It is also believable that both consumption and growth are simultaneously caused by some third factor (WDI, 2015).

Even though there are several studies that have investigated the causal relationship between energy consumption and economic growth using a production function framework for developed and some developing countries, very few studies that examined the relationship between energy consumption and Economic growth in Ethiopia. The research about African countries is almost exclusively based on the bivariate causality with energy consumption used as the sole factor input.

Most economists believe that capital, labor, and technical change play a significant role in determining output. "When there is more than one input both capital and natural resources there are many alternative paths that economic growth can take, determined by both the nature of technology and institutional arrangements. When relevant variables are omitted from the model, there will be no co-integration and a spurious regression will result" (Stern, 2011).

The study conducted by Chontanawatet al., (2006) although it includes Ethiopia, the model is based on the bivariate causality model with energy consumption used as the sole factor input. It is possible that the introduction of capital and labor in the causality framework may not only alter the direction of causality but also the magnitude of the estimates (Loizides and Vamvoukas, 2005; Odhiambo, 2008 as cited by Wolde Rufael, 2008 and Mehari, 2011).

Wolde-Rufael (2008) re-examine the causal relationship between energy consumption and economic growth for seventeen African countries in a multivariate framework by including labor and capital as additional variables and the most prominent result he found from the empirical evidence is that the introduction of both gross capital formation and labor has altered the direction of causality and the study conducted by Wolde-Rufael (2008) did not include Ethiopia albeit his model is multivariate including capital and labour. Hence, the bivariate causality tests between energy consumption and economic growth is not satisfied due to the omission of important variables affecting both energy consumption and economic growth. The multivariate methodology is vital since changes in energy consumptions are often challenged by the substitution of other factors of production resulting in an insignificant overall impact on output (Stern, 2003).

In the same way, Yohannes (2010) examined co- integration and causality relationship between economic growth and energy consumption in Ethiopia, using the Autoregressive Distributive Lag model and Johansen test for co-integration. The study has shown a unidirectional causality running from energy consumption to economic growth.

Furthermore, Mehari (2011) the results give the evidence of causality running from economic growth to energy consumption. The reveals that energy was no more than a minor contributing factor to output growth and certainly not the most important one when compared to capital and labor. The answers to questions pose in the hypothesis, which are recognized in many previous studies, have important implications for policy makers.

As noted by Wolde-Rufael cited in Mehari (2011), amongst others, if causality runs from energy consumption to RGDP then it implies that an economy is energy dependent and thus, energy is a motivation to growth implying that a shortage of energy may negatively affect economic growth or may cause poor economic performance, leading to a fall in income and employment. On the other hand, energy is a limiting factor in economic growth (Stern, 2000) whereas if causality only runs from RGDP to energy consumption this implies that an economy is not energy dependent. Thus, as noted by Masih (1998) amongst others, energy conservation policies may be implemented with no adverse effect on growth and employment. If, on the other hand, there is no causality in either direction, which referred to as the 'neutrality hypotheses, it implies that energy consumption is not correlated with RGDP, so that energy conservation policies may be pursued without adversely affecting the economy. Looking at Ethiopia, almost there is no such research works, and yet there are inconclusive empirical results about causality, and thus, one of the aims of this study is to fill this gap.

Moreover, similar to other developing countries, Ethiopia is also an energy intensive growing economy, and as in most other non-oil producing countries its energy needs are met by large quantities of imports. Hence, to meet its growing demands of energy, Ethiopia faces both energy shortages from the supply side and demand side policies (ibid). Therefore, for any such policy making it is essential to determine the causal relationship between energy consumption and economic growth. Hence, the aim of this study is to determine such a relationship. This was done by examining Granger Causality between growth in energy consumption and RGDP growth. To further enrich this study was analyzed the sectoral relationship viz-a-viz, imported energy and electricity consumption growth with that of RGDP growth. Energy consumed consists of both domestic and imported sources. Thus, it would be useful to outline appropriate policies regarding each component.

Having different school of thought with regard to energy consumption, there are many researches which have tried to figure out the casual relationship between energy use growth and economic development. The relationship between energy consumption and economic development is nowadays well established in the literature, yet the direction of causation of this relationship remains controversial. That means, whether economic development leads to energy consumption or energy consumption is the engine of economic development. The direction of causality has significant policy implications. Empirically it has been tried to find the direction of causality between energy consumption and economic activities for the developing as well as for the developed countries employing the Granger techniques. But, results are still mixed. Thus, this study investigates the causal relationship between energy consumption and economic growth in Ethiopia by applying techniques of co-integration and Granger causality.

In general, the theoretical literature reviewed showed that, in the model Stern added an energy input that has low substitutability with capital and labor, while allowing the elasticity of substitution between capital and labor to remain at unity. In this model, depending on the availability of energy and the nature of technological change, energy can be either a constraint on growth or an enabler of growth. More, mainstream economists usually think of capital, labour, and land as the primary factors of production, and goods (such as fuels and materials) as intermediate inputs and consider the energy as complementary inputs of classical factor of land, including all natural resource inputs. To the best knowledge of the researcher, this study used the energy as separate input in production function rather as complementary inputs and also this study was investigated the contribution of energy to economic growth to contribute in paucity in the areas of theoretical literature.

Furthermore, the above empirical reviewed studies revealed that there is no common consensus the causality between energy consumption and economic growth in the developed and developing countries in general and in Ethiopia in particular. To best of the researcher, none of them have tried to study the sectoral relationship between energy and economic growth. Hence, still there are inconclusive empirical results which make it difficult to draw a conclusion about Ethiopia (Mehari and Yohannes) and the important role energy plays in economic development in country. More, as per the researcher reviewed there is only two researches (Mehari and Yohannes) had done on the relationship between Energy use and economic growth in Ethiopia, and no one done on Energy consumption and economic growth with sectoral relationship. As a result this study also attempts contribute to the constraint of literature paucity.

This study mainly aimed to investigate empirically the existence and direction of causal relationship between energy consumption and economic development in Ethiopia, and to analyze the Sectoral relationship vise, imported energy and electricity consumption growth with that of RGDP growth. Specifically, test the direction of causality between the energy consumption and economic growth; investigate empirically the long-run and short run effect of energy consumption on economic growth in Ethiopia; to determine the causal relationship between the components of energy consumption and economic growth; to test whether the growth in components of energy consumption affects the long term economic growth of the country; to identify the causal relationship between the growth in labor, capital, export, gross domestic saving and economic growth; to evaluate how the causal impact of energy consumption on economic growth relative to intermittent variables.

2. General Overview of Energy Consumption in Ethiopia

The energy sector of Ethiopia is one of the least developed in the world despite the presence of an enormous energy resource endowment. This is reflected by the low per capita energy consumption of households. Furthermore, heavy reliance on traditional energy of rural households of Ethiopian has been focused by a number of studies. For example, Jargstorf stated that Ethiopia is the third largest user in the world of traditional fuels for household energy use, with 96% of the population dependent on traditional biomass (e.g., fuel wood and dung) to meet their energy needs. This is in comparison to 90% for Sub-Saharan Africa and approximately 60% for the African continent. The excessive deforestation, which led to the depletion of tree stock, caused what is known as the household energy crisis in Ethiopia. For the great majority of the population wood and other biomass fuels are the only source of energy which has negative environmental, ecological, and economic as well as health impacts on the life of the rural poor (David, 2008).

Energy as a Factor of Production and Unified Models of Energy and Growth
Primary factors of production are defined as inputs that exist at the beginning of the period under consideration and are not directly used up in production (though they can be degraded or accumulated from period to period), while intermediate inputs are those created during the production period under consideration and are used up entirely in production. Mainstream economists usually think of capital, labour, and land as the primary factors of production, and goods (such as fuels and materials) as intermediate inputs. The prices paid for the various intermediate inputs are seen as eventually being payments to the owners of the primary inputs for the services provided directly or embodied in the produced intermediate inputs. This approach has led to a focus in mainstream growth theory on the primary inputs, and in particular, capital and labour. The classical factor of land, including all natural resource inputs, slowly diminished (Stern, 2011).

The mainstream growth models ignore energy in the economic growth, by contrast, the ecological economics literature posits a central role for energy in driving growth but argues that limits to substitutability and/or technological change might limit or reverse growth in the future. However, none of the models and theories reviewed so far really provides a satisfactory explanation of the long-run history of the economy. Until the industrial revolution, output per capita was generally low and economic growth was not sustained. Ecological economists point to the invention of methods to use fossil fuels as the cause of the industrial revolution. However, the mainstream growth models that ignore energy resources can at least partly explain economic growth over the last half a century (Mehari, 2011).

There are currently two principal mainstream theories that explain the growth regimes of both the preindustrial and modern economies and the cause of the industrial revolution, which formed the transition between them. These are endogenous technical change approach, and the second approach is represented by two sectors- Malthusian Sector and Solow Sector. The approximations inherent in the use of a single-sector equilibrium model based on the Cobb–Douglas production function result in a potentially misleading mathematical implication: namely that the output elasticities of the factors should correspond to payments in the National Accounts. However, the national accounts reflect payments only to capital (as interest, dividends, rents and royalties) and to labor (as wages and salaries). The accounts do not reflect payments to 'nature'. This fact, in combination with other standard economic assumptions and mathematical characteristics of the Cobb- Douglas function implies that resource (energy) flows do not contribute much to aggregate productivity and thence cannot be a significant contributor to growth (Ayres, 2001).

To integrate the different approaches, Stern (2011) proposed to modify Solow's growth model. In the model Stern added an energy input that has low substitutability with capital and labor, while allowing the elasticity of substitution between capital and labor to remain at unity. In this model, depending on the availability of energy and the nature of technological change, energy can be either a constraint on growth or an enabler of growth. Omitting time indexes for simplicity, the model consists of two equations:

$$Y = [(1-\phi)(A_L{}^{\alpha} L^{\alpha} K^{1-\alpha} + \phi(A_E E)^{\psi}]^{\frac{1}{\psi}} \quad \textbf{(1)}$$

$$\Delta K = s(Y - P_E E) - \delta K \quad \textbf{.(2)}$$

Equation (1) embeds a Cobb–Douglas production function of capital (K) and labor (L) in a constant elasticity of substitution (CES) function of value added and energy (E) that produces gross output Y.

where, $\phi = \frac{\delta - 1}{\delta}$; Where δ is the elasticity of substitution between energy and the value added aggregate; PE the price of energy; and ϕ is a parameter reflecting the relative importance of energy and value added.AL and AE are the augmentation indexes of labor and energy, which can be interpreted as reflecting both changes in technology that augment the effective supply of the factor in question and changes in the quality of the respective factors.

Equation (2) is the equation of motion for capital that assumes like Solow that the proportion of gross output that is saved is fixed at s and that capital depreciates at a constant rate δ .

As $\delta \rightarrow 1$ and $\phi \rightarrow 0$ we have the Solow model as a special case, where in the steady state, K and Y grows at the rate of labor augmentation. Additionally, depending on the scarcity of energy, the model displays either Solow-style or energy constrained behavior.

3. Research Methodology

3.1 Sources of Data

This study investigates the empirical relationship between energy consumption and economic growth in Ethiopia. This relationship between economic growth and energy consumption was dealt based on the data of the real GDP capita measured in constant ETB and labor force, capital, domestic saving and export. Energy consumption is measured in Kilo tone of oil equivalent per capita. The data was used the annual time series data covering the period from

1974/75 to 2014/15 for Ethiopia regarding 2010/11 as a base year. The data was sourced from the National Bank of Ethiopia, Ministry of Finance and Economic Development-MoFEC (2015/16), Ethiopian Revenue and Customs Authority, Ethiopian economic association (EEA), Ethiopia Electric Power cooperation (EEPCo.).

3.2 Definitions of the Variables

The variables that this study used are described as the following:
Real GDP (RGDP3): Real Gross Product is a macroeconomic measure of the value of economic output adjusted for price changes (i.e., inflation or deflation). This adjustment transforms the money-value measure, nominal GDP, into an index for quantity of total output. GDP is the sum of consumer spending, Investment made by industry, Excess of Exports over Imports and Government Spending. Due to inflation GDP increases and does not actually reflect the true growth in economy. That is why inflation rate must be subtracted from the GDP to get the real growth percentage called the real GDP. Most of the studies conducted on the relationship of economic growth with any variables used the Gross Domestic Product (GDP) as the measurement of economic growth. Hence, this study was used the growth form of real GDP as a proxy to represent economic growth.

Total Energy consumption (ENU): is total energy consumption in the country. Energy use (consumption) kilo tone of oil equivalent in real terms. That is change in real GDP and change in real energy consumption was used to estimate the model.

Energy imports (EIMP): is a net energy import, percentage of energy use. Since energy consumed consists of both domestic and imported sources, it would be useful to drawn appropriate policies regarding each component. In most non-oil producing countries its energy needs are met by large quantities of imports, and this is why this imported source of energy was taken as important variable.

[3] This study use RGDP and Y; TLF and L; K and GCF; E and ENU; GDS and S; X and EXP interchangeable.

Electric power consumption (EPC): it is measured in KWh per capita, and it represents the domestic sources of energy. In Ethiopia there is high demand for electricity consumption. Thus, to meet its growing needs, it is essential to determine the causal relationship between electricity consumption and economic growth.

Gross capital formation (GGG): it is the gross fixed capital formation and in line with many researchers, in the absence of capital stock for all African countries, gross capital formation has been used as proxy for the stock of physical capital. However, getting such a readymade time series data in Ethiopia is difficult. The capital stock series is constructed from real gross capital formation using the perpetual inventory assumption with depreciation rate set equal to 5 percent (Wang and Yao, 2003). As a result, in this study, gross investment was used as proxy of physical capital accumulation and have been expected a positive impact on economic growth.

Gross Domestic Saving (GDS): The Neo-Classical growth model which states that St = It (where S is savings), is modified when we come to the case of Ethiopia. This is because of the existence of an enormous gap between domestic savings and investment in Ethiopia. Hence, investment comprises of both saved fund (S) and borrowed fund (BF) that comes from credit given to the private sector (PRIV) and external resource such as foreign borrowing or as an alternative foreign aid (FA). Thus, this study used gross domestic saving, which is saved fund as one of the explanatory to avoid misspecification bias and since saving is one of the macro variables that enhance economic growth, and have been expected a positive impact on economic growth in general. However, it depends on the potential of saving that given countries have.

Labor (TLF): it is the labor inputs, and labor force 15+ years and below 60 years. It is one of the key inputs in production of output yet. Thus, we expect the positive relationship between economic growth and labor force.

Exports of goods and service (EXP): it is the total exports of goods and service to the rest of the world. It is supposed that export of a country's is one of the macroeconomic determinants of economic growth. The expected sign of this variable is expected to be positive.

3.3 Econometric Model Specification

To investigate the empirical relationship between energy use and output growth we use the modern economic growth theory based on the conventional neo-classical one sector aggregate production technology where we treat capital, labor, and energy as separate inputs. That is

$$RGDP_t = F(GGG_t, TLF_t, ENU_t, EXP_t, GDS_t) \quad \textbf{(3)}$$

Where RGDPt is a real aggregate output, GGG is gross capital formation, TLF is the total labor force, ENU is total energy consumption (or energy use), EXP is export, GDS is gross domestic saving and the subscript t denotes the time period.

All variables are transformed into their natural logarithm so that their first differences approximate their growth rates. On the other hand, to eliminate the impact of heteroscedasticity for economic variable time series data, all variables are in natural logarithm. The empirical model was designed to model the three variables after logarithmic transformation for the linear model, is easy to verify, so the transformed model:

$$\ln RGDP_t = F(\ln GGG_t, \ln TLF_t, \ln ENU_t, \ln EXP_t, \ln GDS_t) \quad \textbf{(4)}$$

The growth rate of a variable refers to its proportional rate of change. That is, the growth of rate of X refers to the quantity $\frac{\dot{X}_t}{X_t}$. A key fact about growth rates is that the growth rate of a variable equals the rate of change of its natural log. That is, $\frac{\dot{X}_t}{X_t}$ equals $\frac{d \ln X(t)}{dt}$

By using Euler's theorem implies that a function that is homogenous degree of one can be decomposed as:

$$F(GGG_t, TLF_t, ENU_t, EXP_t, GDS_t) = F_{GGG} GGG_t + F_{TLF} TLF_t + F_{ENU} ENU_t + F_{EXP} EXP_t + F_{GDS} GDS_t \quad \textbf{(5)}$$

Taking the total derivative of equation 1, we get:

$$\frac{dRGDP_t}{dt} = F_{GGG}\frac{dGGG_t}{dt} + F_{TLF}\frac{dTLF_t}{dt} + F_{ENU}\frac{dENU_t}{dt} + F_{EXP}\frac{dEXP_t}{dt} + F_{GDS}\frac{dGDS_t}{dt}$$

$$\dot{RGDP}_t = F_{GGG}\,\dot{GGG}_t + F_{TLF}\,\dot{TLF}_t + F_{ENU}\,\dot{ENU}_t + F_{EXP}\,\dot{EXP}_t + F_{GDS}\,\dot{GDS}_t$$

$$= F_{GGG}GGG_t\frac{\dot{GGG}_t}{GGG_t} + F_{TLF}TLF_t\frac{\dot{TLF}_t}{TLF_t} + F_{ENU}ENU_t\frac{\dot{ENU}_t}{ENU_t} + F_{EXP}EXP_t\frac{\dot{EXP}_t}{EXP_t} + F_{GDS}GDS_t\frac{\dot{GDS}_t}{GDS_t} \tag{6}$$

divide through Equation (4) by RGDPt to get growth equation and rearranging the resulting expression, we get the following growth equation.

$$\frac{\dot{RGDP}_t}{RGDP_t} = F_{GGG}\frac{GGG_t}{RGDP_t}\frac{\dot{GGG}_t}{GGG_t} + F_{TLF}\frac{TLF_t}{RGDP_t}\frac{\dot{TLF}_t}{TLF_t} + F_{ENU}\frac{ENU_t}{RGDP_t}\frac{\dot{ENU}_t}{ENU_t} + F_{EXP}\frac{EXP_t}{RGDP_t}\frac{\dot{EXP}_t}{EXP_t} + F_{GDS}\frac{GDS_t}{RGDP_t}\frac{GDS_t}{GDS_t} ------- \tag{7}$$

$$\dot{y}_t = \mu\dot{k}_t + \phi\,\dot{l}_t + \gamma\,\dot{e}_t \tag{8}$$

$$\dot{y}_t = \mu\,\dot{k}_t + \phi\,\dot{l}_t + \gamma\dot{e}_t + \pi\dot{x}_t + \varsigma\,\dot{s}_t$$

Where a dot on the top of a variable means that the variable is now in a growth rate form. The constant parameters μ, ϕ, γ, π and ς are the elasticities of output with respect to capital, labor, energy, export and saving respectively.

The relationship between output and capital, labor, domestic saving, export and energy inputs described by the production function in equation (4) suggests that their long-run movements may be related. Additionally, if we allow for short-run dynamics in factor-input behavior, the analysis above would also imply that past changes in capital, labor, domestic saving, export and energy will be contain useful information for predicting the future changes of output, keeping other being constant. These implications can be easily investigated using tests for multivariate co-integration and Granger-causality.

4. Result and Discussion

4.1 Unit Root Test

Apparently, it is necessary to test the nature of stationarity of the variables before running regression analysis. This test was done using the Augmented Dickey-Fuller (ADF) unit root tests. The results of ADF test for unit root of variables used in the study is presented in the following table 1.

Table 1: Results of Augmented Dickey Fuller Test

Variables	ADF t-statistic at level, I(0)		ADF t-statistic at first difference, I(1)		Decision (Order of integration)
	Intercept only	Intercept and trend	Intercept only	Intercept & trend	Decision
LNRGDP	4.341003***(S)	0.9059790(NS)	-1.93515(NS)	-6.650391*** (S)	Stationary (I(1))
LNENU	2.099343(NS)	-0.327623(NS)	-5.495215(S)	-6.135400***(S)	Stationary (I(1))
LNGDS	0.147702(NS)	-3.108926(NS)	-8.583135(S)	-8.881271***(S)	Stationary (I(1))
LNEXP	0.835672(NS)	-1.606373(NS)	-5.344502(S)	-5.660028***(S)	Stationary (I(1))
LNGGG	1.933125(NS)	-0.963244(NS)	-6.972381(S)	-7.751710***(S)	Stationary (I(1))
LNTLF	1.957285(NS)	-0.922402(NS)	-5.939767(S)	-6.463128***(S)	Stationary (I(1))
LNEPC	2.743293 (NS)	-0.013692(NS)	-5.242882 (S)	-6.163507***(S)	Stationary (I(1))
LNEIMP	-0.513052(NS)	-3.13007 (NS)	-6.486246 (S)	-6.479374*** (S)	Stationary (I(1))

MacKinnon (1996) with constant, no trend			with constant and trend		
	1% level	-3.621		1% level	-4.227
Test critical values:	5% level	-2.943	Test critical values:	5% level	-3.537
	10% level	-2.610		10% level	-3.200

Where NS & S represent not stationary and Stationary respectively

Source: Own computation (2017)

Table 1 shows unit root results of the series at level and first differences. The absolute values of the calculated test statistics for all variables are less than its critical value at 5 per cent level of significance. The result indicates that all variables are non-stationary at level, and all the variables are stationary at first difference. Thus, with the establishment of the order of integration, the study proceeded to testing for long-run relationship by employing Johansen approach to test co-integration. However, before applying this test, we need to determine first the appropriate lag length, and check the stability since Johansen's co-integration test and thus VER is very sensitive to lag length determination.

4.2 Optimum lag length

The optimal lag order is determined with sequential modified Likelihood Ratio test statistics (LR), the Final Prediction Error (FPE), the Akaiki Information Criterion (AIC), the Schwarz Information Criterion (SC) and the Hannan-Quinn Information Criterion (HQ). While, checking up to three lag orders to include the 5% significance level suggest that lag 1 would be the optimum lag length for multivariate model and this has been confirmed by LR, FPE, SC and HQ in both cases. The lag exclusion test confirms the first lag to be the appropriate lag. For the trivariate model up to five lag order was checked to include the 5% significance level suggest that lag 3 would be the optimum lag length. Thus, this study was employed the optimal lag length of one and three multivariate and trivariate model respectively for estimation techniques.

Table 2: VAR Lag Order Selection Criteria

Table 2.1: VAR Lag Order Selection Criteria for Multivariate model[4]

VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNENU LNGDS LNEXP
LNGGG LNTLF
Sample: 1- 41
Included observations: 38

Lag	LogL	LR	FPE	AIC	SC	HQ
0	169.8389	NA	7.25e-12	-8.623101	-8.364535	-8.531106
1	416.5587	402.5428*	1.13e-16*	-19.71362	-17.90365*	-19.06964*
2	448.4007	41.89734	1.64e-16	-19.49477	-16.13341	-18.29883
3	499.2522	50.85151	1.14e-16	-20.27643*	-15.36367	-18.52851

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

[4] In this study multivariate was used for more than three variables

Table 2.2: VAR Lag Order Selection Criteria for Trivariate Model

VAR Lag Order Selection Criteria
Endogenous variables: LNRGDP LNEPC LNEIMP
Exogenous variables: C
Sample: 1 41
Included observations: 36

Lag	LogL	LR	FPE	AIC	SC	HQ
0	43.71163	NA	2.09e-05	-2.261757	-2.129797	-2.215700
1	156.4984	200.5098	6.57e-08	-8.027688	-7.499848*	-7.843458*
2	164.6729	13.17008	6.96e-08	-7.981829	-7.058109	-7.659426
3	177.7464	18.88389*	5.72e-08*	-8.208132*	-6.888533	-7.747556
4	181.8229	5.208888	7.96e-08	-7.934605	-6.219126	-7.335857
5	185.4825	4.066273	1.18e-07	-7.637919	-5.526560	-6.900998

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

4.3 Johansen Co-Integration Test for Long Run Relationship

The next step is to estimate Johansen test of co-integration, VECM, Granger causality and Impulse response and variance decomposition models. Both λ trace and maximum Eigen value (λmax) conclude that there is one co integrating vector among the variables and there is only one Eigen value significant at 1% level and this outcome determines that the rank of the co integration is unity. It can be conclude that among the variables there is one long run relationship. The result of testing the number of co-integrating vectors is shown in table 3.1 and table 3.2.

Table 3: Johansen co integration result for Multivariate model

Sample (adjusted): 3 41
Included observations: 39 after adjustments
Series: LNRGDP LNENU LNGDS LNEXP LNGGG LNTLF
Lags interval (in first differences): 1 to 1

Table 3.1: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.728670	123.9305	107.3466	0.0026
At most 1	0.540955	73.05805	79.34145	0.1354
At most 2	0.428980	42.69241	55.24578	0.3881
At most 3	0.250225	20.83952	35.01090	0.6525
At most 4	0.218275	9.608243	18.39771	0.5188
At most 5	0.000113	0.004402	3.841466	0.9462

Trace test indicates 1 cointegrating Eqn (s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Table 3.2: Unrestricted Cointegration Rank Test (Maximum Eigen value)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.728670	50.87243	43.41977	0.0066
At most 1	0.540955	30.36563	37.16359	0.2450
At most 2	0.428980	21.85289	30.81507	0.4084
At most 3	0.250225	11.23128	24.25202	0.8247
At most 4	0.218275	9.603840	17.14769	0.4348
At most 5	0.000113	0.004402	3.841466	0.9462

Max-eigen value test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis1999) p-values

Source: Own computation (2017)

Both the maximum Eigen Value and trace statistic confirm that the variable is cointegrated of at most one. Table 3.1 and 3.2 reports that the null of no co-integration vector is rejected by both trace statistics and maximum eigen value at 1% significance level. On the other hand, one co-integration vector is not rejected by tests, we can concluded that there exists only one co-integration vector, and thus there exists meaningful long run relationship between the economic growth and energy consumption, gross capital formation, labor force, export, and domestic saving.

In addition to this, the existence of one co integrating vector indicates that the first row of β coefficient and the first column of α vectors are important for further analysis. Thus, table 3.3 below reports β vector.

Table 3.3: Estimates of β coefficients normalized to LNRGDP

Vector Error Correction Estimates
Sample (adjusted): 3-41
Included observations: 39 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	Coint Eq1
LNRGDP(-1)	1.000000
LNENU(-1)	-8.390586
	(1.31134)
	[-6.39847]
LNGDS(-1)	0.006089
	(0.01745)
	[0.34901]
LNEXP(-1)	-0.120451
	(0.01109)
	[-10.8585]
LNGGGG(-1)	-0.035206
	(0.02500)
	[-1.40823]
LNTLF(-1)	-4.418151
	(0.39839)
	[-11.0899]
@TREND(1)	0.105446
C	113.9666

Note: Since the table is not in equation form, the real sign of the coefficients are changed
Source: Own computation (2017)

Table 4: Johansen co integration result for Trivariate model

Sample (adjusted): 5 41
Included observations: 37 after adjustments
Trend assumption: Linear deterministic trend
Series: LNRGDP LNEPC LNEIMP
Lags interval (in first differences): 1 to 3
Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.425178	34.35614	29.79707	0.0139
At most 1	0.311418	13.86940	15.49471	0.0866
At most 2	0.001727	0.063942	3.841466	0.8004

Trace test indicates 1 cointegrating Eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level

**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.425178	20.48674	21.13162	0.0613
At most 1	0.311418	13.80546	14.26460	0.0590
At most 2	0.001727	0.063942	3.841466	0.8004

Max-eigen value test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

1 Cointegrating Equation(s): Log likelihood 183.8585

Normalized cointegrating coefficients (standard error in parentheses)

LNRGDP	LNEPC	LNEIMP
1.000000	-1.515270	1.270095
	(0.32128)	(0.51191)

Adjustment coefficients (standard error in parentheses)

D(LNRGDP)	0.030425
	(0.06035)
D(LNEPC)	0.238485
	(0.06390)
D(LNEIMP)	-0.070273
	(0.11786)

Source: Own computation (2017)

It can be shown from the table 4 that the unrestricted cointegration rank test (Trace) shows two cointegrating vectors at the 5% critical value in the system while table, the unrestricted cointegration rank test (Maximum Eigen value) shows no co-integrating vectors in the system. Sporadically, the trace and the maximum eigen value test statistics yield conflicting results. In such a case the trace statistics is more robust than the maximum eigen value statistics in testing for co-integration (Luintel & Khan, 1999, and Roman, 2012). Hence, based on trace statistics result we can conclude that there exists meaningful long run relationship between the variables under investigation. As it is presented in Table 4, the long run Cointegrating vector indicates that all variables have registered the expected sign and statistically significant. A 1% change in LNEPC will result in 1.51% increase in LNRGDP, on average. A 1% change in LNEIMP will result in 1.27% decrease in LNRGDP, on average. The speed of adjustment of LNRGDP and LNEPC adjusted toward their long run equilibrium by 3.04% and 23.84% respectively. Nonetheless, the adjustment coefficients of the LNEIMP is positive which indicate the extent to which this variable may deviate from its long run steady state path after a certain shock.

4.4 Long-run and Short-run Models

4.4.1 The Long run Impact of Variables on Economic Growth

The long run relationship is derived by normalizing growth in real GDP from Table 3.3.

The normalized co-integration equation can be written as:

$$LNRGDP = 8.392586\,LNENU - 0.006089\,LNGDS + 0.120451\,LNEXP + 0.035206\,LNGGG + 4.418151\,LNTLF + 0.105446\,@TREND + 113.9666$$

The numbers in parenthesis under the estimated coefficients are the asymptotic standard errors. For the coefficients that are normalized to 1, standard errors will not be shown. Where, T is time trend. The trend exerts a positive effect on growth in RGDP. This implies that holding all other factors constant in the long run, as time passes by one year, the growth in real GDP of Ethiopia increase by about 10.54% each year. This can due to the fact that the country is on process of achieving high growth.

As it is presented in Table 3.3, and from the above equation it can be observed that LNENU, LNEXP and LNTLF have positive and statistically significant relationship with real GDP in the long run. However, domestic saving has a negative and insignificant effect on real GDP in the long run. And LNGGG has positive and statistically insignificant relationship with real GDP in the long run. A 1% change in LNENU, LNEXP, LNGGG and LNTLF, will result in 8.39%, 0.12%, 0.035%, and 4.41% increase in LNRGDP respectively, on average; LNGDS has a negative sign and statistically not significant. This is due to the fact that, in Ethiopia there is a lack of continuous saving behavior over time, and the existence of low saving rate. According to Abu, (2004), the insignificant level of domestic saving in the economy has necessitated increasing reliance on foreign aid to finance investment requirements of the country. Furthermore, when peoples are believe they need to save more they will have to forgo some present consumption, and this may lower GDP temporarily though savings, wisely invested, boost future consumption (FFE, 2010). Saving, correctly understood or defined, is the acquisition of interest- or dividend-earning financial assets, such as bank deposits, certificates of deposit, mutual fund shares, bonds, and stocks. Thus, saving is not cash hoarding but the transfer of funds from income earners to borrowers who spend the funds. Savings are the source of loanable capital sought by businesses, as Adam Smith in the Wealth of Nations well explains: “By what a frugal man saves, he not only affords maintenance to an additional number of productive hands, but like the founder of a public workhouse, he establishes as it were a perpetual fund for the maintenance of an equal number in times to come.” However, in our country there is no such well developed saving definition and it may negatively contribute to economic growth. Also, “Capitals are increased by parsimony; whatever a person saves from his revenue he adds to his capital, and either employs it himself in maintaining an additional number of productive hands or enables some other person to do so, by lending it to him for an interest, that is, for a share of the profits.” Indeed, increased savings make increased borrowing at lower interest rates possible. However, in our country there is high interest rate and high collateral that financial request to for borrowing that discourage investors.

Despite the insignificant effect of saving in economic growth of Ethiopia (both in the short run and long run), energy use has a strong positive impact on economic growth in the long-run in Ethiopia. According to Bencivenga and Smith (1991), economic growth can occur even if savings is reduced because labor force, export and energy use has a significant impact on economic growth.

Among the coefficients of variables only two got statistical significance, however measuring the statistical significance of two independent variables jointly would be very important in order to clearly say whether two independent variables at a given lag length are jointly significant or not.

Furthermore, this study was applied Wald tests on the various null hypothesis involving sets of regression coefficients. The results are shown in table 5. The P-value indicates that we reject the null hypothesis that regression coefficients of all the variables in the LNRGDP equation are equal to zero. The null hypothesis that regression coefficients in each equation are equal to zero is also rejected as shown by the p-values. Thus, it indicates that all variables are jointly affects RGDP.

Table 5: Wald Coefficient Test

Test Statistic	Value	Df	Probability
F-statistic	20.96068	(5, 33)	0.0000
Chi-square	104.8034	5	0.0000

Null Hypothesis: C(1)=C(2)=C(3)=C(4)=C(5)=C(6)
Source: Own computation (2017)

4.4.2 Granger Causality Test/Long Run Causality

The dynamic relationship is the simplest technique use to examine the cause and effect relationship between variables in bivariate system and it is applied in the context of the simple linear regression model. However, the simple linear regression model fails to capture the underlying dynamic causality between variables which is efficiently analyzed by Granger (1969) in terms of the Granger causality tests.

To further investigate the dynamic relationship between the variable, we employed Granger causality test using the VAR model. The institution behind of this test is that to find out whether changes in one variable cause the other to change. In order to infer the direction of causation between two variables, the granger causality test analysis must make sense. The following table shows Granger causality test for energy consumption and economic growth in Ethiopia.

Table 6: Pairwise Granger Causality Tests for Multivariate Model
Pairwise Granger Causality Tests

Sample: 1 41
Lags: 1

Null Hypothesis:	Obs	F-Statistic	Prob.
LNENU does not Granger Cause LNRGDP	40	0.09772	0.7563
LNRGDP does not Granger Cause LNENU		16.4018	0.0003

Source: Own computation, (2017)

As can be seen from the table above, we reject the null hypothesis that LNRGDP does not Granger Cause LNENU, but we fail to reject the null hypothesis that LNENU does not Granger Cause LNRGDP. Therefore, it is shown that granger causality runs one way from LNGDP to LNENU and not vice verse. Thus, in the long run the granger causality is unidirectional from Economic growth to Energy consumption, implies that it not viable to depend on energy consumption alone to promote economic growth and the government can implement stronger energy conservative policy without compromising economic growth in the long run. It suggests that policy on energy consumption have no effect on the economic growth. It may be due to little share of energy in the production function, and economic growth is vital for the energy consumption in Ethiopia in the period of 1974/75 to 2014/15. This is the indicator of developing country. The scenario may different for developed economy, the more the country is developed, the more energy use is essential to fasting economic growth Chontanawat et al. (2008). The conservation hypothesis implies that energy conservation policies designed to reduce energy consumption and waste may not reduce real output. Unidirectional Granger-causality from real output to energy consumption would lend support for the conservation hypothesis. This result is in line with the findings of Thoma (2004) and Sari et al. (2008), Mehari (2011), and Sheilla et al. (2017) support this conservation hypothesis.

Table 7: Pairwise Granger Causality Tests for Trivariate model

Pairwise Granger Causality Tests
Sample: 1 41
Lags: 3

Null Hypothesis:	Obs.	F-Statistic	Prob.
LNEPC does not Granger CauseLNRGDP	38	2.42269	0.0846
LNRGDP does not Granger Cause LNEPC		4.64058	0.0086
LNEIMP does not Granger Cause LNRGDP	38	0.32899	0.8044
LNRGDP does not Granger Cause LNEIMP		9.95298	9.E-05

Source: Own computation (2017)

As can be seen from the Table 7 above, we reject the null hypothesis that LNRGDP does not Granger Cause LNEPC, but we fail to reject the null hypothesis that LNEPC does not Granger Cause LNRGDP. Therefore, it is shown that granger causality runs one way from LNGDP to LNEPC and not vice verse. This is due to the per capita consumption of electricity in Ethiopia remains relatively low at about 200 kWh per year, due to the heavy reliance on traditional biomass energy sources, such as wood fuels, crop residues, and animal dung (Guta et al., 2015,).Thus, in the long run the granger causality running from economic growth to Electricity consumption and not conversely, implies that it not viable to depend on electricity consumption and energy import alone to promote economic growth and the government can implement stronger energy conservative policy without compromising economic growth in the long run.

On the other hand, the import equation we see that economic growth leads to energy import and not vice versa. Some logical inferences could be drawn from the above results. It seems that increased economic activity causes growth in energy consumption and since petroleum products are largely imported, is also affected by growth in GDP. Furthermore, as economic growth is boosting energy consumption. That is this study support conservation hypothesis' which suggests that policy on electricity energy consumption have no effect on the economic growth. It may be due to little share of electricity consumption in the production function, and economic growth is vital for the electricity consumption in Ethiopia in the period of 1974/75 to 2014/15. This indicator of Ethiopia is still developing country. The scenario may different for developed economy, the more the country is developed, the more energy use is essential to fasting economic growth Chontanawat et al. (2008). Unidirectional Granger-causality from real output to electricity consumption and energy import would lend support for the conservation hypothesis. The result of causal running from economic growth to energy import is supported by Aqeel (2001) while the causality running from Economic growth to electricity consumption is contradicted with the findings of Aqeel (2001).

4.4.3 Short Run Vector Error Correction Model

The error correction terms lagged one period is shown in table (8).The result from the following Table (8) shows that, in the short run only the one year lagged value of Energy consumption and labor force is significant in affecting current growth in real GDP whereas LNEXP, LNGGG and LNGDS are not statistical significance.

Like in the long run, total exports of goods and service is not significant in the short run though with positive coefficient, which shows the positive relationship between export and Ethiopian economic growth during the period of investigation. This insignificant result might be related with agricultural primary product; more than 68 percent of export level in the country comes from agricultural primary product, which suffered from international price shock. Furthermore, the insignificant result might be due to huge gap resource balance (17.8% as ratio to real GDP), which indicates that exports of goods and services have insignificant impact on Ethiopian economic growth. This result also confirmed by MoFED particularly during 2011/12 and 2012/13 despite it was expected to play an important role in accelerating the economic growth during the GTP period. Furthermore, this finding is consistent with the study conducted in Ethiopia by Gezehegn (2012), they found that, total exports of goods and service was insignificant on Ethiopian economic growth even though there is positive impact, while there is an inverse relationship between economic growth and export volatility.

The capital is insignificant in both short run and long run, result may be due to the fact that benefits from capital accumulations (both private and public) are not ensured in the short period of time and may have crowding out effect on growth, and it may also due to small capital accumulation in the country. The additional justification may be due to the macro economic instability like inflation and thus no one is willing to invest and thus accumulate the capital as in lined with Belay (2015).Domestic saving has statistically insignificant effect on real GDP in both the long and short-run models. This might be due to lack of continuous saving behavior in Ethiopia over time. According to Abu, (2004), the insignificant level of domestic saving in the economy has necessitated increasing dependence on foreign to finance investment project of the country.

In spite of the insignificant effect of saving in economic growth of Ethiopia both in the short run and long run, labor has a strong positive impact on economic growth in the long-run in Ethiopia as in lined with Bencivenga and

Smith (1991), and Roman (2012).Thus, the impact on real GDP can be explained on average in the short run as, a 1% growth in LNENU of the lagged one year decreases the current economic growth by 4.96%, on average; this due to the fact that a low level of energy efficiency in Ethiopia. 1% growth in LNTLF of the lagged one year decreases the current economic growth by 3.63%, on average. This is due to labor tends to be abundant and relatively cheaper and thus the existence of hidden unemployment in the sector. Hence, additional labor may reduce the industrial value added. In the long run determinants of value added are found insignificant in all. As seen from the long run time trend the positive sign show that as time passes, the economy of Ethiopia is on good progress.

Table 8: Estimation of Vector Error Correction Model

Dependent Variable: D(LNRGDP)
Method: Least Squares
Sample (adjusted): 3 41

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)= CointEq1	-0.739481	0.282110	-2.621247	0.0136
C(2)=D(LNRGDP(-1))	0.408876	0.257326	1.588940	0.1226
C(3)=D(LNENU(-1))	-4.696662	2.735798	-1.716743	0.0963
C(4)=D(LNGDS(-1)	-0.012933	0.030808	-0.419809	0.6776
C(5)=D(LNEXP(-1))	0.009755	0.039559	0.246584	0.8069
C(6)=D(LNGGG(1)	0.050448	0.065640	0.768559	0.4482
C(7)=D(LNTLF(1))	-3.632774	1.649442	-2.202426	0.0355
C(8)=CONISTANT	0.074035	0.043306	1.709580	0.0977

R-squared	0.439692	Mean dependent var	0.050992
Adjusted R-squared	0.290277	S.D. dependent var	0.059229
S.E. of regression	0.049897	Akaike info criterion	-2.958534
Sum squared resid	0.074692	Schwarz criterion	-2.574635
Log likelihood	66.69141	Hannan-Quinn criter.	-2.820794
F-statistic	2.942752	Durbin-Watson stat	2.009267
Prob(F-statistic)	0.014922		

Normality test: Jarque-Bera: 0.575999; probability: 0.749762
Serial correlation test: Obs*R-squared: 0.007493; probability: 0.9310
Heteroskedasticity test: Obs*R-squared: 18.76871; probability: 0.4944
Source: Own computation (2017)

Since Durbin-Watson stat is greater than R-squared we accept the model. Speed of adjustment towards long run equilibrium but it must be significant and the sign must be negative. The coefficient of error correction model depicts that there is long run causality running from independent variables to LNRGDP.

The speed of adjustment or the error correction term (ECT) from the above model is represented by C (1) and come up with the expected sign and level of significance. In an empirical sense, it implies 74% of the disturbance in the short run is corrected each year or it adjusts any disequilibrium towards long run equilibrium state path. The coefficient indicates that there is high correction for divergence of LNRGDP from equilibrium, implying economic agents taking past experience they correct about 74 per cent of errors in one year and the remaining 26% in the next year, and imply a very high speed of adjustment to equilibrium. According to Bannerjee et al. (2003) as cited in Kidanemarim (2014), the highly significant error correction term further confirms the existence of a stable long-run relationship.

R2 is 0.4396 which indicate that the fitted value explain the model well, indicates 43.96% of the growth in real GDP is explained by the variables included in the regression. Although there is guide line that says R2 for time series should be >60%, it may not hold for all types of regression. For VAR or System equations or normal regressions models it holds absolutely. However, for VECM model it is not mandatory because the result of R2 in VECM model is the result of choice of using difference in RGDP. This is why always R2of estimating a VAR model on RGDP levels rather than differences would give a much higher R2, but the higher R2 is not strictly evidence of having a better model (though the model is better because it incorporates the mean-reversion and co integration effects that your VAR model in differences ignores). In economic and financial data it is common to see approximately level data with high R2 values and then when differencing the R2 value declines. Additionally, in this study the VECM is no spurious regression model as indicated by the R-squared and DW statistics. Furthermore, a model with low R2 may be better than another model in some other respect for example in terms of Akaike information criterion AIC. It has been advised that a variety of criteria be used to compare the good fitness of the model (R2, AIC and Wald Test, F-statistics). Thus, low R2 does not mean that the result of the model is not correct.

The F test which shows the jointly significant indicate that the variables are jointly significant at 5 per cent level of significance.

Also, in order to strength our analysis, the stability of the estimated parameters in the model is examined using stability test of Recursive residuals. The stability of the model is checked using CUMSUM method and the graph that show the result is presented in appendix. Figure 1 affirms that the coefficients of the model are stable over a sample interval.

4.5 Diagnostic tests

The Diagnostics test was also employed for VECM to detect model misspecification and as a guide for model improvement. All these tests include no serial correlation, homoscedasticity and normality tests are satisfied (Appendix).

4.6 Short Run Granger Causality Wald Test: Vector Error Correction Model

As long as, the error correction term has negative sign and got statistical significance that we can test the short run causality between energy consumption (use) and economic growth. To examine the short run causality we use the technique of Wald coefficient restriction. Table 9 shows the result of the tests.

Table 9: VEC Granger causality Wald test result

Dependent Variable: LNRGDP

Test Statistic	Value	Df	Probability
t-statistic	-1.716743	30	0.0963
F-statistic	2.947207	(1, 30)	0.0963
Chi-square	2.947207	1	0.0860
Null Hypothesis: C(3)=0			
Null Hypothesis Summary:			
Normalized Restriction (= 0)	**Value**	**Std. Err.**	
C(3)	-4.696662	2.735798	

Restrictions are linear in coefficients.

Source: Own computation (2017)

There is no short run causality running from Energy use to LNRGDP because the probability of Chi-Square is greater than 5% level of significance, thus we accept the null hypothesis that says there is no short run causality running from Energy consumption /use to LNRGDP.

In the Table 9 where RGDP is dependent variable the null hypothesis energy consumption does not Granger cause economic growth and the alterative hypothesis is energy consumption Granger cause economic growth. From the table it shown that the P value is 0.086, which is higher than 5% and based on the “P-value” we tends to accept H0. That is, energy does not granger cause economic growth in the short run. Here also we can induce that there is no short run causality running from LNENU, LNGDS, LNEXP, LNGGG and LNTLF to LNRGDP.

The result of Table 9 shows whether independent variable jointly has short run causality or not. The short-run causality is determined by the F-statistics on the explanatory variables, based on the Wald Test or the Variable Deletion Test. However, the long-run causality is confirmed by the error-correction term (ECMt-1) in the same function, which is both negative and statistically significant. The results are consistent with the growth-driven energy consumption thesis (see also Ouedraogo, 2013; Stern and Enflo, 2013; Odhiambo, 2014; Sheilla, 2016). These findings imply that in Ethiopia, it is economic growth that drives energy consumption in the long run.

Table 9 where GDP is dependent variable the null hypothesis energy consumption does not Granger cause economic growth and the alterative hypothesis is that energy consumption does Granger cause economic growth. From the table it shown that the joint P value is 0.2331 and thus, we accept H0. That is, energy does not granger cause economic growth. Differently, when energy is dependent variable and with the null hypothesis GDP does not Granger cause energy consumption and the alternative hypothesis that GDP does Granger causes energy consumption. The joint “P-value” is 0.0001 and accordingly we reject the null hypothesis and thus we accept the alterative hypothesis. Hence, the evidence of multivariate analysis is in line with the growth-led energy consumption hypothesis where causality running from economic growth to energy consumption.

The pair wise Granger causality (which is bivariate analysis) and the vector error correction model Granger causality test (which is multivariate analysis including LNGGG, LNTLF, LNEXP and LNGDS) result are not support each other. That is in the long run the result support the growth-led energy consumption hypothesis where causality running from economic growth to energy consumption, indicating that economic development to take first over energy consumption and that economic growth caused high demand for energy. Obviously, the economy of Ethiopia is highly relied on the agricultural sector. As a result, the energy use of agricultural sector is insignificant. Thus, the finding of this study shows that shortage of energy may not adversely affect RGDP growth or cause a fall in the RGDP in the short run. This is due to the fact that Ethiopia the agricultural sector does not depend on energy over the period of investigation, and total energy consumption is very low.

The result of Granger causality running from economic growth to energy consumption in Ethiopia consistent with the findings of Chontanawat et al. (2008), Wolde-Rufael (2005 and 2009), Masih (1996) and Akinlo (2008). However, the result contradicts the result of Yohannes (2010) in Ethiopia and the result of Amirat et.al (undated).

The finding of this study, the unidirectional causality from economic growth to energy consumption may be justified by the fact that:

The insinuation of the unidirectional causality running from economic growth to energy consumption result is that, the result may statistically and empirically suggest that energy conservation measures may be taken without endangering /hindering economic development. However, in practice suggest measures that can lead to the reduction of energy consumption to the consumer in order to stop any conservation problem arising out energy consumption may not be a feasible option for Ethiopia. The reason is that given the magnitude of the energy problems and the fact that the current energy infrastructure of the country is still insufficient to answer the quest for rapid economic growth that is required to alleviate poverty and to raise the living standards of the people.

Reducing energy consumption while the devastatingly majority of the population is still denied access to the use of modern type of energy may not be a feasible option. Ethiopia has not yet reached the energy ladder that may guarantee such a suggestion but it can still substantially improve the detrimental consequences of energy consumption (example the loss of natural resource for energy and the subsequent loss of soil fertility and erosion) without reducing its use. By making its energy sector more efficient and by making it available to a larger part of the population (especially electricity) energy used per unit of output can be raised.

4.7 Test of Volatility: Impulse response and Variance decomposition

Table 10 indicates the following results. In response to a one standard deviation disturbance output (LNRGDP) itself future output increase by 0.0494 in the first year and it declines in second year and consequently in third year and it continue increase but it never die out in the long run and reaches 0.040620 at the 10th year.

A one standard deviation disturbance originating from capital results in an approximately 0.022609 percent increase in output in first year and it further increase to 0.019184 in the 3rd year and it did not die out in the time horizon and consequently it reaches 0.021314 at the 10th year. A one standard deviation disturbance originating from labor results in an approximately 0.013797 increase in output in first year and it never dies out in the long run and consequently it reaches 0.023740 at the 10th year. The result shows the impact of capital and labor is permanent.

A one standard deviation disturbance originating from LNENU produces a -0.004 decrease in LNRGDP in the first year. Its effect continues to fall as the forecast horizon is extended and reaches -0.019818 at the 10th year. LNENU has no permanent impact on GDP, and its effect does die out. In other words, energy consumption has no a long- run impact on economic growth which is in line with the above findings. The impact of LNGGG, LNTLF, LNGDS and LNEXP are permanent.

The conspicuous result is the disturbance originating from energy is negative (although it is small in magnitude) suggesting that energy use negatively impacts on economic growth.

The negative relationship between energy consumption and economic growth implies that the low level of energy efficiency5 in the country. Africa contributes about 4 per cent of total greenhouse gases. Most countries (except for the wealthier and fossil-fuel rich nations) have very low carbon dioxide (CO2) emissions per capita due to low energy intensities, lower GDPs and high levels of biomass energy use (Economic Commission for Africa, 2010).

Though the average African currently uses far less energy than the world average, producing a dollar's worth of GDP uses more energy in Africa on the average than the rest of the world (ECA, 2004).Ethiopia has low level of energy efficiency in Africa, with \$2.6 of GDP for one unit of energy use in 2000 compared to the Sub-Saharan Africa average of \$2.9 (Mehari, 2008).

Furthermore, Energy consumption in Ethiopia is heavily dependent on biomass energy (fuel wood, charcoal, wood waste wood, crop residues and animal dung, including biogas). The total final energy consumption in 2012 was estimated by IEA at 37,048 ktoe. Biomass fuels consumed during the same period was about 29,889 ktoe. The total petroleum consumption in the 2012 was 2,286 ktoe. Total electricity consumption was about 399 ktoe for the same period (2012), representing only the 1% f the total energy consumption. Electricity transmission and distribution losses were a fifth (20%) of total output in Ethiopia compared to 2.9% for Zambia and the world average of between 10 and 12%. Like many African countries, Ethiopia has to reduce inefficacy in the supply and use of energy.

It can be seen that almost all the biomass, the main energy vector in Ethiopia, is consumed in the residential sector. The real problem Ethiopia faces

[5] Energy efficiency measures the amount of GDP generated by one unit of energy use. Energy intensities (measured as tons of oil equivalent per unit GDP) vary widely across the region depending on the structure and energy efficiency of the economy. Energy efficiency means here that the energy inputs are reduced for a given level of service or there are increased or enhanced services for a given amount of energy inputs.

regarding energy consumption comes from the use of biomass for cooking. It is imperative that this issue is addressed and options analysed to overcome the situation; not just for reducing energy consumption, but also to avoid deforestation and the environmental impact that it carries as a consequence. The use of energy in the industry has to be addressed as well, but always with the goals of the GTP and the CRGE in mind; that is reducing energy consumption but aiming at economic development.

It is very important to develop an Energy consumption baseline study as a starting point to set up Energy Reduction Targets. In terms of electricity, the use of appliances and equipment has to be analysed since the potential for energy reduction comes from them. It has to be pointed out that the transport sector is out of the scope of this document. While the energy efficiency of individual system components, such as motors (85%-96%) and boilers (80%-85%) can be quite high, when viewed as an entire system, their overall efficiency is quite low (European Commission, 2015).

The power shortage due to insufficient hydropower generation during time of drought as hydroelectricity represents the primary source of electricity for Ethiopia could be another factor for the negative relationship between energy and economic growth. These shortages and inefficiencies could hinder industrial sector and decrease to the growth of employment in the country.

Table 10: Generalized Impulse Response of VAR model

Table 10.1: Impulse Response of LNRGDP

Period	LNRGDP	LNENU	LNGDS	LNEXP	LNGGGG	LNTLF
1	0.049427	-0.004043	0.024730	0.019656	0.022609	0.013797
2	0.038852	-0.005878	0.008974	0.020139	0.018848	0.013832
3	0.038450	-0.009946	0.005871	0.023185	0.019184	0.015677
4	0.039003	-0.013246	0.004315	0.025593	0.019454	0.017290
5	0.039528	-0.015554	0.003389	0.027325	0.019592	0.018624
6	0.039920	-0.017083	0.002945	0.028605	0.019763	0.019784
7	0.040192	-0.018098	0.002835	0.029611	0.020034	0.020843
8	0.040379	-0.018810	0.002919	0.030452	0.020402	0.021843
9	0.040513	-0.019357	0.003099	0.031193	0.020838	0.022805
10	0.040620	-0.019818	0.003315	0.031868	0.021314	0.023740

Table 10.2: Response of
LNENU period

	LNRGDP	LNENU	LNGDS	LNEXP	LNGGGG	LNTLF
1	-0.000234	0.002862	0.000304	-0.001336	-0.000139	-0.000599
2	0.000877	0.001523	0.001231	-0.000182	0.000824	1.53E-05
3	0.001099	0.000620	0.000815	0.000327	0.000930	0.000243
4	0.001231	3.01E-05	0.000408	0.000598	0.000844	0.000358
5	0.001326	-0.000305	0.000164	0.000744	0.000735	0.000425
6	0.001388	-0.000471	5.34E-05	0.000827	0.000658	0.000474
7	0.001423	-0.000545	2.35E-05	0.000882	0.000622	0.000518
8	0.001441	-0.000578	3.07E-05	0.000926	0.000616	0.000560
9	0.001450	-0.000598	4.86E-05	0.000965	0.000629	0.000601
10	0.001454	-0.000617	6.53E-05	0.001001	0.000648	0.000641

Source: Own computation (2017)

Table 10.2 presents the accumulated response of LNENU. In response to one standard deviation shock of LNENU, LNENU itself increases by 0.0028 in the first year and continues to fall in the long-run reaching -0.000500 in 10th period. A one standard deviation disturbance originating from LNRGDP produces a -0.00023 decrease in LNENU in the first year. However, its effect continues to grow and reaches 0.001454 at the 10th year. Hence, LNRGDP has a significant impact on LNENU implying that economic growth has a long-run impact on Energy consumption. In other words, the empirical results indicated that the response of energy consumption to economic growth negatively while the response of economic growth to energy consumption is positively.

4.7.2 Variance Decomposition of VAR model

The impulse response functions trace the effect of a shock to one endogenous variable on the other variables in the VAR whereas variance decomposition separates the variation in an endogenous variable into the component shocks to the VAR. The relative importance of each random innovation in affecting the variables in the VAR can be seen by the variance decomposition results. It highlights the proportion of the movements in the dependent variables that are results of their own shocks, against shocks from the other variables.

Table 11.1 reports the results of the variance decomposition of output growth in Ethiopia within a 10-period horizon. We limited our discussion on the relative importance of endogenous variables in explaining the variation in LNRGDP and LNENU; thus, we only decompose the forecast error variance on LNRGDP and LNENU. In table below (table 11.1), the variance estimates indicate that a greater proportion of the variation in LNRGDP is due to its own innovations. The variation due to the other variables is smaller. The other five variables together explain approximately 18.03% of the future variation in GDP growth in Ethiopia. The remaining 81.97% are due to changes in GDP growth itself within the period under investigation. When we look the partial effect of factor inputs, LNGDS (7.49%) as percent of LNGDP has the highest effect on GDP growth followed by LNEXP (4.59%) and LNENU (3.22%). The fourth and fifth, are 2.66 % due to LNGGG and due to 0.05128% LNTLF respectively. 3.22% of future changes in GDP are due to changes in LNENU, showing it has less important impact on future growth rate of output in Ethiopia. Energy has less important compared to GDS and EXP. As it can be seen from the Table 11.2 the response of output growth to shocks coming from energy input is slow during the first periods and its full effect on output continues to over time horizon and its has permanent effect. LNGGG, LNGDS, and LNTLF have permanent effects over all period.

The result is in line with Amirat et.al (undated) who found the variance error decomposition of capital high compared to energy and it is also consistent with the result of Sari and Soytas (2007) who found in Singapore, energy to be less important than the other inputs in short run.

The relatively low level contribution of energy to economic growth for Ethiopia may be suggest that the causal relationship between energy consumption and economic growth is relatively weak when compared to either capital or labor, LNGDS, LNEXP. The low economic performance of the country reinforces the limited energy development and consumption. The current energy infrastructure is not enough to promote sustainable economic development (ECA, 2010).The finding evidence shows that GDS, LNEXP, LNENU may be relatively more important input than both labor and capital in Ethiopia in the long run. This may be due to the fact that in Ethiopia, labor tends to be abundant and relatively cheaper, our results suggest that in order to sustain high economic growth rates in the long run, the country need to expand its Gross Domestic saving capacity to encourage investment and thus, economic growth, and export to generate foreign currency.

Table 11: Variance Decomposition position

Table 11.1: Variance Decomposition position of LNRGDP

Period	S.E.	LNRGDP	LNENU	LNGDS	LNEXP	LNGGGG	LNTLF
1	0.049427	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.064962	93.65860	0.173955	3.297758	1.600032	1.264950	0.004704
3	0.078455	88.23246	0.875821	5.670334	3.022204	2.195353	0.003832
4	0.091010	83.93423	1.880049	7.330892	4.092820	2.758324	0.003681
5	0.102793	80.58297	2.920154	8.503760	4.900389	3.083246	0.009485
6	0.113846	77.99043	3.863696	9.311383	5.536210	3.273824	0.024461
7	0.124226	75.96966	4.675936	9.844697	6.063334	3.396201	0.050172
8	0.134009	74.36129	5.366195	10.17759	6.519875	3.487946	0.087109
9	0.143280	73.04448	5.956492	10.36761	6.927596	3.568619	0.135204
10	0.152118	71.93407	6.468311	10.45703	7.298901	3.647518	0.194166

Table 11.2: Variance Decomposition of LNENU

Period	S.E.	LNRGDP	LNENU	LNGDS	LNEXP	LNGGGG	LNTLF
1	0.002862	0.668961	99.33104	0.000000	0.000000	0.000000	0.000000
2	0.003460	6.883978	89.32057	3.545927	0.001427	0.207481	0.040618
3	0.003736	14.56193	80.23138	3.290294	0.290512	1.459576	0.166315
4	0.003991	22.27618	70.43744	3.327766	0.810372	2.849525	0.298717
5	0.004288	28.86353	61.23091	4.537092	1.334667	3.660319	0.373486
6	0.004607	34.07269	53.63423	6.167305	1.794337	3.941169	0.390274
7	0.004926	38.16302	47.68911	7.608929	2.211340	3.953933	0.373664
8	0.005232	41.42316	43.05519	8.689215	2.614704	3.874080	0.343653
9	0.005523	44.05419	39.38763	9.447808	3.017433	3.781600	0.311337
10	0.005802	46.19132	36.42933	9.971717	3.419646	3.705840	0.282150

Source: Own computation (2017)

Table (11.2) on the other hand shows the variance decomposition result for LNENU. The variance estimate result shows that high variation in LNENU is due to RGDP changes. Hence, economic growth is significantly important as it explains 46.19% of future changes in Energy consumption. This finding is consistent with our previous result. The variation due to the other variables, when compared to GDP is smaller.

5. Conclusions

This study has examined the causal relationship between energy consumption and economic growth using the time-series data from Ethiopia during the period from 1974/75 to 2014/15. The study is basically different from the majority of previous studies on energy-growth causality link in that it has used a multivariate framework – with capital, labor, gross domestic saving, and export as the intermittent variables.

In the long run, the model estimation shows LNENU, LNEXP and LNTLF have positive and statistically significant relationship with real GDP in the long run. However, domestic saving has a negative and insignificant effect on real GDP in the long run. And LNGGG has positive and statistically insignificant relationship with real GDP in the long run. LNEPC has positive and statistically significant relationship with real GDP where as LNEIMP has negative and statistically significant relationship with real GDP. Furthermore, in the long run the granger causality test reveals unidirectional from economic growth to energy consumption. That is this study support conservation hypothesis' which suggests that policy on energy consumption have no effect on the economic growth, implying that reducing energy consumption may be implemented with little or no adverse effect on economic growth. In practice however any conservation measures taken to reduce energy consumption may not be a viable option for Ethiopia particularly given the magnitude of its energy problems and the fact that the current energy infrastructure of the country is still inadequate to support its quest for rapid economic growth and for eradicating poverty. The option therefore might be for Ethiopia to enhance the level of efficiency in the energy sector. Increasing energy efficiency can cut down growth of energy demand that can mitigate conservation and health problem. As noted by IEA (2016), finding ways of expanding the quality and quantity of energy services while simultaneously addressing the environmental impacts associated with energy use represents one of the critical challenges Africa is facing. This means that energy regulation policies supporting the shift from lower-quality (typically less efficient and more polluting) to higher-quality energy services could provide impulse to economic growth rather than be detrimental to the development process (Costantini and Martini, 2010).

Furthermore, the estimated results infer that economic growth causes electricity consumption but not vice verse in the long run; this is due to the fact that, the per capita consumption of electricity in Ethiopia remains relatively low at about 200 kWh per year, due to the heavy reliance on traditional biomass energy sources, such as wood fuels, crop residues, and animal dung (Guta et al., 2015,). The study also investigate that economic growth leads to the growth in petroleum consumption (energy import) in the long run.

In the short run, the empirical revels that only the one year lagged value of Energy consumption and labor force is significant in affecting current growth in real GDP. Like in the long run, in the short run, the estimated short run Wald test for causal relationship reveals no short run causality running from Energy use to LNRGDP in Ethiopia for the period under investigation. Contrary to long run, in the short run there is no causality running from economic growth to energy consumption. The short run speed of adjustment coefficient is estimated is significant and have a correct sign. The adjustment coefficient of -0.7394 indicates that 73.94 % of the short run adjustment made within a year, and it is the speed of adjustment is high implying that it takes short time (less than two year) for growth in real GDP to move back to its equilibrium once it drifts away from its long run equilibrium value.

The results of Impulse response and variance decompositions also indicate the energy consumption has no a long- run impact on economic growth which is in line with the above findings. LNRGDP has a significant impact on LNENU implying that economic growth has a long-run impact on Energy consumption.

The strength of this causal relationship, as measured by the variance decomposition analysis, reveals that, energy has high contributing factor to output growth and certainly the most important one when compared to capital and labor. However, it is an important factor in output growth in Ethiopia next to GDS and EXP.

Although this may be due to the fact that in Ethiopia, labor tends to be abundant and relatively cheaper, our results suggest that in order to sustain high economic growth rates in the long run the country need to expand its saving capacity. Energy needs of Ethiopia will not only be affected by rising residential energy demand as a result of income growth, but also by the industrial demand for energy as the economies expand in the long run, and based on promote long-term sustainable economic development of Ethiopia, the following policy recommendation was forwarded.

6. Policy Implications

Based on the empirical result, we can infer the following recommendations:
The results of this study show, there is a unidirectional causal flow from economic growth to energy consumption in the long run. However, in practice any conservation measures taken to reduce energy consumption may not be a feasible alternative for Ethiopia particularly given the magnitude of its energy problems and the fact that the current energy infrastructure of the country is still insufficient to support its quest for rapid economic growth and for eliminating poverty. Thus, policy makers should consider expanding their energy-mix options, to address the future demand arising from increased economic growth, and adjust the industrial structure, development high value-added industries, promote energy conservation structures, and improving energy efficiency, enhance the level of efficiency in the energy sector. Increasing energy efficiency can cut down growth of energy demand that can mitigate conservation and health problem.

The increased demand for energy in Ethiopia's economic growth and development process needs that the path must be cleared for clean energy, develop new energy sources and increasing the use of renewable energy sources like, solar power, wind farms, geothermal and natural gas with long-term investments on technology in spite of their grave (huge) economic cost, and for instance, in 2015/16, the Ethiopian Petroleum Enterprise imported about 3 million metric tons of petroleum products worth Birr 30.3 billion which was 20.1 percent lower than last year mainly due to a significant drop in international oil price. The volume of petroleum imports however rose 7.8 percent with higher imports of regular gasoline (25.7 percent), gas oil (11.7

percent) and jet fuel (3.3 percent). As a result, using oil more efficiently and substituting gas for oil wherever possible could be a good policy measure. Thus, the regulations to be arranged and policies to be implemented must aim to minimize our dependency on foreign energy sources and reduce it over time the outflow of domestic currency.

An energy growth policy in the case of both electricity consumption and energy import, conservation would not lead to any adverse side-effects on economic growth in Ethiopia, growth in these sectors doesn't stimulates economic growth in the long run.

More, promote energy for sustainable development including the diversification of energy supply, diffusion of environmentally sound technologies, modernized energy systems in agriculture, industries and households, and optimizing energy consumption structure, actively develop the tertiary industry with lower energy consumption, thus the light of the economic structure and energy development.

Promoting energy efficiency and focusing on decreasing energy intensity may also have positive impacts on economic growth rates without putting considerable pressure on the environment. Developing energy sources that are renewable and that have low or no carbon content seem to be essential for this purpose.

Besides that, to ensure sustainable economic growth and protect the environment needs building a resource-saving society. It will be helpful for the government to utilize innovative technologies and more intensive management, improve the efficiency of the use of coal, oil, natural gas and other energy and lead aggressive research and development of new technologies, energy use technology so that a resource-saving and environment-friendly society will be built.

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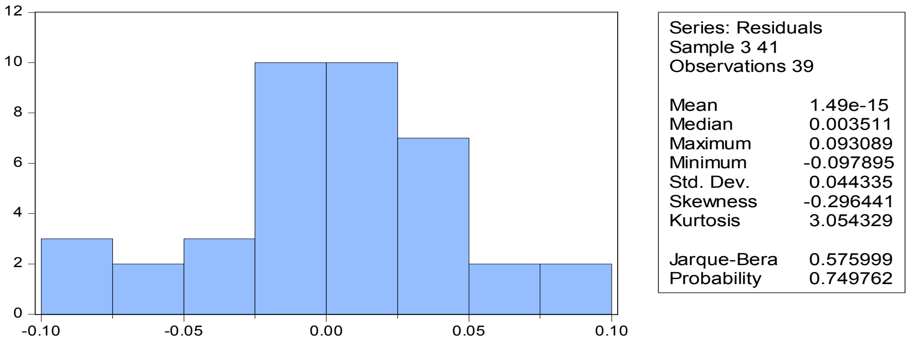
Appendix:

1. Diagnostic tests of VECM

1.1 Residual test of normality



Serial correlation test

Breusch-Godfrey Serial Correlation LM Test:

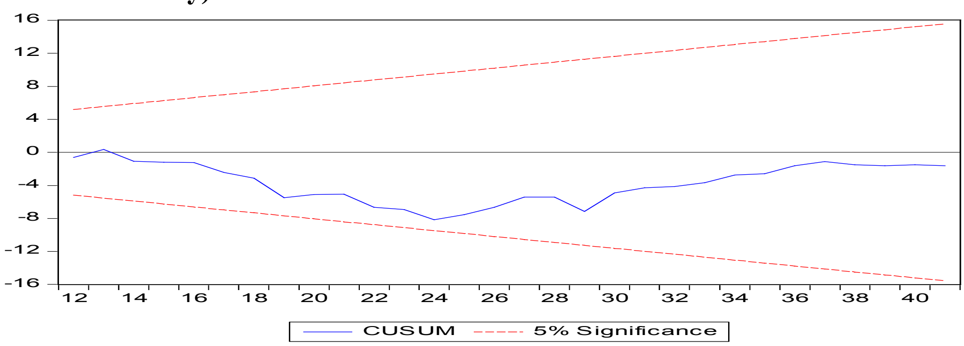
F-statistic	0.005573	Prob. F(1,29)	0.9410
Obs*R-squared	0.007493	Prob. Chi-Square(1)	0.9310

Heteroskedasticity test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.010031	Prob. F(12,26)	0.0663
Obs*R-squared	18.76871	Prob. Chi-Square(12)	0.0943
Scaled explained SS	11.40743	Prob. Chi-Square(12)	0.4944

Figure 1: Parameter Stability Test VECM: Recursive Estimates (OLS only)



Source: Own drawing (2017), and EViews version 9 using NBE data.

Impact of Trade Costs on Export Performance of Ethiopia – A Ppml Panel Gravity Equation Approach

Benat Mohammedamin Mussa[1] and Gollagari Ramakrishna

Abstract

This paper is an attempt to examine the impact of trade costs on export performance of Ethiopia. We have estimated a panel gravity model using a balanced panel data gathered over the period of 2010 -2015. A sample of 10 major trading partners of Ethiopia has been used in the analysis. Whilst two types of panel data models: pooled model and importers and exporter fixed effects model have been used, the Poisson Pseudo Maximum Likelihood (PPML) estimation procedure has been employed for their estimation. The results indicate that trade costs proxied by distance had a significant negative impact on exports of Ethiopia. In contrast, tariff rate and GDP of Ethiopia had no impact on its exports. The empirical result also suggests that Ethiopia trades more with landlocked countries than coastal countries. In view of these findings, it is suggested that the country would be better off if it exports to its neighbouring countries by diversifying its exported goods and participates in regional linkages with the neighbouring countries. The study also recommends that focusing on trade facilitation measures such as making trade information available, harmonization and simplification of documents would help reduce trade costs.

Key Words: Ethiopia, Exports, Gravity model, PPML estimation, Trade Costs
JEL classification: B41, C13, C33, C50, F19

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4. Introduction

Developing countries, including Ethiopia, have been striving hard to promote economic development and alleviate poverty. Export is conceived as one of the very important contributing factors for economic growth. It stimulates growth through different means including smoothing of supply – demand linkages, and increased economies of scale as a result of larger international markets (Giles and Williams, 2000). Greater access to world markets in turn may bring competitive pressures and may arouse innovation which facilitates technological advancement and knowledge spill over into the domestic economy. Engaging in Exporting activities is also believed to boost development and reduce poverty by generating growth through increased commercial opportunities, enhance competitiveness by reducing costs of inputs and investment, as well as broaden the productive base through private sector development (European Commission, 2015).

However, with all such advantages of exporting goods, the costs related to exporting goods have become one of the major concerns for Ethiopia. These costs are termed as trade costs. Trade costs are broadly defined to include all costs incurred in getting a good to a final user other than the production cost of the good itself (Anderson and Wincoop, 2004).

Moreover, the effect of trade costs becomes much higher for countries that are landlocked than coastal countries. As Ethiopia is a landlocked country and relies heavily on neighbouring countries particularly Djibouti and Kenya for accessing the sea, it suffers from considerably high trade costs in exporting its products as well as importing key inputs (Aschenaki, 2004). According to the World Bank (2016) Ethiopia's cost of export per container was $2380 in 2014.[2] This could possibly be one of the factors for the low competitiveness of Ethiopia's products in the world market.

Of course, there are some studies that show the reduction of trade costs globally. According to WTO (2008) there have been considerably large

[2] This figure is much higher compared to other neighbouring countries. For instance, export cost of Eritrea was $1850 while it was only $885 for Djibouti in the same period.

reductions in the cost of transportation and communication which makes trade between countries very simple[3]. In this regard, given the net benefit of trade remains positive, the question of whether the rising costs of trade actually matter for countries export or not could be raised. In line with these, this paper explores whether trade costs have negative impact on Ethiopia's export or not. In particular, in order to address the objective of the study, this paper raises the following research questions; what determines exports of Ethiopia? And do trade costs have any impact on the export performance of Ethiopia?

The rest of the paper is organized as follows: Review of theoretical and empirical evidences has been presented in chapter II followed by model specification and data sources in Chapter III. Data analysis and empirical findings are presented in Chapter IV. Finally, conclusion, policy implication and suggestion will be presented.

5. Review of Theoretical and Empirical Evidences

Many studies in trade costs have been conducted by Anderson and Van Wincoop (2001, 2003, and 2004). These authors broadly defined trade costs as "all costs incurred in getting a good to a final user other than the production cost of the good itself. Among others this includes transportation costs (both freight costs and time costs), policy barriers(tariffs and non-tariff barriers), information costs, contract enforcement costs, costs associated with the use of different currencies, legal and regulatory costs, and local distribution costs (wholesale and retail)" (Anderson and Wincoon, 2004). Similarly, Ali (2015) defined trade costs to include all factors that drive a wedge between producers' price in the country of origin and consumers' price in the country of destination. Trade costs (in the absence of information) are also narrowly defined to include costs related to border procedures, transportation and logistics (WTO, 2015).

[3] More efficient telecommunications, from telephone to internet interaction have allowed companies to exchange goods more efficiently and exchange information between potential buyers and sellers which lowered the costs of international integration (WTO, 2008).

Trade costs can be classified in to two: border costs and non-border trade costs. Border costs are costs related to national borders and generate trade costs that involve real resources, such as gathering information about foreign regulations, hiring lawyers familiar with foreign laws, learning foreign languages, and adjusting product designs to make them consistent with foreign customs and regulations while non-border costs are largely natural trade costs that arise from distance and geological irregularity interacting with the most efficient transport and communication technology (Anderson and Wincoon, 2001).

Trade costs matter because they have significant effect both on consumers and producers' welfare. From consumer's side, the high price of goods due to high trade costs hampers their ability to take advantages of comparatively low priced goods from import. From producer's side, trade costs obstruct production by denying firms access to high quality foreign inputs (Portugal & Wilson, 2008). On top of that, according to Portugal and Wilson (2008) although trade costs may not explain why some countries are poor, in combination with other factors like corruption, underdeveloped institutions, constraints on business competition, and weak governance make international trade (export) and investment very costly.

There are several empirical evidences that have been conducted by different researchers on the effect of trade costs on exports of goods. McCallum (1995) estimated the loss of trade volume when goods are shipped from US to Canada. The study found a negative impact of trade costs on export of US. This study also makes a comparison to the losses incurred when products cross the provincial borders within Canada and it is found that beyond the border trade costs are higher than behind the border trade costs even for countries that are highly integrated through the North American Free Trade Agreement (NAFTA). However, McCallum's study has raised numerous questions with regard to trade costs and the empirical measures used to analyse the study, which lefts large unexplained trade costs. Subsequently, Anderson and Van Wincoop (2003) have tried to solve the 'border puzzle' using McCallum's data via gravity model by including other multilateral resistance factors. The authors managed to explain larger border puzzle and reduced McCallum's unexplained border effects to 44 percent.

Similarly, Suresh and Aswal (2014) have studied the determinants of India's manufactured exports to its developing countries and developed countries markets using an augmented gravity model. Their findings confirmed that India's exports were explained by total GDP, GDP similarity and difference in per capita income. In that study, it was found that trade costs such as distance had more negatively affected India's exports to developed countries than the developing market since proximity to the developing countries market was closer.

On the other hand, some studies showed that the reduction of trade costs lead to increase in exports of countries products. For instance, Khan and Kalirajan (2011) used gravity model to examine the impact of trade costs in Pakistan. The analysis in their study includes tariff rate and bilateral exchange rates in addition to the traditional gravity model variables. Their findings confirmed that the growth of exports in Pakistan between 1994 and 2004 was mainly due to the reduction of trade costs in its importing partner countries. Similarly, De (2007) found that trade in Asia is gaining high momentum partly because of low level of trade costs. The author confirmed that the reduction of tariff and transport costs by 10 percent, each would increase bilateral trade by about 2 and 6 percent, respectively. Likewise, Bernard et al. (2006) examined the response of U.S. manufacturing industries and plants to changes in trade costs on industry-level tariff rates and transportation. Their results indicate that industries that experience relatively large declines in trade costs exhibited relatively strong productivity growth and the tendency of high export.

In Ethiopian context, Mohammed (2008) studied the impact of Ethiopia's COMESA membership on its export using gravity model. In this study trade costs (proxied by distance between Ethiopia and its trading partners) had been incorporated. The estimation result for distance revealed negative sign implying that Ethiopia would be better off to export to neighbouring countries. Similarly, Bekele (2011) has studied the impact of real exchange rate on export of Ethiopia. In addition, variables that explain trade cost like distance and importers trade policy were also included in the estimation. The result showed that real exchange rates are not in a position to exert significant effect on bilateral exports of the country. On the other hand, internal transport, infrastructure and trade policy of importing countries were found important determinants for Ethiopia's export.

Studying the bilateral trade of Ethiopia and east African community countries, Tebekew (2014) analysed the determinants of Ethiopia's export using an augmented gravity model over the nine years panel data (2004 -2012). The author found that trade costs such as distance and nominal exchange rate had significant negative impact on Ethiopia's bilateral trade. The study had also found a negative relationship between Ethiopian export and trade agreement for preferential trades.

From the above literature, while some studies find the negative effect of trade costs on export, others found the increase of volume of exports due to reduced trade costs specifically transportation and communications costs. This probably is due to difference in estimation techniques, choice of variables, study period, and level of development of the country under study. By the same token, the costs of exports to a certain country may be significantly higher than others due to specific bilateral factors like lack of infrastructure, road and communication network or they may be lower due to preferential trade agreements and regional integration. Therefore, it is important to empirically assess the impact of trade costs on export of Ethiopia in order to reach at a conclusion.

On the other hand, there viewed literatures in the context of Ethiopia are related to export growth or determinants of export which includes trade cost variables in their analysis. Therefore, this particular study is an attempt to specifically address the impact of trade costs on export of Ethiopia. In this regard, our study applied gravity model and incorporated the impact of trade costs on export performance of Ethiopia in a specific way by extending the gravity model to include the effect of other factors.

3 Model Specification and Data

The determinants of international trade of a country in relation to its partners are usually explored using the gravity equation approach. Though, the traditional approach is based on bilateral trade or multi-country models which usually studies a huge trade panel data sets, this study aims in the analysis of one-way trade flow of home country so that the relationships in the gravity model can be studied in a more precise way. Defining Ethiopia as a single 'home country', the analysis is based on an econometric estimation of export function from home country to its trading partners. To get the parameter estimates of the model, we used Poisson Pseudo Maximum Likelihood (PPML) estimation method.

We have used a panel data for 10 major trading partners of Ethiopia (China, Japan, Germany, Saudi Arabia, United Arab Emirates, United Kingdom, Italy, India, Sudan and Switzerland) over the period of 2010-2015 based on their share in Ethiopia's trade and availability of data on the variables for the model estimation. The time period is also chosen based on availability of data for the included countries.

Model Specification

The model in this study emanates from the basic gravity model. The concept of gravity model was originally introduced by Tinbergen in 1962 analogous to Newton's law of gravity.[4] In this traditional gravity model, trade (exports) between two countries is directly related with their economic sizes (GDP/GNP) and is inversely related to the physical land distance between them. This forms the basis of gravity model and would typically take the following form:

$$Xij = \beta(GDPi.GDPj)/Disij \qquad \textbf{(1)}$$

Where X_{ij}= trade (export) from country i to j, β = constant, GDP_i/GDP_j= Gross Domestic product of the respective countries, Dis_{ij}= distance between country i & j. An intuitive gravity model follows from the above mentioned equation in a linear outline:

[4] Just like Newton's law of gravity that states the gravitational attraction between any two objects is proportional to the product of their masses and diminishes with distance, trade between any two countries is proportional to the product of their GDPs and diminishes with distance (Krugman et.al. 2012).

$$lnXij = \beta 0 + \beta 1 lnGDPi + \beta 2 lnGDPj + \beta 3 lnDisij + \varepsilon ij \qquad \textbf{(2)}$$

However, distance is found to be a poor proxy of trade costs because trade encompasses several costs in terms of policy and environmental facilities. Consequently, various economists tried to explain trade costs by including other variables. Anderson and Wincoop (2003) included two additional variables, namely, outward and inward multilateral resistance[5]. Likewise, most studies estimate the gravity model by adding a number of dummy variables like being a member of a trade agreement, sharing a common land border, speaking the same language and so on to test for specific effects.

Econometric Strategy

The empirical analysis of gravity equation has traditionally been analysed using cross- sectional data which cannot sufficiently account for heterogeneity among countries which, in turn, can lead to an estimation bias (Kareem, 2013). To alleviate this problem, researchers have turned towards panel data, which allows taking into consideration of more general types of heterogeneity and makes it easier to identify the specific time or country effects like institutional, economic, cultural or population-invariant factors. Moreover, the problem of potential multicollinearity that sometimes arises from cross- section data might be avoided with panel data (Baltagi, 1995, Hsiao, 2014).

However, the logarithmic transformation of the model for its estimation still causes problems even with panel data estimation methods. This is because the estimation results based on the logarithmic transformed model could be significantly misleading in the presence of heterodscedasticity because of Jensen's inequality[6] (Silva & Tenryero, 2016).

This can be explained as follows:

[5] According to these authors the inward multilateral resistance emanates from the existing infrastructural and institutional inefficiencies and rigidities in home country and the outward resistance arises from tariffs and exchange rate on which home country does not have any control.

[6] Jensen's inequality states that the expected value of a logarithm of random variables does not equal to the logarithm of expected value.

$$\ln(Xij) = ln\beta 0 + \beta 1\ln(GDPi) + \beta 2\ln(GDPj) + \beta 3\ln(Disij) + \ln(\varepsilon ij) \quad \textbf{(3)}$$

The expected value of the above log-linearized equation would be:

$$E[lnXij] = E[ln\beta 0 + \beta 1 lnGDPi + \beta 2 lnGDPj + \beta 3 lnDisij + ln\varepsilon ij] = (\mathbf{4})$$

$$[lnXij] = E[(ln\beta 0)] + \beta 1E[\ln(GDPi)] + \beta 2E[\ln(GDPj)] + \beta 3E[\ln(Disij)] + E[(ln\varepsilon ij) \quad \textbf{(5)}$$

Since lnE[εij] ≠ E[ln(ε_{ij})] (which is Jensen's inequality), the conditional distribution of X_{ij} is misrepresented and estimation through OLS will result in misleading and inconsistent estimates[7]. On the other hand, the data of export may involve zero or missing values due to the nature of the data itself. The logarithmic transformation in this case is then improper because logarithm of zero is undefined[8] (Westerlund & Wilhelmsson, 2009).

Due to the above facts, log- linearized model is not an appropriate model. The alternative approach to the estimation of log- linearized model then lies in the direct estimation of the multiplicative form of the gravity equation using Poison Pseudo Maximum Likelihood (PPML).

$$X_{ijt} = \beta_0 GDP_{it}^{\beta 1} GDP_{jt}^{\beta 2} Dis_{ij}^{\beta 3} DGDPPC_{ijt}^{\beta 4} TR_{jt}^{\beta 5} e^{\theta j} e^{\theta i} \varepsilon_{ijt} \quad \textbf{(6)}$$

Without any further information on the pattern of heteroscedasticity, Santos Silva and Tenreyro (2006) has stressed that this is the most appropriate

[7] "*the log linearization of the empirical model in the presence of heteroskedasticity leads to inconsistent estimates because the expected value of the random variable depends on higher- order moments of its distribution"* (Sillva & Tenreyro, 2006, p.653).

[8] To solve the problem of zero- valued trade flows, adding some small positive values to all observations or get rid of the zero-valued observations from the trade matrix have been suggested in the literature (Mohammed, 2008).However, in the case of adding some small value, the resulting estimation varies highly with the chosen of such a small number (Flowerdew & Aitkin, 1982). On the other hand, omitting the observations causes serious problems as well like losing of information that are encompassed in the deleted data (Eichengreen& Irwin, 1996). Besides, according to Burger et al. (2009) the estimation will very likely suffer from a sample selection bias caused by omitted zero-valued trade flows observations which are probably non-randomly distributed.

method. Since there is no need of undertaking the logarithmic transformation of the dependent variable and the variable is measured in level, the problem of handling zero trade flows is no more an issue in this process.

Thus in this study, a panel data model has been used for the estimation of gravity equation taking in to account of the above justifications. To get the parameter estimates of the model, this paper applies the Poisson Pseudo Maximum Likelihood (PPML) estimator. The equation can be written as in the following function:

$$Xijt = \beta 0 + \beta 1 \ln(GDPit) + \beta 2 \ln(GDPjt) + \beta 3 \ln(Disij) + \beta 4 \ln(DGDPPCijt) + \beta 5 \ln(TRjt) + Contig + Landlock + Comlang\_off + \varepsilon ij \quad \textbf{(7)}$$

Table 1: Definition of Variables

Variables	Definition	Expected sign	Source
X_{ijt}	Denotes the total value of exports from country i (Ethiopia) to country j at time t.		Ethiopian Revenues and Customs Authority
GDP_{ijt}	Denotes GDP of exporting and importing countries. (GDP_{it}) and (GDP_{jt}) are used to control for the supply and demand side respectively.	+	World Bank, WDI database
Distance (Dis_{ij})	Measures the distance between trading partners.	-	www.distancecalculator.net
$DGDPPC_{ijt}$	The per capita GDP differential between two countries.	+/ -	World Bank, WDI database
TR_{jt}	Denotes the tariff rate of importing countries at time t.	-	World Bank data base
Contig	*Contig*is a dummy variable signifying whether country i and j share a common border or not.	+	
Comlang_off	*Comlang_off* is a dummy variable that signifies whether country i and j share a common language or not.	+	
Landlocked	*Landlocked* is another dummy showing whether the importing country j is landlocked or not.	-	

4. Model Estimation and findings

Panel Unit Root Test

Before estimating a regression, this study has checked for stationarity using panel unit root test. If the variables are non-stationary the regression results may be spurious. In effect, it is very important to test the existence of unit root and examine the order of integration for each variable beforehand, so as to avoid the spurious correlation problems, if any.

Table 2 Test Result for Panel Unit Root

Ho: panel data has unit root(not stationary)		Ha: panel data has not unit root (stationary)	
Variables	**Summary Statistic**	**p-values**	**Test for unit root in level**
ln_Export	-72.1493	0.000	I(0)
ln_GDPi	-51.4163	0.000	I(0)
ln_GDPj	-3.4963	0.000	I(0)
ln_DGDPPC	-3. 894	0.000	I(0)
ln_TR	-2.531	0.000	I(0)

We have employed the Levin- Lin- chu (2002) panel unit root test to examine whether the series contains a unit root or not. As the output above indicates, all variables are found to be stationary in levels.

Choosing between Fixed and Random Effect Model

In order to choose between fixed and random effect models, Hausman (1978) test has been used in this study. This test answers whether there is a significant correlation between the unobserved country-specific random effects and the regressors.

Table 3: Test for Choosing between Fixed and Random Effect Model.

Test summary	
Chi-sq statistic (4)	31.06
Prob.	0.0000
Appropriate model	Fixed effect model

The null hypothesis states that random effect model is appropriate and the alternative hypothesis states fixed effect model is appropriate. From the above output result, we reject the null hypotheses since the probability is less than 0.05 and conclude that fixed effect model is the appropriate model.

Diagnostic Tests

i) Test for Cross Sectional Dependence

We test a cross sectional dependence to assess whether the residuals are correlated across entities or not. Cross sectional dependence can lead to bias in tests results (also called contemporaneous correlation). The null hypothesis is that residuals are not correlated. In this study we used the Pesaran CD test (2004) to test whether there is cross sectional dependence or not.

Pesaran's test of cross sectional independence = 0.600, Pr = 0.5483

Average absolute value of the off-diagonal elements = 0.339

The probability for this test is 0.5483 which is greater than 5 percent which means we cannot reject the null hypotheses. Therefore, we conclude that there is no cross sectional dependence.

ii) Test for Multicollinearity

In order to identify the correlation between explanatory variables and to avoid the double effect of independent variable from the model, multicollinearity test has been conducted in this study.

Table 4: Correlation Matrix

e(V)	ln_GDPi	ln_GDPj	ln_Dis	ln_DG D~C	ln_TR	Contig	Comlan~f	Land lock	_cons
ln_GDPi	1.0000								
ln_GDPj	-0.4826	1.0000							
ln_Dis	0.4976	-0.8583	1.0000						
ln_DGDPPC	0.1832	-0.0979	0.1694	1.0000					
ln_TR	0.4896	-0.0979	0.4115	0.5530	1.0000				
Contig	-0.2031	0.3340	-0.0741	0.3684	-0.0797	1.0000			
Comlang_off	-0.0805	0.1334	-0.1807	0.3932	0.0267	0.2999	1.0000		
Landlock	-0.2713	0.5850	-0.5375	-0.2641	-0.1659	0.1147	0.1106	1.0000	
_cons	-0.5960	-0.1821	-0.1790	-0.4643	-0.5988	-0.3506	-0.0853	-0.0309	1.0000

As indicated on the correlation matrix almost all correlations that have occurred among explanatory variables are surprisingly weak correlations; this indicates that the non-existence of multicollinearity problem in our data. According to Hailer et al. (2006) correlation coefficient below 0.9 may not cause serious multicollinearity problem. He suggested that multicollinearity problem should be corrected when the correlation extent is above 0.9.

iii)Test for Heteroscedasticity

The other test which is conducted in this study is heteroscedasticity test. In this study we have tested for heteroskedaticicity using Breuch pagan test. The null hypothesis is homoskedasticity (or constant variance of error) and the alternative hypothesis is that there is heteroskedasticiy.

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity

Ho: Constant variance

Variables: fitted values of ln_export

chi2 (1) = 0.07

Prob.>chi2 = 0.7979

According to the above STATA output for heteroskedasticity test, we fail to reject the null hypothesis of homoskedasticity such that the assumption of homoskedasticity was fulfilled.

iv) Test for Autocorrelation

The autocorrelation test is the other important diagnostic test which was performed in this study. It is expressed as cov(εi,εj) = 0; the covariance between the error terms is zero. In other words, it is assumed that the errors are uncorrelated with one another. If the errors are correlated with one another, it would be said that they are "autocorrelated". In this study Wooldridge test for autocorrelation is used.

Wooldridge test for autocorrelation in panel data

H0: no first-order autocorrelation

F (1, 9) = 3.861

Prob.> F = 0.0810

From the Wooldridge test, the F statistic is greater than 0.05. Therefore, we cannot reject the null hypotheses of there is no autocorrelation and therefore, we can conclude that the residuals are not serially correlated.

Estimation Results and Interpretation

The econometric model of gravity equation contains many time invariant variables. For instance, in our model some important variables such as distance, common border, common languages and land locked which manifests no within variation in the data sets. Consequently, using the traditional fixed effects method of estimation would result in omitting those variables during the regression. To solve this problem, we have used a dummy variable regression with importers and exporter effect model as a possible appropriate estimator. This procedure is based on the notion that the fixed effects of partner's countries could be proxied by a bunch of country specific dummy variables. With this assumption, we have estimated the gravity equation using PPML.

To compare the correct specification of fixed effects and pooled models, we performed the traditional RESET (Ramsey Regression Equation Specification Error Test) test. After we predicted the fitted values for each specification, we included a higher order of fitted values into the regression. If the model is correctly specified, the fitted values term would be confirmed as insignificant. We test this hypothesis by X^2 .

Pooled Model Estimation using PPML

Once the pre estimation tests are accomplished the next step is estimation the model. In this study we first estimate the pooled model using PPML method as below.

Table 5 Regression Result of Pooled Model Using PPML

Number of parameters: 9

Number of observations: 60

Number of observations dropped: 0

Pseudo log-likelihood: -558660.61

R-squared: .78607811

(Std. Err. adjusted for 10 clusters in D is)

Variables	Coefficients	S.E	Z –test	Prob.
ln_GDPi	.1358125	.2091069	0.46	0.647
ln_GDPj	1.582369*	.3270501	4.69	0.000
ln_Disij	-3.005792*	.4243438	-4.65	0.000
ln_DGDPPCij	.2938851	.2967988	1.25	0.210
ln_TRj	.2858186	.1687998	0.66	0.511
Contig	.2858186**	.7584001	2.21	0.027
Landlocked	1.851038*	.457262	4.24	0.000
Comlang_off	-.5198697	.0565518	-1.52	0.129
Cons	-14.06297	10.04258	-1.40	0.161

The *, ** Indicates one and five per cent statistical significant respectively

As we can see in table 5 above the coefficient of importers GDP have a positive sign and is significant at 1 per cent level. The interpretation goes as: a 1 percent increase in the importers GDP increases export of Ethiopia by 1.5 per cent. On the other hand, GDP of Ethiopia is insignificant in explaining its export.

The Distance coefficient on the other hand is negative and significant at 1 percent level. Thus, a 1 percent increase in distance between Ethiopia and its trading partner decreases export by about 3 percent. The coefficient on common border is also statistically significant and affects export of Ethiopia positively. The effects of GDPPC difference, tariff rate and common language are found to be insignificant in explaining exports of Ethiopia. However, the variable Landlocked is able to impact Ethiopia's exports, as it has a statistically significant positive impact. This means that Ethiopia trades more with countries that are landlocked than coastal.

RESET Test

The RESET test tells us that the model is correctly specified. Prob.> chi2 = 0.52 which implies that adding other variables to our model is irrelevant.

chi2 (1) = 0.41

Prob.> chi2 = 0.5238

Adding importers and exporter fixed effect into our model results to an outcome as shown in Table 6 below. The estimation results are better than the PPML model as all the coefficients of the variables except tariff rate, GDP of Ethiopia and common border have become significant at 1 per cent level.

Furthermore, the coefficient of Common official language becomes positive and significant at 1 per cent level as per our expectation.

Exporter and Importers Fixed Effect Model Estimation using PPML

Table 6: Regression Result of Exporter and Importers Fixed Effect Model Using PPML

Number of parameters: 14
Number of observations: 60
Number of observations dropped: 0
Pseudo log-likelihood: -179579.2
R-squared: .92051004
(Std. Err. adjusted for 10 clusters in D is)

Variable	Coefficients	S.E	Z –test	Prob.
ln_GDPi	.3186194	.2091069	1.52	0.128
ln_GDPj	2.036159*	.3270501	6.23	0.000
ln_Disij	-2.00359*	.4243438	-4.72	0.000
ln_DGDPPCij	-1.632555*	.2967988	-5.50	0.000
ln_TRj	.3127604	.1687998	1.85	0.064
Contig	-1.36363	.7584001	-1.80	0.072
Landlocked	4.607744*	.457262	10.08	0.000
Comlang_off	.1996714*	.0565518	3.53	0.000
Cons	-20.42435	4.191719	-4.87	0.000

The * and ** Indicates one and five per cent statistical significant respectively

RESET Test
chi2 (1) = 1.25
Prob.> chi2 = 0.2640

The RESET test for the PPML with importers and exporters fixed effect shows that the model is correctly specified. Therefore, including additional variables to the model is not relevant.

5. Conclusion, Policy Implication And Suggestions

Conclusion

Trade costs play a key role in determining the level of trade that occurs between countries. In spite of its importance, less attention has been given to its impact on export in the literature with regard to Ethiopian context. It is in this context that this study aimed at assessing the impact of trade costs on export of Ethiopia. Using panel data for the period of 2010 – 2015, this paper has analysed the impact of trade costs on export performance of Ethiopia. The paper assessed the following research questions; what determines export of Ethiopia? And do trade costs have any impact on the export performance of Ethiopia? Based on the Hausman test, fixed effect model is found to be the appropriate model. Accordingly, this study has provided estimation of two types of panel data models: pooled model and importer and exporter fixed effects model using the Poisson pseudo maximum likelihood (PPML) estimation technique.

The empirical result indicates that GDP of importing countries is statistically significant and affects exports of Ethiopia positively whereas, GDP of Ethiopia is found to be statistically insignificant in explaining its export. The Distance variable affects export of Ethiopia negatively in both models. Similarly, Landlockedness is found to be statistically significant in both models apart from its unexpected sign. On the other hand, Tariff rate have found to be statistically insignificant in explaining export of Ethiopia. The other variables; common border, GDPPC difference among Ethiopia and its trading partners and common languages have inconsistence outcomes in terms of sign and significance effects.

Policy Implications

The analysis provided good evidence that trade costs have significant influence on export performance of Ethiopia. The distance component of trade costs has an absolute significant negative effect on export of Ethiopia. This could be due to the fact that most of the trading partners of Ethiopia are countries from Europe and Asia which are relatively distant. Therefore, it is better for Ethiopia to trade with its neighbouring countries by diversifying its exported goods so as to reduce the negative effect of transportations and other related hindrances.

Besides, the country should participate in regional linkages to shift from landlocked to land-linked economy along with its neighbouring countries in order to ship goods more smoothly.

Furthermore, it is important to focus on the most significant trade facilitation measures that help reduce trade costs such as making trade information available, harmonization and simplification of documents. Improving infrastructures that are necessary to ship products abroad might also reduce trade costs.

Finally, trade policies should be transparent in their regulations and procedures, and consistent, predictable and non-discriminatory in their applications. Most of all, good governance and impartiality helps reduce trade costs to a greater extent.

Suggestion

The landlocked variable becomes statistically significant in explaining export of Ethiopia in both cases with surprisingly unexpected outcome. This parameter has positive sign that means Ethiopia trades more with countries that are landlocked than coastal countries like Switzerland. This might be due to the fact that the landlocked country included in our data have very low tariff compared to other countries included in our sample. Therefore, even though being landlocked increases the cost of trade in the form of transportation cost, the low tariff rate may compensate this cost and still invites Ethiopia to send its products to this country. Nevertheless, this is the area where further research is required.

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Beer Multinationals Enhance Agricultural Commercialization in Africa: Empirical Evidence from Ethiopia

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Abstract

Foreign investment can facilitate modernization of domestic food chains in emerging economies through increased use of vertical coordination. The paper sheds lights on how beer multinational investments in African food chains affect smallholder market participation and value chain development. In particular, we examine the impact of contract farming arrangements among malt barley producers in Ethiopia. On the basis of cross-sectional survey data, we employ OLS regression and propensity score matching techniques to analyze the impact of contracting on a number of performance indicators. We find that contracting has positive impact on malt barley production, intensification, commercialization, quality improvement and farm-gate prices, ultimately resulting in increased net income and spillover into the productivity of other crops.

Key words: Beer multinationals; inclusive transformation; food systems; contract farming arrangement; Ethiopia; Africa

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1. Introduction

Smallholder agriculture remains important for economic development in sub-Saharan Africa (SSA) and produces about 80% of the food consumed in the region (FAO, 2013b). In recent years, food systems in this region witnessed major changes and rapid structural transformation. The increase in urbanization, rising incomes, industrialization, a burgeoning middle class, and globalization have led to the emergence of modern supply chains, including modern food retail (Maertens and Swinnen, 2012; Minten et al., 2016; Reardon et al., 2009; Verhofstadt and Maertens, 2013). These developments have resulted in changes in the food production process, increasing vertical coordination, and dominance of food processors (Swinnen and Maertens, 2007).

Increased vertical coordination and modernization in food chains present market opportunities for smallholders (Dries et al., 2009; McCullough et al., 2008; Verhofstadt and Maertens, 2013). However, smallholder access to modern chains is limited due to several constraints. Smallholders are unable to comply with the stringent standards (safety, quality and reliability) and technical requirements. They often are constrained by the lack of access to improved technology, low access to resources, low bargaining power, and high transaction costs (Poulton et al., 2010).

Contract farming has been presented as a possible solution to raising productivity and engaging smallholders in modern chains (FAO, 2013a). For instance, supermarkets and processors use private quality standards and modern procurement systems which favor increased use of vertical coordination through contracting. Many scholars studied the increasing prevalence of contract farming arrangements (CFAs) in the changing food systems (Bellemare, 2015; Bijman, 2008; Minot and Sawyer, 2016; Oya, 2012; Wang et al., 2014b). Most of these studies claim that CFAs promote smallholder linkages to high-value markets and increase farm income. Yet, there is also evidence that suggests that participating in a CFA has a negative association with farm income (Michelson et al., 2012; Narayanan, 2014; Wendimu et al., 2016).

Most studies have focused on supply chains of high-value products (e.g. vegetables), traditional cash crops (e.g. coffee, tea, cocoa) and industrial commodities (e.g. cotton, palm oil, and rubber) destined to international markets (Minot and Sawyer, 2016; Otsuka et al., 2016). The empirical evidence on the impact of CFAs in domestic food chains is sparse, with the exception of Maertens and Vande Velde (2017). In this paper, we seek to fill the knowledge gap on domestic food chains by studying the implications of CFAs for the economic performance of smallholders in the malt barley sector in Ethiopia. Understanding the role of CFAs in the malt barley sector in Ethiopia is particularly relevant because the country aims at expansion of the domestic malt barley production to cut the import bill for malt barley and to increase smallholder commercialization. The paper also discusses how foreign investment in developing countries - in Africa in particular - affects modernization of domestic food chains.

The main objective of this paper is to analyze the impact of CFAs on production, commercialization, and farmer income, within a staple food chain. Specifically, we seek to address: (i) What factors determine farmers' participation in malt barley CFAs? (ii) How do CFAs improve production, crop yield, product quality, and commercialization and prices in malt barley chains? and (iii) How do CFAs improve malt barley producers farm income in the chain? The study is based on cross-sectional survey data and uses parametric (OLS) and non-parametric (propensity score matching) methods to analyze the impact of CFAs.

The rest of the paper is organized as follows. The next section provides a short review of the literature on CFAs in emerging economies. In section 3 we present a brief account of the Ethiopian malt barley chain and describe the process of vertical coordination. Section 4 describes the methodology. Section 5 presents the empirical results. Section 6 discusses and puts the results into perspective. Section 7 concludes.

2. A review of the literature

Various empirical studies investigated the prevalence and effectiveness of CFAs in food chains of developing and emerging economies. We present a short review of these studies using the following perspectives: (a) the prevalence in the use of CFAs, (b) which farmers participate in CFAs; (c) the welfare impacts of CFAs; and (d) the organization of the contract and the role of intermediaries. Applying New Institutional Economics, it is often argued that a CFA can reduce transaction costs and solve market failure problems (Kirsten et al., 2009).

Contract farming can be defined as "agricultural production carried out according to an agreement between farmers and a buyer which places conditions on the production and marketing of the commodity" (Minot, 1986 pp.2). Agreements are made in advance and often on the volume, quality, time of delivery, use of inputs, and the price that will be offered. The recent development in food systems of emerging economies has witnessed a rapid expansion and use of contract farming (Jia and Bijman, 2014). The expansion of high-value products, improvement in food processing, consolidation in retail markets, and increased demand for quality and food safety cause the growth in CFAs (Minot and Sawyer, 2016; Otsuka et al., 2016).

In studying the implications of CFAs, it is crucial to understand which factors determine smallholders' decision to enter in a CFA. Participation in a CFA depends on a number of demographic and socio-economic factors. For instance, demographic factor such as age, gender and education, and economic factors including family labor, farm size, farmer experience and asset ownership are often used in empirical studies. Several studies conclude that the farmer's level of education has a negative effect on the likelihood of participation in a CFA (Maertens and Vande Velde, 2017; Miyata et al., 2009; Simmons et al., 2005; Wainaina et al., 2014), whereas others find a positive effect (Mishra et al., 2016). There are also studies that show that education does not determine CFA participation (Bellemare, 2012; Girma and Gardebroek, 2015). Many studies conclude that the farmer's age has a negative effect on participation in a CFA (Bellemare, 2012; Maertens and Vande Velde, 2017; Simmons et al., 2005), implying that younger farmers are more likely to join a CFA.

Several empirical studies have found that farm size positively determines farmers' participation in CFAs (Bellemare, 2012; Mishra et al., 2016), whereas other studies conclude that farm size is not an important determinant of CFA participation (Maertens and Vande Velde, 2017; Miyata et al., 2009; Wainaina et al., 2014). Thus, the empirical evidence on the effect of farm size is conclusive. Access to public institutions such as extension services (Girma and Gardebroek, 2015) and credit (Ma and Abdulai, 2016; Simmons et al., 2005) determines farmers' likelihood of participation in CFAs. Ownership of a mobile phone has also been found to affect CFA participation (Kumar et al., 2016; Mishra et al., 2016). Finally, distance to market has a positive and significant effect on CFA participation (Kumar et al., 2016; Maertens and Vande Velde, 2017), but Wainaina et al. (2014) found a negative effect.

There are numerous empirical studies on the impact of CFAs (Andersson et al., 2015; Barrett et al., 2012; Bellemare, 2012; Bolwig et al., 2009; Briones, 2015; Girma and Gardebroek, 2015; Mishra et al., 2016; Simmons et al., 2005; Wang et al., 2014a). These studies show that participating in a CFA improves the income of farmers who have chosen to participate. There is also empirical evidence on effects other than income. For example, Maertens et al. (2012) show the implications of CFAs for gender, Dedehouanou et al. (2013) show the impact of CFAs on subjective well-being in Senegal, and Minten et al. (2009) document implications of CFAs for food security and technology adoption in Madagascar. Yet, most of these studies focused on high-value products, industrial crops, traditional cash crops, and seeds production. With the exception of Maertens and Vande Velde (2017), there are no rigorous empirical studies on the impact of CFAs in grain and staple food chains. Maertens and Vande Velde (2017) have studied the impact of CFAs in the Beninese rice sector, and document positive effects of CFAs on intensification of rice production, commercialization of rice, and household income.

A recent discussion in CFA literature is the role of intermediaries such as producer organizations (POs) and NGOs (Briones, 2015; Roy and Thorat, 2008; Royer et al., 2017). POs can reduce transaction costs of contracting with a large number of dispersedly-located small farms. POs can facilitate the supply of inputs to contracted farmers and improve their bargaining power as well. Contracts are often between a processor and a PO; a farmer must first be a member of the PO before she can enter the CFA. In such arrangements, POs ensure the quantity, quality and timely delivery of products. However, some authors have argued that POs become selective when achieving this business objective, and resource-poor farmers may be left out of membership (Bernard and Spielman, 2009; Bijman et al., 2016).

Several empirical studies on export-oriented chains found a positive effect of CFAs on the income and productivity of the contracted farmer. Minot and Sawyer (2016) conclude from their review of the literature that income effects of CFAs ranges between 25 and 75%. However, the literature falls short when it comes to CFAs in domestic grain and staple food chains. Our study seeks to fill this gap by analyzing the economic impact of CFAs in the malt barley sector in Ethiopia.

Our study is particularly relevant with respect to the literature on CFAs in Ethiopia, where the development and impact of CFAs are a mixed story. First, CFAs are in the inception stage in Ethiopia. There are only a few recent studies (Abebe et al., 2013; Girma and Gardebroek, 2015), which show that CFAs improve farmer income in export-oriented chains. Second, there is also recent evidence against CFAs, as Wendimu et al. (2016) show that participation in CFAs significantly reduces farm income and asset stocks of farmers in the Ethiopian sugarcane industry.

We hypothesize that CFAs assure markets for smallholder barley producers and potentially lead to improvement in farm income and productivity. We expect that farmers with contracts earn a higher income than farmers without contracts, because the buyer (brewery) introduces improved technology (e.g. improved seeds), provides key inputs and technical assistance, and facilitates logistics and coordination in the supply chain. In return, buyers demand higher quality and they are willing to pay a higher price.

3. Beer Multinationals and CFAs in Malt Barley Industry-Ethiopia

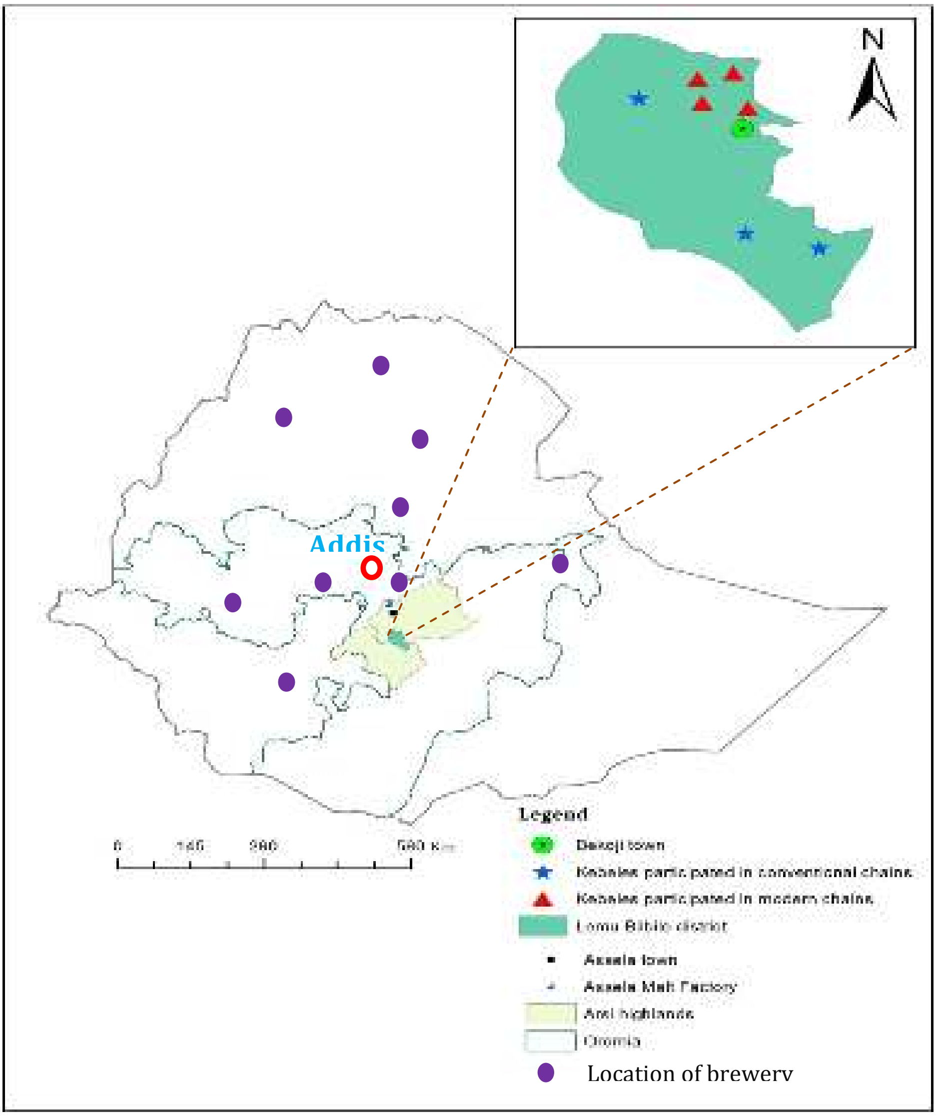
Ethiopia is the largest producer and consumer of barley in the African continent (Rashid et al., 2015). Barley is a smallholder crop and currently more than 4 million smallholders produce barley and derive their livelihood from the barley value chain (CSA, 2015). Nationally, two types of barley are grown: food barley for home consumption and malt barley for brewing. Driven by rising income and increased urbanization, per capita beer consumption in Ethiopia has grown rapidly at an annual rate of 20% (ATA, 2015). This promising beer market has attracted beer multinationals, including Heineken, Diageo, and Bavaria. These breweries invest both in beer brewing and in local sourcing of malt barley. Companies used CFAs to organize their supply chains and source malt barley.

The appearance of foreign breweries in the malt barley chain has increased the annual demand for malt barley, on average at a rate of 20% (ATA, 2015). This has affected the malt barley sector by generating new market opportunities for smallholders, reducing price volatility, ensuring reliable supply chains, and cutting the import bill thus saving foreign currency for the government. Heineken, Diageo, and Assela Malt factory (AMF) are engaged in the sourcing of malt barley from smallholders in the Arsi highlands, Ethiopia (Figure 1).

We have identified two types of malt barley supply chains: the conventional and the modern chain. The co-existence of the conventional and modern chains has led to important changes in barley production and marketing. The conventional chain starts from smallholders selling malt barley to local traders and retailers. Transactions are governed by market prices negotiated at the spot. AMF is the dominant aggregator of malt barley from local traders. The modern chain, however, is driven by breweries and characterized by vertical coordination. In this chain, a strict requirement for quality and quantity is arranged together with price premiums. Written contracts are used to safeguard these agreements. The modern chain is characterized by few intermediaries, supply chain management (control of quality and quantity), and technology transfer.

The foreign companies have organized local sourcing through public-private-partnerships (PPPs) consisting of four partners: brewery, non-government organization (NGO), PO, and government. For contracting with smallholders, foreign breweries have subcontracted NGOs (e.g., Technoserve and Hundee) to select and organize farmers, select POs, facilitate input supply and provide technical assistance. POs play an intermediary role through distributing modern inputs, arranging logistics, and aggregating malt barley. As part of the contractual agreement, breweries provide improved seeds, fertilizers and pesticides on pre-financing basis to smallholders. In return farmers deliver malt barley that fulfils the quality requirements. The companies pay quality-based price premiums.

Figure 1: Location of brewery plants in Ethiopia and research area



4. Methodology

4.1 Data collection

Data were collected from the main barley-belt of Ethiopia, the Arsi highlands (Figure 1). The Arsi highlands consist of many districts that are known for production of barley. Among these, the district of our study, Lemu Bilbilo, is in the top three. We purposively selected Lemu Bilbilo district for three reasons: it has a high production of malt barley; it has seen the appearance of foreign breweries in the local sourcing of malt barley; and it already has multiple cases of CFAs between breweries and farmers.

To investigate the economic impacts of CFAs in the malt barley sector, we used original survey data. We conducted the survey on a total of 262 farm households in different villages of Lemu Bilbilo district. The survey was carried out from April to May 2015, but the field study started in January. A multi-stage sampling procedure was used for the selection of a targeted sample. First, four POs with contract arrangements were selected from four different villages in the district (Figure 1). From this group, we randomly selected a total of 110 households. Second, a total of 152 non-contract farmers were randomly selected from three other villages in the district. These farmers could incidentally be PO-members without contract arrangements. Lists of contract and non-contract farmers were obtained from the POs and village chair persons respectively. However, in the final analysis only 258 households were used, as four questionnaires from the non-contract group were incomplete.

A structured questionnaire was prepared and carefully administered to gather household-level primary data. Well-trained enumerators were used to collect the data through face-to-face interview. Data were collected on household demographic characteristics, sources of livelihoods, conditions of food security, off-farm employment, asset ownership, types and quantities of crops produced, sale of crops and output prices, household access to credit, markets and extension services, membership in irrigation associations and POs. Moreover, the data collected included information on types and volume of inputs used in malt barley production, inputs supply arrangements, costs of inputs (hired labor, fertilizers, pesticides and improved seeds), quality improvement practices, quality grading and post-harvest issues, malt barley prices, market outlets, and overall production and marketing challenges in the value chain.

4.2 Econometric approach

To examine the economic impact of participation in breweries CFAs, we start with a comparative analysis of contract and non-contract farmers using a series of t-tests. Then we use different techniques to measure the average impact of CFA participation. First, we apply ordinary least squares (OLS) regression, which is used in related studies (Girma and Gardebroek, 2015; Maertens and Vande Velde, 2017; Wang et al., 2014a). We estimate regression models of the following type:

$$Y_i = \alpha_i + \beta P_i + \gamma X_i + \varepsilon_i \qquad (1)$$

Where Yi measures the outcome of household i, Xi a vector of control variables, Pi is the dummy variable for participation in CFA, and ε is the error term. α, β and γ are parameters to be estimated. We use the following nine outcome indicators and estimate the model separately for each indicator: 1) total malt barley production, measured in quintal or 100kg; 2) malt barley yield, measured in quintal per hectare; 3) malt barley selling price, measured in Ethiopian birr (ETB) per quintal; 4) cost of inputs for malt barley production, measured in ETB per hectare; 5) share of malt barley sold, measured in percentage (i.e., malt barley sold / malt barley produced ratio); 6) gross income from malt barley production, measured in ETB per hectare (calculated as malt barley produced X malt barley price); 7) net income from malt barley production, measured in ETB per hectare (calculated as the difference between gross income and malt barley-related variable costs); 8) product quality; measured in a scale (i.e., farmers stated quality on a 3-point Likert scale; ranging from 1 = low and 3= high); and 9) gross income from other crops, measured in ETB per hectare (calculated as volume other crops produced X selling prices). These are all continuous variables, and hence linear regression and OLS are used (Maertens and Vande Velde (2017).

Our main variable of interest (Pi) is a dichotomous variable for participation in a brewery CFA. Participation in a CFA is likely not randomly distributed among malt barley farmers; hence we include a large set of observable farm and farmer characteristics, Xi. The vector Xi includes various covariates selected on the basis of theory and previous studies (see section 2). We include the following covariates: age and education of the household head, family available labor, number of people in the household, land and livestock ownership, malt barley cultivated area, farming experience, proportion of off-farm income (as proxy for off-farm employment), distance to markets, mobile phone ownership, credit received from microfinance, and extension contact. We provide a detailed description of these variables in Table 1.

Second, we apply propensity score matching (PSM) to control potential selection bias and estimate an average treatment effect of CFA participation (Rosenbaum and Rubin, 1983). PSM reduces the selection bias through employing counterfactuals that control all other factors but treatment. The essential mechanism of PSM is to find comparison groups (non-contracted farmers) that are similar to the treated in all relevant pre-treatment characteristics. First, a logit model is estimated with the binary treatment variable (CFA status of the farmer) as selection variable, conditional on the baseline characteristics of both the treatment (contracted) and the comparison group (non-contracted). From this, propensity scores, i.e., the conditional probability of assignment to a treatment given their baseline characteristics, are predicted. In the logit model, we used the same covariates that are employed in the OLS models. Second, two balanced groups are created based on their estimated propensity scores for final comparison.

Following Caliendo and Kopeinig (2008), let Wi be a binary treatment variable that equals one if a farmer participates in a CFA, and zero otherwise. The potential outcomes of the CFA are represented by (Wi) for each household i. The average treatment effect on the treated (ATT) is expressed as:

$$\tau ATT = \mathrm{E}\,(\tau \mid \mathrm{W} = 1) = \mathrm{E}[\mathrm{Y}(1) \mid \mathrm{W} = 1] - \mathrm{E}(\mathrm{Y}(0) \mid \mathrm{W} = 1] \quad (\mathbf{2})$$

Where E[Y (1) |W = 1] is the expected outcome value for contracted farmers; E[Y (0) |W = 1] is the expected outcome value for contracted farmers if they had not been contracted. E[Y (0) |W = 1] is the counterfactual and not-observed, as we need a proper substitute to estimate ATT. In this case, PSM helps to construct the counterfactual from the non-contracted farmers. In doing so we invoke the conditional independence assumption (CIA) and the common support assumption to control the selection bias problem (Caliendo and Kopeinig, 2008). The non-confoundedness assumption (i.e., CIA) ensures that selection into treatment is only based on observable covariates, which is a strong assumption. We address this assumption using the bounding approach (Rosenbaum, 2002). The common support condition ensures that farmers with similar observable covariates have a positive probability of being both participant and non-participant (Caliendo and Kopeinig, 2008). We check this assumption using balancing properties and a density distribution histogram. If CIA holds and there is overlap between contract and non-contract groups, the PSM estimator forτ ATT is given as:

$$\tau_{ATT}^{PSM} = E_{p(x)|W=1}\{\mathrm{E}[\mathrm{Y}(1) \mid \mathrm{W}=1, \mathrm{p}(\mathrm{x})] - \mathrm{E}[\mathrm{Y}(0) \mid \mathrm{W}=0, \mathrm{p}(\mathrm{x})]\} \quad \mathbf{(3)}$$

Where p(x) is the predicted propensity score from the logit model. We used different methods to match similar contract and non-contract farmers. We apply nearest neighbor matching (NNM), radius matching (RM), and kernel-based matching (KBM) as the main ATT estimation methods (Becker and Ichino, 2002; Caliendo and Kopeinig, 2008). In the NNM, each treated farmer is matched with a comparable farmer that has the closest propensity score. But in case of KBM, a treated farmer is matched with a weighted average of all controls, using weights that are inversely proportional to the distance between the propensity scores of treated and control groups. This indicates that KBM uses more information. In the RM, information is used only from the nearest neighbor within the caliper distance.

The PSM method is usually built on a strong assumption that observable characteristics determine selection to treatment and control groups (i.e. CIA). Thus, matching estimators are often prone to selection bias. We used the inverse-probability-weighted-regression-adjustment estimator (IPWRA) to further check the robustness of treatment effect estimates.

IPWRA provides efficient estimates by allowing the modeling of both the outcome and the treatment equations (StataCorp, 2017). This allows us to control for selection bias at both the treatment and outcome stages. Thus, the IPWRA estimator has the double-robust property, which means that only one of the two models is correctly specified to consistently estimate the impact (Bang and Robins, 2005; StataCorp, 2017). One could say that regression adjustment (RA) concentrates on outcomes and inverse probability weight (IPW) focuses more on treatment in calculating treatment effects. IPWRA estimators use probability weights to obtain outcome regression parameters and the adjusted outcome regression parameters are used to compute averages of treatment-level predicted outcomes. The IPWRA method is recently used by Kebebe (2017) in the impact evaluation of dairy technology adoption in Ethiopia.

5. Empirical Results

5.1 Comparison of contract and non-contract farms

Farm characteristics

In Table 1, we present summary statistics for contract and non-contract farmers. Contract farmers are, on average, more educated than non-contract farmers. Contract and non-contract farmers are also significantly different in access to a mobile phone, access to extension services, access to savings, access to credit, and PO membership. In addition, the mean distance to the market was lower among the contract farmers. All contract farmers are member of a PO; which reflects the fact that organizing themselves in groups is a precondition for engaging in the CFA.

Economics of malt barley production

Smallholders use various inputs to produce malt barley. The main inputs include fertilizers, pesticides and improved seeds. Farmers have access to improved seeds from buyers (i.e., breweries) and other sources. Another input category is labor, whereby farmers mostly use family labor and some additional hired labor during the peak farming season. Table 1 presents the mean comparison of the various outcome indicators. On average, contract farmers produce more malt barley (17qt) than the non-contract farmers (12qt). The average yield is also 15% higher than non-contract farmers. Contract farmers receive a 22% higher average price and commercialize on average 21% point more of their malt barley production than non-contract farmers. In addition, contract farmers have a 20% higher average cost of production per ha than non-contract farmers. Finally, farmers participating in CFAs obtain on average 42% and 41% higher malt barley gross income and net incomes per ha respectively than those who do not participate.

Table 1: Characteristics of contract and non-contract malt barley farmers

Variables	Description	Full sample	Contract	Non-contract	Diff.
Socioeconomic characteristics					
Age	Household head (HH) age in years	44.32	44.55	44.16	0.39
Family size	Number of people in the household	6.35	6.21	6.45	-0.24
Family active labor	Family members 15-65 years age	3.87	3.81	3.91	-0.1
Education	HH education level in years	5.14	5.96	4.54	1.42***
Off-farm income	HH share of off-farm income (%)	4.51	3.18	5.51	-2.32*
Innovativeness	HH innovativeness in farm business†	3.30	4.06	2.73	1.33***
Entrepreneurship	HH entrepreneurial skills	3.13	3.77	2.66	1.10***
Mobile ownership	HH mobile phone ownership(0-1)	0.70	0.81	0.62	0.19***
Malt barley cultivation					
Farm size	HH landholding size in hectare	2.75	2.70	2.79	-0.09
Malt barley area	MB cultivated area in hectare	0.74	0.79	0.69	0.10
Experience	MB farming experience in years	20.29	20.69	20.0	0.69
Total livestock	Total livestock ownership in TLU‡	11.09	14.45	8.59	5.85

Access to public institutions					
Savings	HH saving in last 12 months(0-1)	0.59	0.74	0.48	0.25***
Extension contact	HH access to public extension service(0-1)	0.53	0.67	0.42	0.24***
Access to credit	HH credit received from Microfinance(0-1)	0.14	0.20	0.09	0.10***
Distance to market	Distance to market(km) (1way walk)	7.93	5.59	9.67	-4.08***
Access to collective institution					
Iddir membership	HH membership to Iddir in year	19.37	19.81	19.04	0.77
PO membership	HH membership to POs(0-1)	0.72	1.00	0.52	0.47***
Debo membership	HH membership to Debo in year	20.09	20.62	19.66	0.96
Outcome indicators					
Total production	HH malt barley production in quintal	14.17	17.10	11.99	5.10***
Yield	Malt barley yield (qt/ha)	20.03	21.67	18.80	2.87***
Price	Malt barley selling price (ETB/qt)	906	1013	829	184***
Share sold	Malt barley sold to produced ratio	0.59	0.71	0.51	0.21***
Cost	Cost of MB production per ha (ETB/ha)	4442	4803	3994	809***
Product quality	HH stated malt barley quality (scale1-3)	2.39	2.80	2.08	0.71***
Goss income	Malt barley gross income per ha (ETB/ha)	18346	22177	15576	6601***
Net income	Malt barley net income per ha (ETB/ha)	13604	15532	10990	4542***
Other crop income	Income from other food crops sale (ETB/ha)	9952	13653	7202	6452***
N		258	110	148	258

Source: Field survey, 2015; *** P < 0.01, ** P < 0.05, * P < 0.10; note: † = Likert scale variables with 5 scales; ‡ = tropical livestock unit to describe livestock numbers of various species as a single unit.

5.2 Factors determining CFA participation

A farmer's decision to participate in a CFA could be conditioned by demographic variables, socio-economic characteristics, and access to assets. We used a logit model to estimate the parameters. Specific variables were selected based on theory and previous empirical research. From the selected covariates six were significant in influencing a farmer's decision to enter a CFA. These are education level, off-farm income, distance to markets, having a mobile telephone, access to public extension service, and receiving microfinance credit (Table 2). All these covariates positively affect the probability of farmers' participation in CFAs except off-farm income and distance to markets.

Table 2: Determinants of farmers' decision to participate in CFA

CFA Participation	**Coefficient**	**Std. Error**	**z**	**P > |z|**
Age	-0.006	0.036	-0.18	0.855
Family size	-0.004	0.116	-0.04	0.968
Family active labor	-0.086	0.182	-0.48	0.634
Education	0.144	0.058	2.48	0.013**
Farm size	0.008	0.110	0.07	0.942
Malt barley area	0.331	0.313	1.06	0.290
Farming experience	0.051	0.033	1.51	0.130
Total livestock	0.006	0.013	0.47	0.638
Share of off-farm income	-0.041	0.019	-2.16	0.031**
Distance to markets	-0.392	0.067	-5.82	0.000***
Mobile ownership	1.287	0.441	2.91	0.004***
Credit received from microfinance	1.283	0.499	2.57	0.010***
Extension contact	1.179	0.347	3.40	0.001***
_cons	-0.589	1.352	-0.44	0.663
Summary statistics				
Pseudo R2 = 0.359	Percentage of correct prediction = 77.95%			
Model $\chi 2$ = 124.65***	Number of observations = 254			
Log likelihood = -110.883				

Source: Field survey, 2015; *** P < 0.01, ** P < 0.05, * P < 0.10

The results show that education of the household head has a positive and significant effect on participation in a CFA. Education facilitates managerial capacity, farmers' ability to make informed decisions and to comply with quality requirements. Having a mobile phone increases farmers' likelihood to participate in a CFA by enhancing access to information and effective communication. Farmers having received credit from rural microfinance institutes are more likely to participate in a CFA. Results further show that access to government extension service is positively correlated to CFA participation, while off-farm income is negatively correlated. Our results also show that distance to markets negatively influences the likelihood of CFA participation. This is plausible as companies prefer farms near the road or the market center for logistic reasons and reduction of transaction costs in monitoring and provision of technical assistance.

Finally, variables representing access to productive assets such as available family labor, farm size, malt barley area and total livestock, did not affect farmers' decisions to participate in CFAs. This implies that small and large farms both participate in contracting. Though not included in the model, membership to a PO is a pre-requisite to breweries' CFAs. Based on the pseudo-R2 (0.359), which is high and significant at 1% level, the covariates clearly explained the participation probability. In addition, the model indicates that 78% of the sample observations are correctly predicted.

5.3 Impact of smallholder participation in CFA

Estimating propensity scores

We estimated the propensity scores for the contract and non-contract farmers using the logit model. The magnitude of the propensity score ranges between 0 and 1; the higher the score, the more likely that the farmer would participate in CFA. The predicted propensity scores for contract farmers range from 0.030 to 0.990 with a mean of 0.660 and from 0.001 to 0.926 for non-contract farmers with a mean of 0.246.

Based on these predicted propensity scores, we test the common support assumption. Using the rules of minima-maxima (Caliendo and Kopeinig, 2008), the common support assumption is satisfied in the region of 0.030 – 0.926. The common support region is also examined using the density distribution for the two groups of treated (contract) and untreated (non-contract) (Figure A1 in Appendix I: line graphs and histogram). The overlap in the distribution of the propensity scores for contract and non-contract farmers is also visually checked: the result suggests that there is a high chance of obtaining good matches.

Estimating impacts of CFA

We then estimated the average treatment effects on the treated (ATT), which is the mean impact that participation in CFA has on malt barley farmers along a number of outcome variables. The result for PSM estimates (NNM, KBM and RM) are presented in Table 3. We also included the summary of results from OLS and the naive t-test. We found positive and significant impact of participation in CFAs on all the selected outcome indicators. We find that results are quite robust, with the same signs and significance levels and comparable point estimates among the different matching algorithms. The results from the OLS regression analysis and PSM are also comparable, indicating the robustness of our results. The full regression results are presented in Table 7 in Appendix I.

(a) Malt barley production

We find that CFAs result in a significantly larger malt barley production (Table 3). Participation in a CFA increases production with about 5 quintals, which is an increase of 36% compared with the average malt barley production in Arsi highlands. This could be associated with improved access to modern inputs and technical assistance.

(b) Malt barley yield, quality and intensification

We find that CFAs lead to using more inputs per ha in malt barley production, which is evidenced by a higher variable cost per ha (Table 3) and higher quantity of fertilizers used (Table 4 in Appendix I). We also find that CFAs lead to larger malt barley yields and higher quality. On average, a CFA increases input costs with about 828 ETB per ha, which is an increase of 19% compared with the average input costs per ha in the research area. Yields are found to increase with 2.54 quintal per ha or 13% in comparison with the average yield in the Arsi highlands. The results also show that CFAs increase the quality of malt barley grown by contract farmers by an average of 31% as compared to the sample average. Higher yield, quality, and variable costs of production would lead to higher malt barley net income.

(c) Malt barley commercialization

Our results reveal that participation in a CFA positively influences smallholders' commercialization in the malt barley sector. We find that participation in a CFA leads to an increase in the share of produced malt barley that is commercialized and a higher farm-gate price. The share of malt barley that is commercialized is significantly higher for those with contract, on average 17% points. The price is significantly higher for those with a contract, on average 197 ETB per quintal. CFAs increase the average price farmers receive for their malt barley with 22% compared with the sample average. The effect on farm-gate prices is most likely associated with improved quality.

Table 3: Average estimated effects of participation in CFAs

Outcome indicators	Naive t-test	OLS	PSM			Critical level of hidden bias (Γ)
			NNM	KBM	RM	
Production	5.1 (1.38)***	2.84 (0.900)***	5.37 (2.42)**	5.09 (2.63)**	5.47 (2.52)**	1.6 – 1.7
Yield	2.86 (0.8) ***	2.30 (0.991)**	2.40 (1.45)*	2.38 (1.38)*	2.76 (1.33)**	1.4 – 1.5
Price	184 (10)***	190 (11.61)***	206 (22.72)***	198 (23)***	207 (22)***	3.0 – 3.1
Share sold	0.21 (0.033)***	0.14 (0.04)***	0.17 (0.072)**	0.16 (0.067)**	0.16 (0.065)**	2.4 – 2.5
Costs	809 (71)***	799 (96)***	839 (101)***	845 (143)***	850 (135)***	3.0 – 3.1
Gross income	6601 (785)***	6265 (995)***	7350 (1358)***	7101 (1342)***	7223 (1306)***	3.0 – 3.1
Net income	4542 (1027)***	3577 (1416)***	3864 (2062)*	5004 (2505)**	4502 (2046)**	2.8 – 2.9
Product quality	0.71 (06)***	0.63 (0.082)***	0.78 (09)***	0.78 (12)***	0.78 (11)***	3.0 – 3.1
Other crops income	6452 (1615)***	5603 (2047)***	6974 (2932)**	7168 (2688)**	6534 (2602)**	1.5 – 1.6

Source: Field survey, 2015; Standard errors in parentheses;*** $P < 0.01$, ** $P < 0.05$, * $P < 0.10$

(d) Income

We find that participation in a CFA has a positive effect on farm family income. We find that a CFA leads to a higher malt barley gross income and net income, on average 6908 and 4298 ETB per ha respectively. These are crucial effects, which implies that participation in a CFA increases malt barley gross income and net income by 38% and 31% respectively in comparison with the sample average. Our results also reveal that CFA participation leads to an increase in other crops' gross income, on average 6546 ETB per ha. This implies that participation in a CFA increases farmer's income from other crop production with 66% compared with the sample average. There may be a significant spillover from CFA benefits into the production of food crops such as food barley and wheat, the major staples in the research area, probably due to modern inputs usage and technical assistance.

Robustness and assessing matching quality

For examining the quality of the matching process we conducted two tests. First, on the observable factors, the credibility of the PSM procedure is evaluated using the covariates balancing test (Table 5a and 5b in Appendix I). Using pseudo-R2 values we assessed the extent of systematic differences in covariates between contract and non-contract farmers after matching. Our result show that the pseudo-R2 reduced from 0.241 before matching to a range of 0.07-0.08 after matching (Table 5b in Appendix I). This fairly low value indicates that after matching there was no systematic difference in the distribution of covariates between the two groups. The chi-square test for Pseudo-R2 is also insignificant after matching. Thus, the matching process is successful regarding balancing distribution of covariates between contract and non-contract farmers.

Second, we assessed the sensitivity of the ATT estimates to unobserved heterogeneity or hidden bias. In the PSM technique, selection to treatment is only based on observed characteristics, and it does not control for hidden bias due to unobserved factors (Caliendo and Kopeinig, 2008). Heterogeneity may arise when contract and non-contract farmers differ on unobserved variables that simultaneously influence assignment to treatment and the outcome variable. We checked this using the bounding approach (Rosenbaum, 2002). This method relies on the sensitivity parameter gamma (log-odds ratio) that determines how strong an unobservable variable must be to influence the selection process so as to bias the results (DiPrete and Gangl, 2004).

Following DiPrete and Gangl (2004) and Girma and Gardebroek (2015), we consider various critical gamma value levels. We reported the results of rbound-tests in Table 3 last column. It indicates that the estimates of ATT are robust to hidden bias due to unobserved factors, even to the extent that would triple ($\Gamma = 3$) log odds of differential assignment to treatment. For the outcome indicators production, yield and other crops income, the critical level of gamma at which we would have to question our positive causal inference is between 1.6 and 1.7, 1.4 and 1.5, and 1.5 and 1.6 respectively (Table 3).

Table 6: Average treatment effects using Inverse-Probability-Weighted Regression Adjustment

Outcome indicators	Mean outcome		Difference (ATT)	% change
	Contract	Non-contract		
Total production	14.52	12.57	4.29(1.25)***	34.12
Yield	19.41	18.75	3.34(0.98)***	17.81
Price	993	822	208(22.7)***	25.36
Share sold	0.66	0.52	0.18(0.06)***	34.61
Cost	4702	3920	946(84)***	24.13
Gross income	19604	15312	7743(696)***	53.56
Net income	13009	10755	4829(1317)***	45.01
Product quality	2.5	2.07	0.83(0.099)***	40.09
Other crops income	11809	7575	4811(2112)**	63.51

Source: Field survey, 2015; Standard errors in parentheses;*** $P < 0.01$, ** $P < 0.05$, * $P < 0.10$

Finally, we also assess the robustness of NNM, KBM, and RM results by comparing to the results of a doubly robust inverse-probability-weighted-regression-adjustment (IPWRA) estimator. The results for the IPWRA estimator are presented in Table 6. The IPWRA approach produces almost similar results as the estimates in Table 3.

6. Discussion

The literature on CFAs in emerging economies shows a debate on whether CFAs improve smallholders' income and production efficiency. Several empirical studies document a positive impact of CFAs, focusing on high value chains (Abebe et al., 2013; Andersson et al., 2015; Bolwig et al., 2009; Kariuki and Loy, 2016; Roy and Thorat, 2008; Wang et al., 2014a). There is, however, also evidence that CFAs have negative income effects (Narayanan, 2014; Wendimu et al., 2016). In addition, CFAs are criticized for favoring large-sized farms at the expense of smallholders. It is claimed that CFAs exclude the participation of resource-poor farmers (Otsuka et al., 2016; Weatherspoon and Reardon, 2003).

On the effectiveness of CFAs, the results of our study are in agreement with earlier findings about the positive impact of contract farming on farmers' income. Our findings demonstrate that CFA participation has a positive impact on the following performance indicators: malt barley production, yield, intensification, quality, share sold, farm gate price, malt barley income and other crops income. Contract farmers achieved better performance in all of these indicators. For example, a CFA increases malt barley production with 36%, yield with13%, input costs with 19%, farm-gate prices with 22%, and net income with 31% compared with sample average. Our result is consistent with CFA literature both in high-value chains and domestic food chains (Maertens and Vande Velde, 2017; Mishra et al., 2016; Wang et al., 2014a). This strong positive outcome is attributed to the improved technologies, technical assistance, and coordination introduced in the malt barley supply chain.

Foreign breweries introduced quality-based pricing and the use of a grading system, which resulted in quality improvement. For instance, CFAs increase the farm gate prices that farmers receive with 22% compared with the sample average. Our finding is in line with the result from Maertens and Vande Velde (2017) that rice contract farming in Benin increases farm-gate prices with 11% and from Miyata et al. (2009) that vegetable contract farming for supermarket in China increases farm-gate prices with 8%. Foreign breweries are investing in the supply chain to ensure reliable local supply and consistent malt barley quality, for instance by coordinating supply chain activities in different stages of the chain with the support of NGOs and POs. This has brought dynamism in malt barley production and distribution, and has led to more coordinated chains. By investing in local sourcing of malt barley, breweries can reduce the high cost of import, manage price volatility, and show their corporate social responsibility.

On the determinants of CFA participation, our findings show mixed evidence. Contrary to the results of Wainaina et al. (2014), we have found a positive relationship between household education and the likelihood of participation in CFA. Similar positive effects of education on CFA participation have been reported for ginger farmers in Nepal (Kumar et al., 2016) and avocado farmers in Kenya (Mwambi et al., 2016). Education, as an indicator of human capital, enables households to understand information and take decisions on modern technologies and quality issues. It may also lead to more entrepreneurship and increased aspiration about the future of households' farming business. However, Girma and Gardebroek (2015) and Miyata et al. (2009) have reported that education has no significant effect and a negative effect on CFA participation in Ethiopia and China, respectively.

Our results also reveal that having a mobile phone, access to credit and access to public extension services are positively related with participation of CFAs. With regard to a mobile phone, similar results have been reported by Mishra et al. (2016) and Kumar et al. (2016). Our result is also in line with the findings reported by Ma and Abdulai (2016) and Mwambi et al. (2016), who show a positive relationship between access to credit and CFA participation. However, Wainaina et al. (2014)report that access to credit has no significant effect on participation. In addition, Kariuki and Loy (2016) and Girma and Gardebroek (2015) have been reporting that extension services positively and significantly influence CFA participation. Contrary to this, Wainaina et al. (2014) have reported that access to extension services is negatively related with CFA participation.

The positive association between access to credit and CFA participation could be explained by farmers who are able to access credit, tending to invest in the production of malt barley that meets the buyer's quality requirements, which can then earn them premium prices. Extension service as an important determinant could be explained by households who have better extension contacts, being in a better position to access useful information regarding benefits of modern agricultural technologies and marketing schemes.

Furthermore, we find that distance to markets and off-farm income negatively relate with CFA participation. Similar results have been reported by Miyata et al. (2009) for apple farmers in China, Wainaina et al. (2014) for poultry farmers in Kenya, and Mwambi et al. (2016) for avocado farmers in Kenya. The pattern observed could be explained by breweries preferring to work with nearby farmers for reasons of logistics, monitoring, provision of technical assistance and farm visits. Thus, a larger distance to the main road (or market) increases the transaction cost of sourcing malt barley from smallholders. Contrary to this, Maertens and Vande Velde (2017) have reported a positive effect of distance to markets on the likelihood of farmers' participation in rice CFAs in Benin.

Our results also show that off-farm income negatively affects the likelihood of participation in CFAs. This may be explained by smallholders specialized in farming (less off-farm activities) are more likely to join in CFAs. However, Azumah et al. (2016) and Wainaina et al. (2014) report that the likelihood of CFA participation increases with off-farm income. They argue that farmers' access to finance from off-farm activities improves their ability to buy basic inputs and this increase their probability of CFA participation.

7. Conclusion

The paper is an original contribution to the few empirical studies analyzing the impact of CFAs within domestic (staple) food chains using robust econometric methods, with correction of selection biases. The paper examined the factors that influence farmers' decision to participate in a CFA, as well as the impact of CFA participation on intensification of production, commercialization and prices, and farmer income in malt barley chains of Ethiopia. The study utilized cross-sectional survey data of malt barley farmers collected from the Arsi highlands of Ethiopia.

Our empirical findings demonstrate the positive impacts of CFAs on all selected outcome indicators. We find that CFAs result in intensification of malt barley production, increased commercialization of malt barley, higher farm-gate prices, increased net malt barley income, and higher income from other crops. Our estimated results are robust, consistent across different matching methods and OLS regression. Our findings imply that CFAs in a value chain context lead to higher smallholder farm income. In addition, promoting CFAs and its interlinkage with POs might be an effective way to increase smallholder commercialization, intensification of barley production, and quality improvement in the value chain. Previous studies on the impact of CFAs mainly focused on high-value and export oriented chains, while studies on domestic and staple food chains are few. Our study, thus, contributes to the agribusiness and development literature through providing empirical evidence on CFAs in domestic food chains.

Consistent with literature our results reveal that contracting in domestic and local food chains can be beneficial for smallholder producers. This seems against the expectation, as expressed Maertens and Vande Velde (2017), that contracting in domestic food chains is not feasible due to contract-enforcement problems that stem from a low value of produce and a large number of buyers in the chain. Three arguments could be forwarded why CFA works in barley value chains: First, low side-selling could be related to a high premium price of 22% that contract farmers received. Second, involvement of a PO may have a positive impact on the sustainability of the CFA. Third, linked to the new development paradigm - from-aid-to-trade – the role of NGOs has changed from providing generic farming support towards subcontracting specific supply chain activities.

The findings have several important implications for policymakers and stakeholders involved in the transformation and development of food systems. The study provides empirical evidence on how multinationals influence upgrading of food chains and commercialization of smallholders in Africa. It also indicates that supporting CFAs in the malt barley chains is an effective way to contribute to reaching the government aim of expansion and intensification of malt barley production and quality upgrading. Public support on capacity building of POs also helps for smallholder linkages to modern chains and the smooth functioning of contract arrangements.

A major constraint for the expansion of contract production is the poor condition of the physical infrastructure such as the lack of all-season roads. The brewery companies only have contracts with POs close to the district towns (within a 6km radius). Thus, the government should invest in building infrastructure so that farmers in remote areas can be included.

Our findings encourage further research on the following issues. First, we have not addressed the impact of malt barley production on food security. Does malt barley production compete with food barley production? Second, it would be worthwhile to carry out a within-country comparison of impact of CFAs in staple food chains and export-oriented chains. In particular, such research should focus on contract attributes in the two distinct chains and the implications for key actors including smallholders.

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Appendix I

Figure A1: Propensity score distribution and common support (before and after matching)

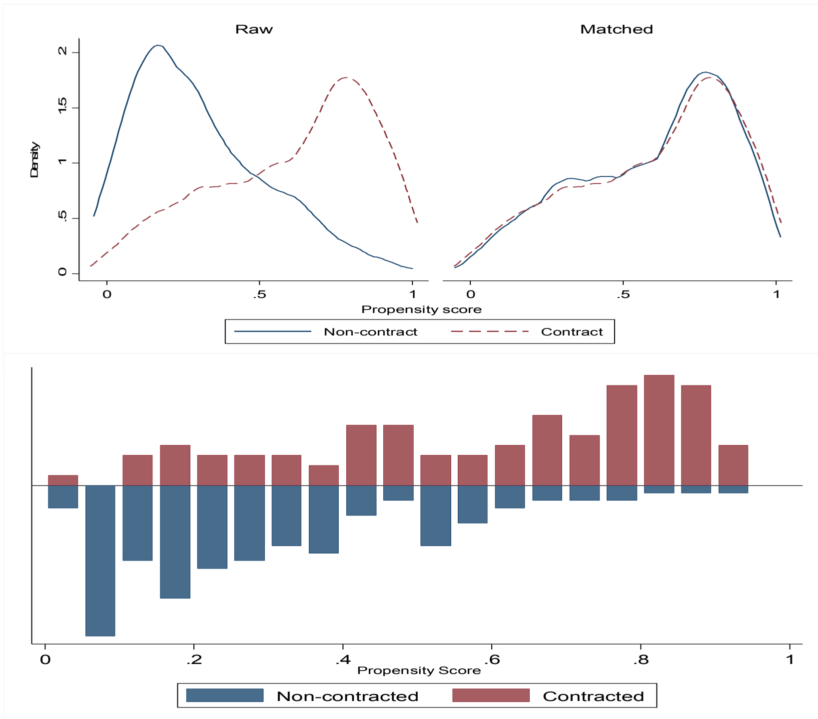

Table 4: Effect of CFA on intensification

Indicators of intensity	Contract	Non-contract	t-stat	Sig.
Improved seeds (0-1)	1.0	0.39	13.2	***
Quantity of fertilize-DAP(qt)	2.6	1.6	4.24	***
Quantity of fertilizer-NPS(qt)	1.96	1.65	1.09	
Quantity of fertilizer-Urea(qt)	0.48	0.45	0.41	
Cost of seed (ETB/ ha)	1245	799	44.62	***
Cost of fertilizer (ETB/ha)	1307	1280	5.94	***
Cost of weeding (ETB/ha)	620	380	12.75	***
Cost of harvesting(ETB/ha)	709	571	4.04	***
Total variable costs (ETB/ha)	4803	3994	11.33	***

Source: Field survey, 2015; *** significant at 1% level

Table 5a: t-tests for equality of means for each variable before and after the match

Variable	Sample	Mean		% bias	% reduction (bias)	t-test p> |t|
		Contract	Non-contract			
Age head	Unmatched	44.39	43.692	6.1		0.667
	Matched	44.39	43.107	11.1	- 83.0	0.473
Family size	Unmatched	6	6.359	-14.3		0.318
	Matched	6	5.747	10.0	29.7	0.463
Working labor	Unmatched	3.59	3.837	-13.7		0.340
	Matched	3.59	3.447	8.0	42.0	0.550
Education head	Unmatched	5.79	4.837	23.9		0.057
	Matched	5.79	6.117	-10.7	60.2	0.446
Farm size	Unmatched	2.64	2.859	-9.5		0.514
	Matched	2.64	2.802	-7.0	26.1	0.607
Malt barley area	Unmatched	0.75	0.735	1.9		0.898
	Matched	0.75	0.648	15.1	- 711.3	0.297
Farming experience	Unmatched	22.99	21.650	11.1		0.432
	Matched	22.99	22.047	7.8	29.7	0.620
Total livestock	Unmatched	9.06	8.849	2.4		0.868
	Matched	9.06	8.674	4.4	- 82.9	0.768
Off-farm income	Unmatched	3.24	5.299	-21.1		0.144
	Matched	3.24	2.719	5.3	74.8	0.670
Distance to market	Unmatched	6.18	8.170	-67.9		0.000
	Matched	6.18	7.145	-33.0	51.4	0.011
Mobile ownership	Unmatched	0.81	0.675	30.2		0.035
	Matched	0.81	0.862	-12.8	57.7	0.323
Access to credit	Unmatched	0.17	0.094	22.6		0.105
	Matched	0.17	0.352	-53.7	- 137.6	0.006
Extension contact	Unmatched	0.61	0.427	37.8		0.008
	Matched	0.61	0.574	7.9	79.2	0.603

Table 5b: Matching quality test: balancing property

	Before matching	After matching (algorithms)		
		NNM*	KBM	RM
Pseudo-R2	0.241	0.073	0.081	0.080
LR $\chi 2$	67.59	17.3	19.1	18.9
P-value	0.000	0.188	0.120	0.127
Mean bias	20.4	14.1	14.5	15.1
Median bias	14.3	11.6	9.0	12.1

Note: * seven nearest is used

Table 7: Full OLS regression results

Variable		Yield	Price	Share sold	Cost	Gross income	Net income	Product quality	Other crops income
Contract	2.84***	2.30**	190.26***	0.14***	798.94***	6264.59***	3577.2***	0.63***	5602.78***
	(0.900)	(0.991)	(11.61)	(0.04)	(96.44)	(994.56)	(1416.3)	(0.082)	(2047.15)
Age	-0.131*	-0.15*	0.493	0.003	-7.038	-138.32*	-177.81	0.008	-55.36
	(0.076)	(0.084)	(0.971)	(0.003)	(7.93)	(83.22)	(115.02)	(0.007)	(173.22)
Family size	-0.165	-0.173	3.18	-0.014	25	-160.87	-62.63	-0.006	236.09
	(0.241)	(0.265)	(3.104)	(0.1)	(24.449)	(265.87)	(352.58)	(0.022)	(548.67)
Active labor	0.773**	0.66*	-3.30	-0.006	-10.45	602.50	606.8	0.035	36.12
	(0.361)	(0.397)	(4.60)	(0.016)	(34.80)	(394.18)	(498.61)	(0.033)	(820.79)
Education	0.33***	0.39***	1.46	0.008	13.58	409.43***	532.87***	0.013	239.01
	(0.119)	(0.131)	(1.55)	(0.005)	(11.66)	(132.88)	(174.203)	(0.011)	(271.25)
Farm size	-0.12	0.054	-1.93	0.005	24.566	32.13	35.41	-0.023	982.52*
	(0.228)	(0.251)	(2.91)	(0.01)	(20.72)	(249.12)	(299.69)	(0.021)	(518.70)
Malt barley area	15***	-1.78***	37.76***	-0.137***	184.72***	-1031.37	-1260.84	0.167***	-4616.65***
	(0.637)	(0.702)	(8.12)	(0.028)	(55.46)	(698.59)	(789.8)	(0.058)	(1448.54)
Off-farm income	0.065*	0.065	0.22	-0.001	5.57	62.77	48.28	-0.002	53.11
	(0.037)	(0.042)	(0.48)	(0.001)	(4.09)	(41.37)	(58.96)	(0.003)	(86.24)
Mobile phone ownership	-0.65	-1.09	34.25***	0.07*	-48.44	-315.07	-1887.19	0.081	-1080.53
	(0.915)	(1.00)	(11.68)	(0.04)	(97.12)	(1001)	(1387.97)	(0.084)	(2081.22)
Extension contact	0.688	0.571	12.07	0.005	11.45	673.80	226.35	0.21***	3903.59**
	(0.757)	(0.835)	(9.73)	(0.033)	(74.90)	(833.46)	(1090.74)	(0.07)	(1723.57)
Farming experience	0.106	0.11	-0.006	0.0002	9.19	122.58	124.1	-0.004	-141.78
	(0.072)	(0.08)	(0.931)	(0.003)	(7.36)	(79.75)	(107.74)	(0.006)	(164.84)
Total livestock	-0.003	-0.007	0.027	0.0004	0.083	-6.78	-5.96	0.0003	1.22
	(0.009)	(0.009)	(0.114)	(0.0004)	(0.75)	(9.80)	(10.61)	(0.0008)	(20.46)
Distance to market	-0.12	-0.142	5.03***	-0.01**	-6.55	-14.92	-107.65	0.002	-216.45
	(0.095)	(0.105)	(1.22)	(0.004)	(9.09)	(104.24)	(134.81)	(0.008)	(216.17)
Credit from microfinance	-0.43	-1.25	-9.41	0.033	8.03	-1510.25	-1366.48	-0.03	-1059.89
	(1.05)	(1.159)	(13.57)	(0.047)	(103.92)	(1162.51)	(1523.21)	(0.096)	(2392.1)
Intercept	2.69	22.5***	695.47***	0.58***	3733***	16334***	15022***	1.44	11508.64*
	(2.80)	(3.09)	(35.89)	(0.125)	(301.115)	(3074.92)	(4370.4)	(0.258)	(6378.09)
F-value	57.48	3.48	35.03	7.16	11.73	7.01	3.26	11.26	2.66
Prob> F	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0013
Adjusted R2	0.7710	0.1205	0.6559	0.2565	0.4550	0.2517	0.1583	0.3621	0.0841

Figures in parentheses are standard errors; *** P < 0.01, ** P < 0.05, * P < 0.10; Source: Field survey, 2015

Determinants of Child Labour Exploitation and its Impact on Their Educational Achievement in South Western Ethiopia: The Case of Jimma Town

Terefe Admaw Bekure[1]

Abstract

This study aimed to identify determinants of child labour exploitation and its impact on children's educational achievement in Jimma town. The study utilized a cross sectional data collected from 196 sample child labourers and interview is also made with the supervisor of children's right protection office and other concerned staffs. Primary data from child labourers were collected through structured questionnaire. For identifying the determinants of child labour OLS estimation technique was used. Two- limit tobit model was employed for estimating the determinants of educational achievement which is proxied by cumulative grade point average (CGPA). Result from OLS estimation indicates that child labour exploitation is associated with age of the child, household size, monthly income of child's parent, sex of the child, educational level of child's father and parents of the child who takes debit among others. In addition, tobit estimator result shows that children's educational achievement is significantly determined by age of the child, monthly income of child's parent, educational level of child's father, marital status of the household head and total working hours of the child per week. To this end, the study suggests strengthening school based financial support and creating awareness in the community about the detrimental effect of child labour exploitation on their physical and mental wellbeing and off course the long lasting solution to curb the problem of child labour and promote human capital accumulation is overcoming poverty level.

Keywords: Child labour, Children's educational achievement, OLS, Two-limit tobit model

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1. Introduction

Children constitute the most vital base of human resource endowment. They are the most valuable future citizens of the country. However, they face different pressure that potentially harms their social, physical, psychological, and behavioral developments. Hence, more attention is now paid to the issues of children in the world (Temesgen, 2015).

Child labour is participation of child in any exploitive and full time work to sustain oneself or add to family income. However, all work done by children is not child labour, rather when the work interferes with moral, physical, mental, educational, spiritual and social development of a child (Musandrire, 2010). The most extreme forms of child labour exploitation involves children being enslaved, separated from their families, exposed to serious hazards and illness for themselves on the street of large cities often at a very early age. Whether or not particular forms of "work" can be called "child labour exploitation" depends on the children's age, the type and hours of work performed, the condition under which it is performed and the objectives pursued by individual countries. Child labour perpetuates poverty by depriving children of education and subsequently renders these children without the skills needed to secure the future of their countries (ILO, 2013).

Child labour exploitation in developing countries especially in sub Saharan Africa and South Asian continues to be a controversial issue (Mahendra, 2013). Child labour in these countries affects school performance as children miss important lessons and fall behind academically (Ravinder, 2009).Because of the severity of the problem, elimination of child labour becomes one of the sustainable development goals (SDGs) under goal 8 (target 8.7) by 2025.

According to the ILO (2013), 168 million children worldwide are engaged in child labour. Of these 168 million children, 85 million are engaged in what the ILO deems "hazardous work." The sub-Saharan African region has the second highest number of child labourers in the world with about 59 million engaged as child labour in 2012. Children aged 5 to 17, or 21.4 percent, are involved in child labor while 10.4 percent are engaged in hazardous work. Only one out of five children involved in child labour is paid for his or her work. The majority of children in child labour perform unpaid family work.

Ethiopia is the one among the 10 countries listed as worest forms of child labor in 2012. About 60 percent of children in Ethiopia are engaged in some form of child labor. Many of these children work in the mining industry which poses the biggest dangers for child labourers. Many parents in impoverished countries such as Ethiopia push their children to work out of necessity. Unable to sustain their families on their own income, the parents feel that they have no choice but to push their children into child labor (Matt, 2014).

Like other developing African countries, child labour is severe in Ethiopia. Children's below the working age are exploited for the sake of earning minimum wage for their long hour working. This indicates the severity of child labor in the country at cost of schooling (Beliyou, 2003).

Much of the recent concern over child labour stems from the beliefs that it has detrimental effects on human capital formation. This in turn has a long term impact on economic growth and development. It is a general consensus that human capital accumulation is the way out from poverty and hence to ensure economic growth and development. Education is believed to have a special place in such struggles. The problem is that if children are compelled to start work at their early ages and toil for longer hours means that their ability to attend school is seriously impaired (Bisrat,2014).

Previous studies by [(Udry, 2003), (Priyambada et al., 2005), (Sakurai, 2006)] shows that Child labour is rooted in poverty and its relation to education is often considered two sides of the same coin. It is a result of current poverty and a cause of continued poverty for the children who sacrifice their education in order to work. It interferes with the human capital development of children by either forcing children to drop out of schools or making learning process in schools ineffective. Poverty and the need of poor families for income are the most important factors that push children to engage in working activities Gebremedhin (2013) and educational achievement is significantly affected by child work load (Yibeltal et al., 2014).

In fact, there are few previous studies that explore determinants of child labour exploitation and its impact on their educational achievement and only some researchers have been conducted their researches at national level and studies at local context are scanty. Gebremedhin (2013) and Temesgen (2015) conducted their research on the effect of child labour on education at Mekelle and Jimma towns respectively. Both of them employee cross sectional data which was analyzed by descriptive statistics. But in this study more weight is given for econometric ways of analysis. Besides, future price expectations and parent's debit were included in the analysis as explanatory variables that no one dealt previously.

Although some studies try to explain about child labor exploitation, they did not show the detailed determinants/ factors of child labor exploitation broadly at the local context. Therefore, this research is a novel in that it is an initial study that assesses the determinants of child labor exploitation and its impact on their educational achievement in Jimma town and the main purpose of this study is to identify the factors that determine child labour hour and the impact of child labour exploitation on child school achievement which is measured by semi-annual cumulative result (proxied by cumulative grade point average (CGPA)).

Similarly, it is very common to see children's working in Jimma town at the cost of their education and health. Child labour has the potential to undermine economic growth through its impact on child development, wages, and technology adoption (Edmonds, 2015). Hence, it is a must to examine the various determinants of child labor to take immediate and effective measures to eradicate in all its forms. It is, therefore, imperative investigating factors which determine child labour in Jimma town since there is no comprehensive study so far in the area. In addition, it is interesting to examine the effects of child labour exploitation on his/or her educational achievement. Specifically, the current study aims to address the following questions: What is the extent of child labour exploitation in the study area? What are the factors affecting child labour exploitation? What is the impact of child labour exploitation on their educational achievement?

Finally, since studies which have been done previously assessed the determinants of child labour exploitation and its impact on education separately; this study will bring and combine the different determinants of child labour exploitation and its impact on their educational achievement simultaneously.

2. Literature Review

Classical theory of endogenous growth. It assumes that people are productive resource. Hence higher education will lead to higher productivity. Basic proposition behind this theory is that parents make trade-off when allocating their children‘s time, especially for education and labour. Their decision is based on family economic and social conditions. Accumulation of human capital is affected by child labour (Schultz, 1961).

The second one is Risk Theory, which asserts that poor household faces shocks and risks such as unemployment, natural disasters affecting income like draught, flood, and war among others. The income shocks could be severe among the household who do not have enough reserve resources to meet such shocks. These household are more likely to supply child labour if they remain unable to borrow to smooth their present consumption need. Literature often points out that in extreme cases household could sell the future hours of their child work to overcome the present income shocks. Duryea (1988) concluded that the parent‘s unemployment reduces the probability of grade advancement among the children. Jacoby et al, (1997) working on the data of rural India provide evidence that parents withdraw children from school during unexpected decline in crop income.

From empirical perspectives, there are few studies which focus on the determinants of child labour and the educational achievement. For example, according to [(Kelemu et al., 2016), (Assefa, 2002), (Khanam, 2006) (Eshetu and Teferi, 2014), (Solomon et al., 2011), (Mahendra, 2013), and (Gebremedhin, 2013)] the major determinants of child labour exploitations are poverty, migration, death of parents of the child, low level of education of the child’s parent, age and gender of the child, price of child’s school, household size, disagreement with parents, parental separations, and displacement due to war. Latif et al. (2016) concludes that less education, need for extra money and lack for poor monitoring by government are important factors and reasons of child labour in Pakistan.

[(Temesgen, 2015), (Yibeltal et al., 2014) and (Assefa, 2002)] found that educational achievement is determined by work load at home, parental income, low rate of school attendance, late coming, lack of active participation in class room activities, lack of doing homework, distance to school and quality of education.

According to Eduardo G. et al., (2009) students who work both inside and outside of the home experienced a negative impact on their achievement test scores. However, the negative impact was greater for students who only worked outside the house than those who worked both inside and outside the house. Students who work both outside and inside the home have a heavy work load, possibly tire themselves physically, and have less time and energy to devote to their studies than students who do not work or who only work in one location. Each additional hour that a student works lowers school achievement. Students who work 7 hours or more per day experience the most harm to their school performance, but the harm is modest with at most a 10 percent decrease in their achievement test scores relative to students who do not work.

A study by Blanco et al., (2008) shows that the levels of children's work are significantly and inversely correlated to the number of years that a child will spend at school. They also observe that the data for both boys and girls and is regardless of grade repetition, resulting in lower levels of human capital accumulation. There is a significant inverse correlation between levels of economic activity of children aged 7-14 and youth literacy rates in the 15-24 age group. This finding suggests that the consequences of child labour can be critical not only in terms of human capital accumulation in general, but also in acquiring key educational basic competencies such as the ability to read and write. The absence of these basic skills will leave youth and adults with very restricted options besides working in low remunerated jobs, recreating the conditions for the perpetuation of poverty, inequality and social exclusion.

Ray (2001) examined simultaneous analysis of child labour and child schooling in Nepal and Pakistan for the time period 1981-1990. According to his findings the joint estimation of child labour hours and child schooling experience exertions is the significant rate that child's current school attendance plays in sharply diminishing child labour hours. Rising education level of the adults members in the household and increased public awareness have a highly insignificant positive impact on child schooling and subsequently can play important part in reducing the child's long hours of working.

3. Research Methodology

A cross-sectional study design has been used in order to analyze the various factors of child labour exploitation and its impact on educational achievement in Jimma town. The collected data is analyzed by using both the qualitative and quantitative (econometrics) methods.

3.1 Target Population

The study was conducted on determinants of child labour exploitations and its impact on educational achievement in South Western Ethiopia, particularly in Jimma town. And the target population of the study was child labourers found in Jimma town.

3.2 Sampling Technique and Sample Size Determination

According to Jimma town women and child affair office (2016) there are 40,700 child labourers aged 5-17. In the city there are17 kebeles CSA (2016) and it is not possible for conducting a survey by including all kebeles in the town. To draw representative sample of the population, a multi-stage sampling was used. Firstly three kebeles were selected using purposive sampling. The selection was done depending on the availability of market place where children are participating in labour activities either to help their parents or guardians or earn income for their living, number of population, number of child labourers and the economic condition.

The number of child labourers whose age is 5-17 and at the same time who combine work with school for the three kebeles namely Bauche Booree, Hirmaataa Markaatoo and Hirmaataa Mantiinaa are 2530, 780 and1385 respectively. The total number of child labourers in the surveyed kebeles adds up 4695. For sample size determination the formula developed by (Yamane, 1967) was used.

$$n = \frac{N}{1+N(e)^2}$$

Where; n = sample size

N = number of child laborers in the study area

e = is the desired level of precision (e = 7% or 0.07)

$$n = \frac{4,695}{1+4,695(0.0049)} = 196$$

Second, after determining the total number of sample respondents in the study area, the next step involves applying proportional stratified random sampling by dividing the given population in to homogeneous subgroups and then determining sample respondents in each of the three selected kebeles by using simple random sampling techniques. At this stage, children whose age is 5-17 and who are engaged in economic or non-economic activities has been selected randomly proportional to their population size. The formula is as follow;

$$ni = \frac{Ni}{N} * n$$

Where, ni = sample size of ith kebele, Ni = total child laborers of ith kebele, and N = total number of child laborers in the selected kebeles and n = total sample size.

For Bauche Booree kebele, 2530/4695*196=106; For Hirmaataa Markaatoo kebele, 780/4695*196=32; For Hirmaataa Mantiinaa kebele, 1385/4695*191=58

Therefore, the total respondent of the three kebeles is the sum of the above sample that is 106+32+58=196.

3.3 Method of Data Collection

Primarily the structured questionnaire is prepared in English language and converted to local languages where everybody can easily understand each question. To collect data from respondents a trained data collectors, who speak the two languages (English and Amharic) were used in the data collection process and conducted a face to face conversation with the sampled respondents.

3.4 Econometric Model Specification

The aim of this research is to estimate the determinants of child labour exploitation and its impact on educational achievement. There are two models used in this study. The first model is used for investigating the determinants of child labour exploitation in which child labour hours per week is the dependent variable. Child labour hours is chosen because it is assumed the best way to measure the working condition of children and off course used by different researchers like (Kurtikova, 2009) and (Ray, 2001).

Previous studies on determinants of child labour in India and Pakistan by Kurtikova (2009) and Ray (2001) analyzed the determinants using Ordinary Least Square (OLS) estimation technique. This is because; child labour is measured by child labour hours per week which is a continuous variable. Though this study uses OLS estimation technique an attempt was made to compare the result from OLS with that of tobit regression results.

Based on previous studies and common intuitions, the analyst identified a number of independent variables to be included into the first model. Accordingly, the estimable model is specified as follows:

$$\text{Child labour hours (twh)} = \boldsymbol{\beta_0 + \beta_1\,sex + \beta_2\,age + \beta_3 hhs + \beta_4\,minc + \beta_5 maedu + \beta_6 faedu + \beta_7 mshh + \beta_8 brchhh + \beta_9\;\; ebit + \beta_{10} eshh + \beta_{11} agehh + \beta_{12} sexhhd + \beta_{13} hpe + \mu i} \qquad \textbf{(1)}$$

The second model used in this study was to estimate the determinants of educational achievement which is measured by test scores of children's in a semester. To analyze the effect of child labour on student's educational achievement using test score in a semester is preferable [(Shimada, 2010), (Aturupane, 2007), (Eduardo et al., 2009) and (Tassew and Aregawi, 2015)]. Tobit model has been used for estimating the various determinants of educational achievement. Since the students' scores are censored both from below (minimum possible score) and above (maximum possible score), tobit is an appropriate estimator to apply.

The tobit model is a statistical model proposed by James Tobin (1958) to describe the relationship between a non-negative dependent variable yi and an independent variable or vector xi. The tobit model can be described in terms of a latent variable y*. Suppose that yi* is observed if yi* > 0 and is not observed if yi*≤ 0. Then the observed yi can be defined as

$$yi = \begin{cases} yi* = \beta xi + ui & if\ yi *> 0 \\ 0 & if\ \ yi *\leq 0 \end{cases}. \qquad \textbf{(2)}$$

$$Ui\sim IIDN\ (0, \sigma^2)$$

This is known as the tobit model and it is called censored regression model, because it is designed to estimate linear relationship between variables when there is either left or right censoring or both left and right censoring in the dependent variable (Maddala, 2005). Among the different types of tobit model, two-limit tobit model has been used to analyze the determinants of educational achievement which is measured by cumulative result/ average test score which have a minimum and maximum of 0 and 100 respectively. The model then specified as

$yi *= \beta xi + ui$ I = 1, 2, 3,……n **(3)**

y_i * is the latent variable and xi and ui are the set of the explanatory variable and error terms respectively. If we denote y_i the observed dependant variable,

$$\begin{aligned} y_i &= L_{1i}\, if\ y_i \leq L_1 \text{斷} \\ &= y_i *\ if\ L_{1i} < y_i *< L_{2i}.. \\ &= L_{2i}\, if\ y_i * \leq L_{2i} \end{aligned} \qquad \textbf{(4)}$$

Here L_{1i} andL_{2i}, are the lower and upper limits respectively.

Where y_i = the observed cumulative result of students
y_i *= the latent variable which is not observed
β = vector of unknown parameters
xi= vector of independent variable affecting cumulative result
Accordingly, the second estimable model is specified as follows:

Cumulative result (cmr) =

Table 1: Definition of variables used for the two models

Variables used in the analysis	Their definitions
TWH	Total working hours of child labourers per week
CMR	Cumulative results of child labourers per semester (average)
HHS	Household size
AGE	Age of the child
AGHH	Age of the household head
MINC	Monthly income of the child's parent
SEX	1 if the child is male; 0 otherwise
SEXHH	1 if the household head is female; 0 otherwise
MAEDU	a categorical dummy for the level of education attained by child mother's (1 if illiterate; 2 if primary school completed; 3 if secondary school completed; 4 if above secondary school
FAEDU	a categorical dummy for the level of education attained by child father's (1 if illiterate; 2 if primary school completed; 3 if secondary school completed; 4 if above secondary school
BRCHHH	1 if the child is not biologically related with the head of the household; 0 otherwise
MSHH	a categorical dummy for marital status of the household head (1 if single; 2 if married; 3 if divorced; 4 if widowed)
ESHH	1 if the household head is employed; 0 otherwise
DEBIT	1 if the parents of the child take debit; 0 otherwise
HPE	1 if the child works because of expecting higher price in the future; 0 otherwise

Where $\beta's$ are parameters of and μi is an error term of the model.

4. Results and Discussion

4.1 Descriptive Statistics

A Sample of 196 child laborers who combine work with school were selected randomly for this study. Out of the total respondents 80 (40.82%) are females and 116 (59.18%) are males. The data shows 161 (82%) of them are working for wage while 35 (18%) are working without having a paid wage as they are working for helping their parents in work place.

Table 2 (see Annex I) contains information about the type and extent of work that children participate in the study area. As represented by the table above 39 (19.9%) of the respondents' were working as a street venders followed by working in household chores 34 (17.35%) and as shoe shine 26 (13.27%). Children's working in wood work, garage and shop keepers have the same percentage share that is 18 of them are working in each working category taking 9.18% and the same is true for those working in taxi conducting and in cart driver category which accounts 5 (2.55%). The remaining lottery seller and those working in café and restaurant accounts 7 (3.57%) and 3 (1.53%) respectively. From this information we can deduce that most of the participants in labour activities are male as it compared with female. Noting their participation in each work category most of males are working as a shoe shine and wood work, while most of females are working as a street venders and household chores respectively.

As it is clearly shown from the frequency distribution table (see Annex II), 73 (37.24%) % of the respondents are working for 21-35 hours per week followed by 36-50 hours per week accounting 59 (30.10%) of the total respondents'. About 28 (14.29%) of them are working 51-65 and 5-20 hours per week and the remaining 8 (4.08%) are working for 66-75 hours per week which highly interferes with their education. This hour is even almost double of ILO maximum restriction of child labour hour for children's under the age of 18 i.e. 43 hours per week. The mean working hour of the child per week is 36.46939 with minimum of 5 and maximum of 72 hour.

Table 3 (see annex III) shows that respondents semester average cumulative result. Most of the respondents' 94 (47.96%) of them reported that their semester average score is below half (50) and the reason for these low score is participation of in labour activities. About 47 (23.98%), 30 (15.31%), 16(8.16%) and 9 (4.59%) of the children reported their semester average score as satisfactory, fair, very good and excellent respectively. The mean of their semester score is 56.43 while the minimum and maximum test scores are 30 and 99 respectively.

4.2 Econometric Analysis

The estimation of labour hour equation has been done by using both OLS and Tobit estimators for comparison purpose. However, the second model i.e. determinants of child school achievement has been estimated by using two-limit tobit estimator. The result of each of the two models is presented here under.

4.2.1 Determinant of Child Labor Exploitation

After having comparison between OLS and Tobit for estimating the determinants of child labour exploitation OLS result is presented here below as long as both of the models have nearly the same output.

4.2.2 OLS Estimation Result and Discussions

Prior to running OLS estimation, the model is checked for the existence of data problems mainly multicollinerity, hetroskedasticity, normality and omitted variable bias. After doing this procedure the final output or result is presented as follows.

As shown in table 2, sex of the child and monthly income of the child's parent are statistically significant at 5%. This implies that female children are more participant in labour activities than male children. This finding is in sharp contrast with the finding by Mahendra (2013). Similarly, age of the child and household size are found to be significant at 1% level of significance. The negative coefficient of parents' income shows that as parents' income increases children spend few hours on child labour. . This finding is consistent with the finding by Solomon et al., (2011) who find negative association between parents' income and child labour participation.

Table 2: Estimation result of Ordinary Least Square method

Dependent variable (Total working hour per week)	Coefficients	Standard error	T	p> |t|
Dummy for female child	3.990812**	1.993025	2.00	0.047
Age of the child	1.10534*	0.4098644	2.70	0.008
Household size	1.483161*	0.4271158	3.47	0.001
Income	-.0007814**	0.0003899	-2.00	0.047
Mother's education (reference = above secondary school)	-	-	-	-
Illiterate	1.403785	5.942311	0.24	0.814
Primary school completed	-0.1667073	5.752828	-0.03	0.977
Secondary school completed	-0.2851573	6.06059	-0.05	0.963
Father's education (reference = above secondary school)	-	-	-	-
Illiterate	-7.277006**	3.529195	-2.06	0.041
Primary school completed	-8.223797*	3.392914	-2.42	0.016
secondary school completed	-1.471877	3.880505	-0.38	0.705
Marital status of the household head (reference = married)	-	-	-	-
Single household head	3.248912	3.741093	0.87	0.386
Divorced household head	2.893699	2.386803	1.21	0.227
Widowed household head	1.070333	3.941833	0.27	0.786
Dummy for child who is biologically related with the head	-3.106842	2.154626	-1.44	0.151
Dummy for child's parent who have debit	7.825869**	3.801668	2.06	0.041
Dummy for unemployed household head	1.797819	4.271627	0.42	0.674
Age of the household head	0.0443563	0.0881919	0.50	0.616
Dummy for female household head	2.407952	2.212804	1.09	0.278
Dummy for child's who expect higher price in the future	4.278006	3.399594	1.26	0.210
_cons	13.77422	9.193865	1.50	0.136
Number of ob. 196				
R-squared = 0.3371				
Adj R-squared =0.2655				
F(19, 176) = 4.71				
Pro >F = 0.0000				
Root MSE = 12.78				

Source: Author's estimations (2017)

Note: (*) and (**) shows the significant level of the variables at 1% and 5% respectively.

The positive coefficient of age implies that older children work for more hours than younger ones. Household size found to have positive and significant effect on child labour hour. The positive association between household size and total child labour hours implies that as family size increases, parents would be unable to finance the required expenditure which might push their children to work at the cost of schooling. Interestingly, the results are consistent with the findings by Mahendra (2013) and Kausar (2010) who found positive effect of household size on child labour hour per week.

Educational level of child's father is significant at 5% and has negative impact on child labour hour. In addition, children who are from family who are in debt have more probability of being engaged in child labour. This has an indication that parents who are in debit send their children to work more than parents who are not in debit.

4.2.3 Child Labour and Educational Achievement

Cumulative result per semester (average test score) is the dependent variable for the second model. Two-limit Tobit mode has been used for the estimation of the model. However, this model has a limitation, because it does not have test option for detecting hetroskedasticity which is the problem in cross sectional data. If this problem is not detected there should not be constant variance for residuals which result inconsistent estimators so that it has to be corrected before running other tests.

Since, Tobit model does not have robust option in stata for solving the problem of hetroskedasticity we have to follow http://www.stata.com/support/faqs/stat/tobit.html website, which was recommended by James Hardin, stata corporations (Jemal, 2011). Likewise, for this analysis the same procedure is applied. This website tells us to use interval regression for solving hetroskedasticity problem of the Tobit model. As it was explained there to run interval regression new dependent variable should be generated from the existing one for getting similar results with the Tobit regression. Using the new generated dependent variable it is simply adding robust option while performing interval regression for solving hetroskdasticity problem. Prior to running interval regression, the model is checked for the existence of data problems mainly multicollinerity and omitted variable bias. After doing this procedure the final output or result of interval regression is presented as follows.

Table 3: Regression result for educational achievement

Interval regression	Number of obs	=	196
	Wald chi2	=	55.35
Log pseudolikelihood = -805.95288	Prob> chi2	=	0.0000

Dependent variable (cumulative result)	**Coefficients**	**Standard error, (r)**	**Z**	**p> |z|**
Total working hour	-.1600849***	0.0980881	-1.63	0.103
Dummy for female child	-0.760423	2.224069	-0.34	0.732
Age of the child	1.1160527**	0.5207647	2.23	0.026
Household size	-0.0077377	0.4796072	-0.02	0.987
Mother's education (reference = above secondary school)	-	-	-	-
Illiterate	-0.1865272	8.206215	-0.02	0.982
Primary school completed	-1.368748	8.241677	-0.17	0.868
Secondary school completed	-2.222619	8.305177	-0.27	0.789
Father's education (reference = above secondary school)	-	-	-	-
Illiterate	1.388893	3.597779	0.39	0.699
Primary school completed	8.464138**	3.906315	2.17	0.030
Secondary school completed	4.274637	4.3937744	0.97	0.331
Marital status of the household head (reference = married)	-	-	-	-
Single household head	2.10719	4.126051	0.51	0.610
Divorced household head	-5.116781**	2.632465	-1.94	0.052
Widowed household head	4.554516	5.015121	0.91	0.364
Income	.0011748*	0.0004843	2.43	0.015
Dummy for employed household head	-1.974051	4.261686	-0.46	0.643
_cons	44.27335	11.73071	3.77	0.000
/sigma	15.41375	0.6986314		

Source: Author's estimations (2017)

Note: Standard errors are robust;*significant at 1%, **significant at 5% and *** significant at 10%; Observation summary: left-censored observations; 194 uncensored observations; 0 right censored observations; 0 interval observations. Number of obs = 196; Wald chi2 = 55.35; Log pseudolikelihood = -805.95288;Prob> chi2 = 0.0000.

As can be seen in Table 3, child labour hour per week is negatively associated with cumulative result. That is as weekly child labor time increases by an hour, the child's cumulative result falls by 0.16 points. This finding is quite similar to finding by Yibeltal et al., (2014) who argue that when the age of the child increases, there is ways to improve his/her test score. Furthermore, it was found that the monthly income of child's parent is significantly associated with child's educational achievement at 1%. As expected, parents' income level is positively associated with child's educational achievement. This is appealing since increase parents' income increases children's participation in school which improves their academic achievement. As children get older those from poor families stay in the labour market, while those from rich families allocate more time for studying. This finding is in line with the finding by Eduardo et al., (2009) who find positive association between child educational achievement and parent's income level.

Turning to the educational level of child's parents with in the household, educational level of the child's father is found to be statistically significant at 5%, but mothers' education is not statistically significant. However, this finding contradicts with the findings of Khanam (2006) who concludes that mother's education has a positive impact on children's educational achievement than fathers' education. Household head whose marital status is divorced is significant at 5% and it affects child's educational achievement negatively.

5. Conclusion and Recommendations

Empirical result shows that educational achievement is positively associated with age of the child, monthly income of child's parent, educational level of child's father. However, marital status of the household head and total working hours of the child per week are negatively associated with the child's educational achievement. Furthermore, child labour exploitation is associated with age of the child, household size, monthly income of child's parent, sex of the child, educational level of child's father and parents of the child who takes debit among others. Accordingly, the study concludes that child-labour negatively affects child educational achievement in primary schools. Thus, the most appropriate measure to reduce child labour is poverty reduction, provision of education and heightening campaigns against child-labour.

Based on the findings, the following suggestions are forwarded to the poor parents and the administrative authorities.

- Firstly, Parent should be aware of the negative effect of child labour exploitation on their physical and mental safety. This is because family has the primary responsibility for the upbringing and development of the child.
- Secondly, parent's income level is one of the determinants of child labour, therefore incentive mechanisms could be planned for poor families who educate their children and to expand (strengthen) poverty reduction program in order to achieve its goal by providing quality education for all. The support program should also alleviate the gender bias as well.
- Thirdly, child labour exploitation which is the obstacle for development should be reduced by population control program. Since household size has a significant positive impact on child labour hour and indirect but negative impact on child schooling. It is better for the government to strongly put a limit on the number of children birth within a household.
- During the study it is also evidenced that children's know nothing about their right to be free from work and the importance of education for their future, so that awareness raising workshops, trainings, panel discussions among professionals, policy makers and the law enforcing bodies can also be a fruitful strategy to protect children from labor exploitation.
- Finally, Children's are more exposed to child labour with the increase in age. So, care must be given until they fully enjoy their childhood stage.

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Annexes

Annex I:Displays the type of works that children participate

The type of work that children's engaged	Respondents			
	Male	Female	Total respondents	Percentage
Wood work	17	1	18	9.18
Garage	16	2	18	9.18
Taxi conducting	5	0	5	2.55
Shoe shine	26	0	26	13.27
Café and restaurant	3	0	3	1.53
Household chores	16	18	34	17.35
Street venders	8	31	39	19.9
Shop keepers	9	9	18	9.18
Cart drivers	5	0	5	2.55
Lottery selling	4	3	7	3.57
Others	10	13	23	11.73
Total	119	77	196	100

Source: Own survey (2017)

Annex II: Children's working hours per week

Hours per week	Frequency	Percentage
5-20	28	14.29
21-35	73	37.24
36-50	59	30.10
51-65	28	14.29
66-75	8	4.08
Total	196	100

Source: Own survey (2017)

Annex III: Displays Children's Average Score

Average score	Frequency	Percentage
<50	94	47.96
50-59	30	15.31
60-79	47	23.98
80-89	16	8.16
90-100	9	4.59
Total	196	100

Source: Own survey (2017)

Dynamics of Inequality in Child Malnutrition in Ethiopia*

Mengesha Yayo Negasi[1]

Abstract

Although Ethiopia has already achieved a remarkable progress in reducing under-five mortality in the last decades, undernutrition among children is still a common problem in this country. Socioeconomic inequalities in health outcomes in Ethiopia have been thus of focus in academia and policy spheres for a while now. This study provides new evidence on child undernutrition inequalities in Ethiopia using longitudinal perspective. Using three round of household panel survey, we use concentration index (associated curve), different mobility index approaches for measuring inequalities and its dynamics, and decomposition method to identify contributing factors. In all concentration index computing approaches and Socioeconomic Status (SES) ranking variables, the concentration indices are significant with negative value. This implies that in either of short-run or long-run inequality estimates, the burden of unequal distribution of undernutrition remains on the poor with significant difference across regions. While employing different SES ranking variables, the difference in the concentration indices is only found significant in case of Height-for-age Z-score (HAZ). Using standard method, for example, in HAZ, -0.040 and -0.070 of concentration index (CI) for wealth index and consumption are scored respectively. It signifies that relatively higher inequality is measured using consumption as ranking variable. With respect to dynamics of inequalities, results on mobility indices computed based on Allanson et al. (2010) approach show that inequality remain stable (persistence of inequality) in Height-for- age Z-score, and reduction of inequality in Weight-for- age Z-score while in case of Weight-for- height Z-score, there is no clear trend over subsequent waves. Our inequality results are robust to different measurement scale, inequality aversion parameters/distributional sensitivity parameters, and sensitivity to extremity. Results on decomposition of inequalities show that the major contributors are wealth index, consumption and mother's education. Those imply that in both

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socioeconomic status ranking variables, the bulk of inequality in malnutrition is caused by inequality in socioeconomic status in which it disfavors the poor in both cases. This calls for enhancing the policy measures that narrow socioeconomic gaps between groups in the population and targeting on early childhood intervention and nutrition sensitive.

JEL: F22, I15, O15
Key words: Child, undernutrition, dynamics of inequalities, Ethiopia

1. Introduction

Child malnutrition continues to be the leading public health problem in developing countries. Globally, there were 165 million stunted, 99 million underweight, and 51 million wasting children by year 2012. It kills 3.1 million under-five children every year (Black, 2013). Undernutrition among children is a critical problem because its effects are long lasting and go beyond childhood. It has both short and long term consequences (Glewwe, 2007; Abuya, 2012). Ethiopia has the second highest rate of malnutrition in Sub-Saharan Africa (SSA). The country faces the four major forms of malnutrition: acute and chronic malnutrition, iron deficiency anemia, vitamin A deficiency, and iodine deficiency disorder (UNICEF, 2017).

Although Ethiopia has already achieved a remarkable progress in reducing under-five mortality in the last decades, undernutrition among children is still a common problem in this country. Undernutrition can best be described in the country as a long term year round phenomenon due to chronic inadequacies in food combined with high levels of illness in under-five children. It is the underlying cause of 57% of child deaths (CSA, 2011). Thus, socioeconomic inequalities in health outcomes have been of focus in academia and policy spheres for a while now. The vast empirical literature in the area, however, is mixed and context-specific. Many recent papers pursue a cross-country path, documenting widening inequalities in some countries and improvements in others. For example, Wagtaff (2014), based on demographic household survey (DHS) data from 64 developing countries, find that the poor are more likely to face health risks, including child undernutrition and mortality, and less likely to receive key health services. They conclude that health outcomes are pro-rich while health interventions such as vaccinations are pro-poor.

Studies from low income countries reveal similar mixed conclusions (e.g. Baros et al., 2010; Quentin, 2014; McKinnon, 2014). After reviewing vast literature and data from nearly 100 low and middle income countries, Baros et al. (2010) find that poor children and their mothers lag well behind the better-o in terms of mortality and under nutrition. In contrast, they note that poor children are less obese and more adequately breastfed than their rich counter parts. Very recently, McKinnon (2014) analyze wealth-related and educational inequalities in neonatal mortality (NMR) for 24 low- and middle-income countries and find substantial heterogeneity in both magnitude and direction of NMR inequalities between countries. They note that while inequalities declined in most of the countries, pro-rich inequalities increased in a few countries, including Ethiopia. Quentin (2014) compares inequalities in child mortality and their trends across 10 major African cities including the Ethiopian capital, Addis Ababa. Using Demographic Health Survey (DHS) data by computing both absolute (difference and Erreyger's index) and relative inequality (rate ratio and concentration index) measures, they reveal significant inequalities in four of the 10 cities including Addis Ababa in the most recent survey.

The multi-country studies highlighted earlier and many others can provide useful insight into inequalities in child health outcomes. However, for an in-depth scrutiny of the issue, a country-level study would offer more as it takes into account the specific contexts of the country under investigation. To this end, there are various reasons why Ethiopia could be an interesting case study on inequalities in child health outcomes. Firstly, the government of Ethiopia over the past decade and half has enacted various strategies and plans in the health sector to expand health infrastructure (UNICEF, 2015). Nonetheless, the country has not yet met all the international benchmarks established by the WHO for various indicators in addition to issues related quality of health services. Secondly, Ethiopia has been a focus of many in relation to its commitments to achieve child health-related Millennium Development Goals (MDGs). Although Ethiopia has already achieved a remarkable progress in reducing under-five mortality in the last decades, undernutrition among children is still a common problem in this country. To reverse the situation, it still requires that further efforts using a more policy-relevant measure of inequality taking a longitudinal perspective (dynamics aspect). Lastly, there are various household- and child-level surveys in Ethiopia. In addition to the traditional Demographic and Health Survey (DHS), there are Young Lives Survey and the Ethiopia Socioeconomic Survey (ESS). Launched by the World Bank and the country's Central Statistical Agency (CSA) in 2011, the ESS contains selected child health outcome indicators and is superior to the DHS in terms of containing consumption expenditure and providing panel data (of three rounds in 2011/12, 2013/14 and 2015/16). Given those facts, conducting study on inequality of health outcome using different welfare indicators and longitudinal aspect is relevant to get updated evidences for formulating appropriate and timely policy.

In fact, there are few previous studies that explore child health outcome inequalities in Ethiopia such as Ambel et al., 2015; Alemu et al., 2016; Haile et al., 2016 ; Derek, 2014; Misgan et al., 2016; Asfaw et al., 2015; Zewdie and Abebaw, 2013. Estimates from a World Bank (2012) fact sheet on health equity and financial protection on the country show progress over the 2000-2011 periods on a host of child health indicators such as stunting, underweight, diarrhea, fever, etc. However, these DHS-based estimates reveal increased pro-poor inequalities over time. A recent study that is of high relevance to our case is Ambel et al. (2015). They analyze child (and maternal) health inequalities using DHS data from 2000 to 2014. Very recently, Alemu et al. (2016) provide a spatial analysis of all standard indicators of undernutrition and identify hotspot locations in the country. Haile et al. (2016) do the same but only for stunting and identify the determinants of inequality using multi-level regression.

Most of the aforementioned empirical evidences on inequalities in child health outcomes are using cross -sectional such as DHS data and various national surveys. However, previous DHS-based studies have been constrained by the lack of expenditure data. In a predominantly rural society such as Ethiopia, measuring household economic status by a stock variable i.e. wealth index is questionable while analyzing such issues as inequalities in child undernutrition. It is fact that aggregate consumption may well be a better indicator of household welfare than the DHS wealth index because it may not respond quickly to shocks. Again, this implies that the choice of welfare indicator can have a large and significant impact on measured socioeconomic inequalities in a health variable. Moreover, the growing number of countries with longitudinal[2] data sets comprising socioeconomic and health related information has stimulated the development and refinement of different approaches to the measurement of health inequalities. It indicates that we need more sophisticated approaches to monitor inequalities and design appropriate policy interventions because longitudinal measures are required to determine the incidence and effectiveness of interventions designed to tackle such health inequalities in the population[3]. Nonetheless, analyzing inequalities in child health outcome using alternative welfare indicators such as consumption and panel estimation[4] is not common or limited in many studies, especially in Ethiopia.

In this paper, we provide a more policy-relevant measure of inequality taking a longitudinal perspective to analyze dynamics of child undernutrition inequalities in Ethiopia, focusing only on children under five ages. This study differs from the previous literature (with specific to Ethiopia's case) in that it uses a flow measure consumption expenditure (data with good-quality nationally-representative household consumption surveys from the World Bank's Living Standards Measurement Study, LSMS), missing in DHS to investigate inequalities in child undernutrition while still supplementing it

[2] Socioeconomic determinants for health outcome are either interrelated or longitudinal in nature.

[3] Chronic inequalities might call for policies to tackle the structural problems that trap some individuals in deprivation and ill-health while transitory episodes might demand measures such as improvements in access to and delivery of acute health services or temporary welfare assistance. Thus, further work towards a comprehensive framework for modeling and evaluating the impact of specific policies and interventions on health inequalities is required to provide a consistent basis for resource allocation and welfare policies.

[4] Little attention has focused on measuring health mobility or whether the health of the poor is improving relative to the rich over time. This is an important issue since significant income-related inequalities in health have persisted, and even increased, in countries over the last decade in spite of considerable improvements in average health status (Doorslaer and Koolman, 2004). However, measures that do not exploit the advantages of real longitudinal data (i.e., that do not follow individuals over time) are unable to distinguish transitory inequalities (short episodes of ill-health and poverty) from ongoing structural socioeconomic and health-related deprivation. In particular, dynamic measures allow one to distinguish between transitory and chronic health inequalities and to characterize processes of inequality change.

with wealth index. It also examines spatial aspect of inequalities in child malnutrition such as across regions and rural-urban. Besides, unlike previous DHS-based studies, the current study employs panel data trend analysis on the inequalities from similar children tracked by the three rounds of the ESS from 2011 to 2016. Moreover, to address the short-run and long-run situation of inequality, analysis on dynamics of inequalities in child malnutrition over time using different approaches for mobility indices is considered.

The key results of this study show that inequality in undernutrition varies while we use different socioeconomic status (SES) indicators (such as wealth index and consumption); i.e relatively higher inequality is observed in case of consumption as SES ranking variable. Results on inequality using spatial aspect signify that significant difference in inequality of undernutrition is shown across regions. In terms of dynamics inequality, persistence of inequality in undernutrition-stunting is seen. Our inequality results are robust to different measurement scale, inequality aversion parameters/distributional sensitivity parameters, symmetric concentration index or 'sensitivity to extremity. Those results are also standardized for age and gender.

The rest of the study is organized as follows; in section two, we present comprehensive literature review on inequality in child health outcome. Section three covers a brief discussion of methods, data sources and variables measurement. Section four provides results and analyses on inequalities in child malnutrition, dynamics of socioeconomic related inequality using mobility indices, decomposition of inequality to major contributing factors and different robustness of results. Last section puts some concluding remarks.

2. Literature Review

To have better understanding on the dynamic relationship or interaction between socioeconomic and other factors, and health outcomes, it is noteworthy to adopt multidimensional conceptual framework. One of such a framework is developed by Wagstaff (2002) in which it states that health outcomes are subject to different factors such as household and communities, health service and systems, supply side factors and policies which have multidimensional or dynamic nature. There are also alternative frameworks that can be used to describe the complex range of factors that influence child nutrition. One that is widely cited is the United Nations Children's Fund (UNICEF) framework for improving child nutrition, which was developed a couple of years ago. As of Thomson et al. (2014), at the core of this framework, there are a number of direct determinants of nutrition, called `immediate' causes, followed by a further group called `underlying' causes and, at the periphery, a group of `basic' causes. Basic causes include political, ideological, economic, environmental, resource and technology factors. The UNICEF framework describes `short-route' interventions that address the immediate causes and `long-route' interventions that address underlying and basic causes.

There are dozens of empirical findings applied to assess health outcome, particularly the inequality of child health outcome. Basically, they vary in methods/approaches, and data type. Some use cross-sectional while others though limited and at macro level, apply panel data approach. They also differ in following either bivariate-descriptive approach or multivariate-causal analysis. However, some very relevant works are covered here.

One of the debating on health outcome inequalities is on the approach applied to measure inequality. In this regard, Wagstaff et al. (1991) offer a critical appraisal of the various methods employed to date to measure inequalities in health. However, they suggest that that only two of these--the slope index of inequality and the concentration index are likely to present an accurate picture of socioeconomic inequalities in health. Kakwani et al. (1997) also contribute on inequality measurement by looking at standardizing using demographic factors (like age and sex) play a vital role on socioeconomic inequality analysis in health.

Jones and Lobez (2004) present a method for the measurement of changes in health inequality and income-related health inequality over time in a population. However, Allanson et al. (2010) elucidate the nature of the Jones and Lopez Nicholas (2004) index of "health-related income mobility" and explains the negative values of the index that have been reported in all the empirical applications to date. They further question the value of their index to health policymakers and propose an alternative index of "income-related health mobility" that measures whether the pattern of health changes is biased in favour of those with initially high or low incomes. They illustrate their work by investigating mobility in the General Health Questionnaire measure of psychological well-being over the first nine waves of the British Household Panel Survey from 1991 to 1999.

Specifically, with regard to malnutrition inequalities, although many surveys of children have been conducted since the 1970s, lack of comparability between them has made it difficult to monitor trends in child malnutrition. To this end, DeOnis (2000) demonstrates that analysis of cross sectional data from 241 nationally representative surveys in a standard way to produce comparable results of low height-for-age (stunting). He then documents that despite an overall decrease of stunting in developing countries, child malnutrition still remains a major public health problem in these countries. In some countries, rates of stunting are rising, while in many others they remain disturbingly high. Moreover, using decomposition method, Wagstaff et al. (2003) show that inequalities in height-for-age in Vietnam in 1993 and 1998 are largely accounted for by inequalities in consumption and in unobserved commune-level influences. They add that rising inequalities are largely accounted for by increases in average consumption and its protective effect, and rising inequality and general improvements at the commune level. Although it seems superior in using consumption rather than wealth index for ranking household position based on their socioeconomic status, this study is still subject to the usual caveats regarding the causal interpretation of cross-sectional results and also unable to see the long-run inequality situation. Using cross sectional data sets available from the Demographic and Health Surveys (DHS) of 15 countries in sub-Saharan Africa (SSA), Fotso (2006) also notes that though socioeconomic inequalities in stunting do exist in both urban and rural areas across countries in SSA, they are significantly larger in urban areas.

Many recent papers also follow a cross-country path, documenting widening inequalities in some countries and improvements in others (see, for instance, Baros et al., 2010; McKinnon et al., 2014; Wagstaff et al., 2014, and Bredenkamp et al., 2014). For example, using original data from 131 demographic health surveys and 48 multiple indicator cluster surveys from 1990 to 2011, Bredenkamp et al. (2014) examine trends in socioeconomic inequalities in stunting and underweight, as well as the relationship between changes in prevalence and changes in inequality, in 80 countries. Then, they infer that reductions in the prevalence of undernutrition have generally been accompanied by neither widening nor narrowing inequalities. It rather indicates that the picture is one of a strong persistence of existing inequalities. Baros et al. (2010) and McKinnon et al. (2014) also demonstrate similar results. However, to see such kind of dynamics of inequality, panel data is more appropriate than one time snapshot data. Other empirical works from developing countries show similar conclusions.

For an in-depth scrutiny of the issue, a country-level study would offer more as it takes considers the specific contexts of the country under investigation. To this end, only few previous studies explore child health outcome inequalities in Ethiopia. Using cross sectional data from the 2000, 2005 and 2011 Ethiopian Demographic and Health Surveys, Skaftun et al. (2014) compute concentration index and a geographic Gini index to measure inequality. Then, they report that significant pro-rich inequalities were found for all indicators except treatment for suspected pneumonia in 2011. The socioeconomic inequalities seem to increase from 2000 to 2011 for under-five and neonatal deaths, whereas they are stable or decreasing for the other indicators. More importantly, Ambel et al. (2015) analyze trends in child (and maternal) health inequalities by household wealth status, mothers' education, and place of residence in Ethiopia. Using cross sectional DHS data from 2000 to 2014, they compute concentration indices (CIs) in three undernutrition indicators (stunting, wasting and underweight) and show that widening pro-rich inequality. Trend-wise, they report that inequalities more than doubled for all undernutrition indicators over the survey periods. These findings show the issue of inequality in child health outcomes should be a concern of research and policy in Ethiopia.

In summary, as it is aforementioned at the outset of the empirical literature section, the existing literature on the area under this study differs in many ways, even those findings are mixed. They are subject to number of critics. Previous DHS-based studies have been constrained by the lack of expenditure data. In a predominantly rural society such as developing countries, particularly Ethiopia, measuring household economic status by a stock variable i.e. wealth index is questionable[5] while analyzing such issues as inequalities in child undernutrition. This is due to the fact that the choice of welfare indicator might have a large and significant impact on measured socioeconomic inequalities in a health variable which it depends on the variable examined. In terms of data type also, all employ a cross-sectional data for specific context. However, for those who are interest looking at long-run inequality compare to short-run one and policy formulation, rely on cross-sectional evidence is not warranted. It is true that the determination of health is essentially a dynamic process; health today reflects experiences of the past. Hence, applying longitudinal data is superior.

Thus, to the best of our knowledge, this study is different from the previous literature in particular to Ethiopia, in that it uses a flow measure consumption expenditure, missing in DHS to investigate trend and magnitude of inequalities in child undernutrition while still supplementing it with wealth index.

Moreover, unlike previous studies which use DHS and other data sets, the current study provides a panel data trend analysis on the inequalities from similar children tracked by the three rounds of the Ethiopia Socioeconomic Survey (ESS) from 2011 to 2016. Then, for dynamics of inequalities in child undernutrition, we employ different mobility index computing approaches, and thereby see whether the cross-sectional (short-run) evidences on inequality overestimate or underestimate the long-run inequality picture. In the second paper (chapter), we devote merely on impact of Social protection program on child malnutrition.

3. Method and Data

3.1 Data

Data for the study comes from the Ethiopia Socioeconomic Survey (ESS) collected jointly by the Central Statistical Agency (CSA) of Ethiopia and the World Bank as part of the Living Standard Measurement Study-Integrated

[5] The justification behind this is that in developing countries, formal employment is less common, many households have multiple and continually changing sources of income, and home production is more widespread. In these contexts, it is generally far easier to measure consumption than income.

Surveys on Agriculture (LSMS-ISA). It is a longitudinal survey with three waves (2011/12, 2013/14 and 2015/16). The ESS[6] sample is a two-stage probability sample. It employs a stratified, two-stage design where the regions of Ethiopia serve as the strata. The first stage of sampling entails selecting enumeration areas (i.e. the primary sampling units) using simple random sampling (SRS) from the sample of the Agriculture Sample Survey (AgSS) enumeration areas (EAs). The AgSS EAs were selected based on probability proportional to size of population (PPS). The sample design of the first wave provides representative estimates at the national level for rural-area and small-town households while subsequent waves include large towns and cities. The samples are also regionally representative for the major regions of the country (Oromia, Amhara, Tigray, and SNNP) as well as Addis Ababa since the second wave. The second stage of sampling is the selection of households to be interviewed in each EA.

The surveys provide household-level data on a range of issues such as consumption expenditure, assets, food security shocks, copying strategies, non-farm enterprises, credit etc. Very importantly, individual- level data are available on socioeconomic, demographics, education, health and time use (labor and leisure).

Moreover, as traditional in LSMS surveys, community-level data on a host of issues such as health infrastructure as well as market price data from two nearest local markets are collected. Finally, data are obtained from 3,969, 5,262 and 4954 households in the first, second and third waves respectively. However, the sample for health variable data is restricted to children under the age of 5 in this study.

[6] ESS began as ERSS (Ethiopia Rural Socioeconomic Survey) in 2011/12. The first wave of data collection in 2011/12 included only rural and small town areas. The survey name dropped the word Rural in the second wave of data collection when the sample was expanded to include all urban areas. The urban supplement was done in such a way to ensure that the ESS data can provide nationally representative estimates.

Health outcome variable

Our health outcome interest is malnutrition using anthropometric indicator. Theoretically, the body of a child responds to malnutrition in two ways that can be measured by anthropometric survey. First, a reduction in growth over the long-term results in low height-for-age or stunting. Second, a short-term response to inadequate food intakes is assessed by weight relative to height (wasting). The combination of short-term and long-term food shortage and growth disturbances produces low weight-for-age (underweight) (ONIS, 2000). Survey data often contain measures of weight and height, in particular for children. Weight and height do not indicate malnutrition directly. Besides age and sex, they are affected by many intervening factors other than nutrient intake, in particular genetic variation. However, even in the presence of such natural variation, it is possible to use physical measurements to assess the adequacy of diet and growth, in particular in infants and children. This is done by comparing indicators with the distribution of the same indicator for a healthy reference group and identifying extreme or abnormal departures from this distribution (World Health Organization, 1995).

Irrespective of what particular reference data are used, anthropometric indices are constructed by com-paring relevant measures with those of comparable individuals (in regard to age and sex) in the reference populations. There are three ways of expressing these comparisons: Z-score (standard deviation score), percent of median and percentile. However, the preferred and most common way of expressing anthropometrics indices is in the form of z-scores. More specifically, Z-score for an individual i is calculated using equation 1.

$$\mathrm{Z-score i} = \left(\frac{X_i - X_r}{\delta_r}\right) \qquad (\mathbf{1})$$

Where X_i is an observed value for i^{th} child in a target population; X_r is a median of the reference population; and δ is a standard deviation (SD) of the reference population.

Thus, the health outcome variables used in this study are the three anthropometric indicators (Height-for-age Z-score (HAZ), Weight-for-Height

Z-score (WHZ), and Weight-for-Age Z-score (WAZ). We first compute those anthropometric indicators from age, height/length and weight data following the WHO (2006) child growth standards. We then state stunting, wasting and underweight levels for children aged less than 5 years as shown in Table 1.

Table 1: List and description of child undernutrition indicators

Indicator	Description
Stunted	If child's height-for-age z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference group
Wasted	If child's weight-for-height z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference group
Under-weighted	If child's weight-for-age z-score is less -2 standard deviations (SD) from the international median (WHO, 2006) healthy reference group

Other variables

Those are used as explanatory variables for regression -based decomposition analysis as well as socioeconomic (SES) ranking variables in computing SES -related health inequalities. Broadly, they can be grouped as child level characteristics, household and community level characteristics. The child level characteristic includes child's age, age square gender, and illness. Under household level, wealth index, consumption, mother's education, toilet facilities[7] and household sizes are considered. At community level, health facilities, access to safe drink water and spatial dimension such as household's place of residence in the form of rural urban or regions. Detail on each variable definition and measurement are given in Table (2). However, among those household socioeconomic characteristics, wealth index and consumption are chosen as socioeconomic (SES) ranking variables for household position

[7] Categorized based on WHO standard given for toilet type. It includes Flush toilet-private, Flush toilet-shared, Pit lantreen- private ventilated, Pit lantreen-shared ventilated, Pit lantreen-private -ventilated, Pit lantreen-shared not ventilated, Bucket, Field / forest/ and Others.

in measuring inequalities. Let's see below in detail how those values are constructed.

Wealth index: Households were asked whether they owned from a list of asset items (such as farm implements, furniture and kitchenware, entertainment and communication equipment, electronic item personal items etc) or not[8]. It also considers various indicators of housing condition of household such as walls, roof, and floor of the main dwelling; type of kitchen, cooking and bathing facilities. Then, following the standard approach of assessing economic status of the household, the study uses household asset and housing conditions to compute wealth index using principal component analysis (PCA) while sampling weight is taken in to account. Unlike Demographic Household Survey (DHS) and other data sets' wealth index which is constructed from urban-based social and economic amenities and may be measuring more of urban/city condition instead of inclusive socioeconomic status, this study uses Ethiopian Socioeconomic Survey (ESS) data which also includes rural based socioeconomic asset indicators.

Consumption[9]. The surveys include questions on expenditure on food and non-food items, food security, shocks, and coping mechanisms. The total consumption expenditure (available from the survey) is constructed from food consumption, non food consumption and education expenditure. Initially, a

[8] Included 35 asset items such as Kerosene stove, Butane Gas Stove, Electric Stove, Blanket/Gabi, Mattress and /or Bed, Wrist watch/clock, Fixed line telephone, Mobile telephone, Radio/ radio and tape/ tape, Television, CD/ VCD/ DVD / Video Deck, Satellite Dish, Sofa set, Bicycle, Motorcycle, Cart (hand pushed), Cart (animal drawn), Sewing machine, Weaving equipment, Mitad-Electric, Mitad-power saving (modern), Refrigerator, Private Car, Jewels (Gold and Silver), Wardrobe, Shelf for storing goods, Biogas stove (pit), Water storage pit, Mofer and Kember, Sickle (Machid), Axe (Gejera), Pick Axe (Geso), Plough (traditional), Plough (modern) and Water Pump.

[9] In all surveys, consumption and expenditure information was collected on a limited number of items. The consumption and expenditure information was collected within the household questionnaire during the third visit to the household in both surveys; this occurred between January and March 2012 for ESS1 and between February and April 2014 for ESS2. Information was collected for 25 food items consumed over the last 7 days2, 11 basic household goods (matches, batteries soap, etc.) over the past month, and 12 other expenditures (men's clothing, linens, etc.) over the past 12 months.

common reference period is established for all items, and values are imputed in cases in which they are not available (converted to a uniform reference period for example, a year). Then, it follows three steps in constructing a consumption-based living standards measure: (a) construct an aggregate of different components of consumption, (b) make adjustments for cost of living differences, and (c) make adjustments for household size and composition. Household size and a measure of adult-equivalency[10] are constructed based on scale factors such as categorizing age in to different ranges (13 age categories) for both male and female by allocating different weights for each category. In addition, it uses a regional price index (for 10 regions), based on the index created by the Ministry of Finance and Economic Development (MoFED) in their Household Consumption Expenditure (HCE) 2010/2011, 2013/14 and 2015/16 reports. Nominal and real per adult equivalent consumption were then calculated, and real consumption was re-scaled to have the same overall mean value as nominal consumption. The calculated per capita amounts winsorised at the 97th percentile for non-zero consumption for each item (for details, see LSMS annual report of each wave, guideline for constructing aggregate consumption). In this study, we also group the households into quintiles based on the wealth index and consumption adjusted by sample weights for nationally representative inferences.

[10] Bases on Dercon and Krishnan (1998)1 proposed equivalences on nutritional (caloric) requirements of different ages for both men and women.

Table 2: Description and measurement of variables used in decomposition analysis

Variables	Definition/Description	Measurement /type
	Anthropometrics indicators	
HAZ-score	The length/height(in meters) of children 0 months to 59 months of age	Height for age Z-score
WHZ-score	The weigh(in kilogram) and height of children 0 months to 59 months of age	Weight for-height Z-score
WAZ-score	The weight (in kilogram) children of 0 months to 59 months of age	Weight for age Z-score
	Demographic characteristics at individual level	
Age	Age of child	Continuous, in months
Age-square	Child age square	Continuous, in months
Gender	Sex of child	Dummy; 1 if male, 0 otherwise
Child illness Incidence	Whether the child has had diarrhea in the last two weeks leading up to the interview	Dummy; 1 if yes , 0 otherwise
	Socioeconomic characteristics at household level	
Wealth index	How many of each of the following items does the household own? (housing condition)	Continuous, index computed based on PCA
Consumption	Household's real annual consumption (food and non food total expenditure) per adult equivalent	Continuous, annual real total per adult equivalent
Mother's education	What is/was biological mother's highest educational level completed?	Categorical, Level of certificate completed
Household size	Total number of family members	Continuous
Household size under age 5	Number of under 5 age household members	Continuous
Toilet facility	What type of toilet facilities does the household use?	Categorical
	Community level characteristics	
Health care services	Is there any health post in the surrounding community	Dummy ;1 if yes, 0 otherwise
Water availability	Is there water service in the community	Dummy ;1 if yes, 0 otherwise
Place of residence	Household residence place (urban-rural, region)	Dummy; 1 if rural 0 if urban

3.2 Method

3.2.1 Measures of inequality in child malnutrition

The study aims to examine the child undernutrition inequalities in socioeconomic status and spatial dimensions. For socioeconomic inequalities in child health, we use consumption expenditure and wealth Index as alternative welfare measures and see the gap between the worse-off (bottom 60%) and better off (40%) as well as between the poorest (1st quintile) and the richest (5th quintile).

And for the spatial dimension, inequalities are traced between rural and urban children as well as among those in various regions of the country. We also compute absolute and relative inequalities from rate differences and rate ratios.

When there are only two subgroups to compare, difference and ratio are the most straightforward ways to measure absolute and relative inequality. However, the differences and ratios between different groups do not consider inequalities by the whole population. Hence, concentration curves are used to illustrate the trend of the socioeconomic and spatial inequalities in child undernutrition over time. The concentration curve plots the cumulative proportion of the population ranked by a measure of socioeconomic status (such as an index of household wealth and consumption) against the cumulative proportion of the health measure (undernutrition indicators). If concentration curve lies above the diagonal (45 degree line of equality), it is interpreted as child malnutrition is disproportionately concentrated among the poor and the reverse is true while it lies below line of equality. We also conduct tests of dominance between concentration curves following the procedures in O'Donnell et al. (2008).

Since a concentration curve does not give a measure of the magnitude of inequality that can be com-pared conveniently across many time periods, countries, regions, or whatever groups may be chosen for comparison, we examine inequalities using concentration index (Kakwani et al., 1997; O'Donnell et al., 2008) and with possible extension. The concentration index is defined as twice the area between the concentration curve and the line of equality (the 45-degree line). It provides a summary measure of socioeconomic related health inequality, i.e. a measure of the extent to which the concentration curve diverges from the diagonal. The convention is that the index takes a negative value when the curve lies above the line of equality, indicating disproportionate concentration of the health variable among the poor, and a positive value when it lies below the line of equality. However, when there is no socioeconomic-related inequality, the concentration index becomes zero.

In this study, with availability of panel data, we follow dynamic approach to measure inequality in health rather than a static one used in cross sectional data. The basic nationality behind is that longitudinal data are more relevant for policy making analysis. The cross-sectional data, static approach is often used to compare inequality at two different points in time while the panel, dynamic approach is essentially useful when interest lies in the long run rather short-run inequality (which can be the case for, e.g., policy makers). As Jones and Lopez (2004) prove theoretically, looking at a different point in time using short-run concentration index (CI) does not give a complete picture rather in panel, we are able to follow each individual in every year and have thus a complete picture of their relative evolution.

To this end, there are various ways of expressing the concentration index (CI) algebraically. For the measurement of inequality at one point in time, we use the concentration index (CI) stated in Equation 2, that is mostly used in the literature for its convenience. It is derived by ranking the population by a measure of socioeconomic status (SES) and then comparing the cumulative proportion of health with the cumulative proportion of the population ranked by SES.

$$CI_t = \frac{2}{N\bar{y}_t}\sum_{i=1}^{N}(y_{it} - \bar{y}_t)\left(R_i^t - \frac{1}{2}\right) = \frac{2}{\bar{y}_t}cov\left(y_{it}, R_i^t\right) \qquad \mathbf{(2)}$$

Where y_{it} represents the health level of individual i in period t, and R^t denotes the relative fractional rank of i^{th} individual in the distribution of

SES in period t; N is the sample size at period t. $\bar{y}_t = \frac{\sum_{i=1}^{N} y_{it}}{N}$ is the mean of health of the sample in the period t.

Equation 2 shows that the value of concentration index is equal to the co-variance between individual health (y_i) and the individual's rank (R_i^t), scaled by the mean of heath in the population (y_i). Then to ensure the concentration index ranges between -1 and $+1$, the whole expression is multiplied by 2. Alternatively, it can be defined as a measure of the degree of association of between an individuals' level of health and their relative position in the SES distribution. The negative and positive sign of concentration index tells us that health outcome is concentrated among poor and rich people respectively. It is important to highlight that a value of concentration index (CI) is equal to zero does not mean an absence of inequality, but an absence of socioeconomic gradient in the distribution, i.e. an absence of inequality associated with socioeconomic characteristics.

However, Jones and Lopez (2004) illustrate that cross-sectional concentration index (CIs) can lead to wrong conclusions when trying to measure socioeconomic-related health inequality in the long run as these do not take into account the possibility that people may change in socioeconomic rank. As such, they derive a formula to measure inequality in the long run, which is similar to the cross-sectional CI. They find that the CI for the distribution of average health after T periods can be written as the difference between two terms: the weighted sum of the CIs for each of the sub periods (term1) minus a residual which is the difference between period specific SES ($\mathrm{R}_{\mathrm{i}}^{\mathrm{t}}$)and ranks for average specific socioeconomic status (SES) over all periods (R_i^T) and their relationship to health over time (term 2) as stated below in Equation 3.

$$CI^T = \underbrace{\sum_i w_t CI^t}_{Term1} - \underbrace{\frac{2}{NT\bar{y}} \sum_i \sum_i (y_{it} - \bar{y}^t)\left(R_i^t - R_i^T\right)}_{Term2} \qquad (3)$$

where $\bar{\bar{y}} = \frac{\sum_i \sum_i y_{it}}{NT}$ is the overall average health status/population/ in T periods; $\sum \frac{\bar{y}_t}{T} = \bar{y}^T$ is the average health of the individual over the T periods, $\bar{y}^t = \frac{\sum_i y_{it}}{N}$ is the mean of the health of individual in each t period, $\mathrm{w}_t = \frac{\bar{y}_t}{T\bar{y}^T}$ can be seen as the share of total health in each period; and CI^T is defined as long-run CI and CI^t is short-run CI of each health variable under consideration in period t.

The concentration index can be computed easily in stata software either using covariance method or regression-based method. Accordingly, this study adopts the user-written stata command conindex developed by O'Donnell et.al. (2016)[1]. It calculates rank-dependent inequality indices while offering a great deal of flexibility in considering measurement scale and alternative attitude to inequality. Estimation and inference is via a regression approach that allows for addressing the issue of sampling design, misspecification and for testing for differences in inequalities across population or sub-populations. The magnitude and sign of concentration index depends on the method used to compute the required index. These results also affect the inequality analysis. When the variable of interest has an infinite upper bound on a fixed scale, the main normative choice is between absolute and relative invariance. Matters are more complicated when the measurement scale is not unique. Applying the generalized concentration index to a ratio or cardinal variable requires one to accept that the inequality ordering may depend on the scaling adopted. This can be avoided for the relative inequality invariance criterion if one replaces the standard concentration index with the modified one. When the variable has a finite upper bound, one should first choose between relative inequality invariance and the mirror condition. If one prioritizes the relative invariance criterion (in attainments or shortfalls), then the standard concentration index or its modified version can be used. When priority is given to the mirror condition, one faces a choice between the Erreygers index, which focuses on absolute differences, and the Wagstaff index, which mixes concern for relative

[1] With repeated cross-section or panel data, one can use the command to compare inequality across periods. The command can also be used to estimate rank-dependent indices of univariate inequality, such as the Gini and generalized Gini.

inequalities in attainments and relative inequalities in shortfalls (O'Donnell et al., 2016).

In our case, for standard and generalized concentration index (CI), the health variable (the dependent variable) is negative of Z-score which is continuous and unbounded variables while in case of Erreygers and Wagstaff, it is binary which is bounded variables taking a value either 1 if stunted, wasted and underweighted or 0 if not undernutritioned.

3.2.2 Mobility index and dynamics of inequality in child undernutrition

Since this study prefers to use longitudinal data, its other basic concern is examining the measurement of malnutrition inequality with variation of socioeconomic status (SES) variables over time (SES related health inequality mobility). In this regard, even if individuals do not experience health changes, long-run SES- related inequality can be greater or less than that obtained with snapshot cross-sectional estimates, as long as the patterns of SES mobility are systematically related to health. Averaging the short-run measures of inequality will then tend to underestimate or overestimate the long-run picture. However, in situations where SES- related inequality tends to fade either solely due to health mobility or solely due to SES mobility, the mobility index would be zero. In these cases, the information obtained from the series of cross sectional concentration indices would be sufficient to capture the dynamics of interest. Hence, it is useful to measure how much the longitudinal perspective alters the picture that would emerge from a series of cross sections, in the same spirit as Shorrocks' (1978) index of income mobility. With same notational representation used above for computing long-run CI, Jones and Lopez (2004) put mobility index M^{T} for any SES variables:

$$M^T = 1 - \frac{CI^T}{\sum_t w_t \, CI^t} = \frac{2}{N \sum_t \bar{y}^t CI^t}\left(\sum_i \sum_t (y_{it} - \bar{y}^t)\left(R_i^t - R_i^T\right)\right) \qquad \mathbf{(4)}$$

Here, mobility index would be different from zero if the following two conditions hold: i) The SES rank of individuals is sensitive to the length of the time window over which measurement is taken, i.e. there is SES mobility, as defined by Shorrocks (1978)[2]. ii) These changes in SES rank are associated with systematic differences in health variable considered. If mobility index is negative in sign, it implies that short-run concentration index (cross sectional) underestimates long-run one (longitudinal data) while it is positive, it shows that short-run CI overestimate long-run one.

Jones and Lopez (2004) provide an index that measures the difference between short run and long run income-related health inequality and suggest that it can be interpreted as an index of health-related income mobility. Nonetheless, as of Allanson et al. (2010), it is questionable whether this index is more appropriate to health policy makers other than to illustrate that income-related health inequalities may be slightly more important than might be inferred from cross-sectional estimates. Moreover, they note that, initially, health policy-makers are more likely to be interested in income-related health changes, less so in health-related income changes, especially since a large amount of health-related income changes are likely to be unavoidable.

Jones and Lopez (2004) measure is equal zero if there is no income mobility regardless of whether there is health mobility. Conversely, the measure may not equal zero even if there are no health changes. Second, the index provided by Jones and Lopez (2004) is symmetric in the sense that the value of the index is invariant to the ordering of the years. Yet, policy makers may want to distinguish between equalizing and disequalising income changes since these have diametrically opposed implications for the level of income-related health inequality over time. Finally, the value of the Jones and Lopez (2004) index is likely to be little more than a reflection of the unimodal shape of the income distribution and the strength of the association between income and health in the long run compared to the short run.

As a remedy for these shortcomings, Allanson et al. (2010) propose an alternative approach based on the simple observation that any change in income-related health inequality over time must arise from some combination

[2] There is complete immobility when the relative incomes of all individuals remain constant over time. However, as income profiles deviate further from this extreme, income mobility increases. If incomes are not completely immobile, inequality tends to decline as the length of the measurement period increases (Shorrocks', 1978)

of changes in health outcomes and income ranks. By decomposing the change in between two periods, they provide an index of income-related health mobility that captures the effect on short run income-related health inequality of differences in relative health changes between individuals with different initial levels of income. Thus, the measure addresses the question of whether the pattern of health changes is biased in favour of those with initially high or low incomes, providing a natural counterpart to measures of income-related health inequality that address the issue of whether those with better health tend to be the rich or poor. In addition, like Jones and Lopez (2004), they also obtain a health-related income mobility index that captures the effect of the reshuffling of individuals within the income distribution on cross-sectional socioeconomic inequalities in health. Accordingly, in this study, we adopt Allanson et al. (2010) approach to decompose the change in the short run concentration index (CI) between any initial or start period s and any final period f into two part:

$$CI^f - CI^s = \frac{2}{\bar{y}^f} cov(y_{if}, R_{if}) - \frac{2}{\bar{y}^s} cov(y_{is}, R_{is});\; s, f = 1,..T;\; s \leq f$$

$$= \left(\frac{2}{\bar{y}^f} cov(y_{if}, R_{if}) - \frac{2}{\bar{y}^s} cov(y_{if}, R_{is})\right) + \left(\frac{2}{\bar{y}^f} cov(y_{if}, R_{is}) - \frac{2}{\bar{y}^s} cov(y_{is}, R_{is})\right)$$

$$= \left(CI^{ff} - CI^{fs}\right) + \left(CI^{fs} - CI^{ss}\right) = M^R - M^H \quad (5)$$

Where y_{is} and R_{is}; are health and relative fractional rank of individual at starting period. Similarly, y_{if} and R_{if} denote health and relative fractional rank of individual at final period. y^f and y^s represent mean of health at final and starting period respectively. CI^{ss} and CI^{ff} are the CI's in periods starting (s) and final (f) respectively, and CI^{fs} is the CI obtained when health outcomes in the final period are ranked by income in the initial period.

In Equation 5, the mobility index, $M^H = CI^{fs} - CI^{ss}$ provides a measure of income-related health mobility, which captures the effect of differences in relative health changes between individuals with different initial levels of income. M^{H} is positive (negative) if health changes are progressive (regressive) in the sense that the poorest individuals either enjoy a larger (smaller) share of total health gains or suffer a smaller (larger) share of total health losses compared to their initial share of health, and equals zero if relative health changes are independent of income. M^{H} in turn depends on the level of progressivity and scale of health changes.

However, the income-related health mobility index, M^{H} is not exactly equal the change in income-related health inequality because it does not allow for the effect of changes in the ranking of individuals in the income distribution between the initial and final periods. This effect is captured by the health-related income mobility index, $\mathrm{M}^{\mathrm{R}} = \mathrm{CI}^{\mathrm{ff}} - \mathrm{CI}^{\mathrm{fs}}$. It may be negative since the concentration index of final period health outcomes ranked by initial income can exceed that ranked by final income. M^{R} can be equal to zero, irrespective of the degree of reshuffling of individuals in the income distribution, if final period health is uncorrelated with changes in income rank (Allanson et al., 2010).

3.3 Measurement of inequality using decomposition method

In this part of the study, we decompose the concentration index of each child undernutrition indicator in order to identify the major contributing factors to the inequality. Such decomposition method enables us to know what extent of inequality in child malnutrition is explained by inequalities in socioeconomic status such as education, health access to maternal and child health care, etc? Wagstaff, van Doorslaer, and Watanabe (2003) demonstrate that the health concentration index can be decomposed into the contributions of individual factors to income-related health inequality, in which each contribution is the product of the sensitivity of heath with respect to that factor (the elasticity) and the degree of income-related inequality in that factor (the respective concentration index).

To explain variations in a child's under-nutrition level, we adopt a standard household production-type anthropometric regression framework (Lavy et al., 1996; Thomas et al., 1996), in which negative of each child's anthropometrics indicators (Z-score) is specified to be a linear function of a vector of child-level variables, a vector of household-level variables, and community level.

We interpret our estimating equation as a reduced-form demand equation rather than a production function.

Here, we focus on inequalities in all malnutrition indicators measured using the negative of the child's height-for-age z-score, weight-for-height z-score, and weight-for -age z-score respectively following the WHO (2006) child growth standard data. Like Wagstaff et al. (2003) and many others in the literature, we have two reasons for favoring the z-score over a binary variable indicating whether or not the child in question was undernutritioned or not. First, it conveys information on the depth of malnutrition rather than simply whether or not a child was malnourished. Second, it is amenable to linear regression analysis, which is favorable to our decomposition method. Since the equation used for decomposing the concentration index (CI) requires linearity of the underlying regression model, most of the decomposition result holds for a linear model of health outcomes. Moreover, we use the negative of the z-score to make our malnutrition variable easier to interpret. Rising of negative of the z-score indicates an increasing in malnutrition level. Accordingly, for our regression based -decomposition, we rely on malnutrition level rather than binary outcome as dependent variable.

Since this study employs longitudinal data, the specification of our model for decomposing socioeconomic related inequality in health could be simple pooled OLS model, random effect model and fixed effect model. Most studies in this topic use simple pooled linear model, estimating by ordinary least square (OLS) but it doesn't take in to account potential error components structure and dynamics. We then use both random and fixed effect to model and estimate the regression equation for decomposing inequality. We thus consider linear panel models[3] as it is indicated in Equation 6.

[3] With respect to interpretation of decomposition results, one should carefully realized that though decomposition methods are based on regression analyses, there are two possible cases: First, If regressions are purely descriptive, they reveal the associations that characterize the health inequality. Then inequality is explained in a statistical sense but implications for policies to reduce inequality are limited. Second, if data allow identification of causal effects, the factors that generate the inequality are identified. Then, it is possible to draw conclusions about how policies would impact on inequality. Hence, estimation technique and model that fit for our purpose is selected with this context.

$$Y_{ihct} = \beta_0 + \beta_1(X_1)_{it} + \beta_2(X_2)_{it} + \beta_3(X_3)_{it} + \mu_{ihct} \quad (6)$$

Where Y_{ihct} indicates that malnutrition level of child i in a household h , community c and in time t, X_1, X_2, and X_3 are vectors of child level, household level and community level explanatory variables respectively (for details on variable definition and measurement, see Table 2). While β is a vector of regression coefficients which show the effect of X on Y; $\mu_{ihct} = \alpha_i + \varepsilon_{ihct}$, α_i [4] is individual specific effect (could be random or non- random) effect) and ε_{ihct} is idiosyncratic error term.

In decomposing concentration index (CI), we follow the formula proposed by Wagstaff et al. (2003) while linear panel data is taken in to account in this study. Then, the decomposed concentration index as stated in Equation 7 shows that it is equal to the weighted sum of the concentration indices of the K regressors:

$$CI^T = \sum_k \left(\frac{\beta_k \bar{X}_k}{\bar{y}^T}\right) CI_K^T + \frac{GC_\epsilon^T}{\bar{y}^T} = \sum \eta_D \, CI_k^T + \frac{GC_\epsilon^T}{\bar{y}^T} \quad (7)$$

Where CI^{T} is overall long-run CI for health, $\bar{y}^{\mathrm{T}}$ is the mean health over all periods, β_k are coefficients obtained from regression of equation 6, $\bar{X}_k$ is mean of the k^{th} regressor taken over all periods, CI_k^T is the long-run CI of the k^{th} regressor and GC_ϵ^T is long-run generalized concentration index for each error5 term and $\left(\eta_k = \beta_k \frac{\bar{X}_k}{\bar{y}^T}\right)$ is elasticity of health variable under consideration with respect to the explanatory variables (X_k).

Since the main objective of decomposition analysis is to offer an explanation of socioeconomic inequality of health by including the contributions of each explanatory variable to such inequality, the product of elasticity (k) and concentration index of $k^{\sim h}$ regressor CI_k^T gives us the contribution of each explanatory variable in the variation of inequality in health variables.

[4] Depending on our estimator's choice, α_i can be random or non-random if it is random effect or fixed effect estimator respectively.

3.4 Blinder -Oaxaca Decomposition

It is common to raise why do gaps in health outcome exist between the poor and better-o in many countries despite health systems explicitly aimed at eliminating gap in health outcome? Hence, the Oaxaca-type decomposition (Oaxaca, 1973; O'Donnell et al., 2008) is employed to explain the difference between two groups. Such type of decomposition explains the gap in the means of an outcome variable between two groups (e.g., between the poor and the non-poor). The gap is decomposed into group differences in the magnitudes of the determinants of the outcome in question and group differences in the effects of these determinants. But, such method does not allow us to decompose inequalities in health outcome across the full distribution of SES variable, rather we simply restricted to analysis between the poor and the better-o. The decomposition equation we use to estimate the health outcome gap between two groups is given in Equation 9. However, we take panel data rather than different cross-sectional data for our estimate.[6]

$$Y_{ihct} = \beta^{P} X_{ihct} + \varepsilon_{ihct}^{P} \quad if \;\; poor \tag{8}$$

$$Y_{ihct} = \beta^{R} X_{ihct} + \varepsilon_{ihct}^{R} \quad if \;\; Rich \tag{9}$$

$$\bar{Y}_R - \bar{Y}_P = (\bar{X}_R - \bar{X}_P)\beta' + (\beta_R - \beta_P)\bar{X}_R \tag{10}$$

$$\bar{Y}_P - \bar{Y}_R = (\bar{X}_R - \bar{X}_P)\beta^{R} + (\beta_R - \beta_P)\bar{X}_R \tag{11}$$

where C_{it} is individual child undernutrition level at time t, X_{ihc}t is vector of child, household and community level characteristics at time t. $\bar{X}$ represents mean of individual child undernutrition level for each group and $\bar{C}$ represents vector of child, household and community level characteristics evaluated at mean for each groups and β'^{s} also represents estimated coefficients including intercepts for poor and non-poor . So, the gap in Y between the poor and the

[6] The residual component captured by the last term reflects the income-related inequality in health that is not explained by systematic variation in the regressors such as by income, which should approach zero for a well-specified model.

non-poor might come from differences in the coefficients (β) including intercepts (difference in effects), and differences in those determinants level (X). Estimates of the difference in the gap in mean outcomes can be obtained by substituting sample means of the X's and estimates of the parameter's into Equation 8. As it is stated in Equation 12, the mean health outcome difference between the two considered gaps can be attributable to (i) differences in the X's (sometimes called the explained component); (ii) differences in the 's (sometimes called the unexplained component) and interaction effect (change in product of X and ; β, βX).

$$\bar{Y}_R - \bar{Y}_P = (\bar{X}_R - \bar{X}_P)\beta^P - (\beta_R - \beta_P)\bar{X}_R \ + (\bar{X}_R - \bar{X}_P)(\beta_R - \beta_P) \qquad (12)$$

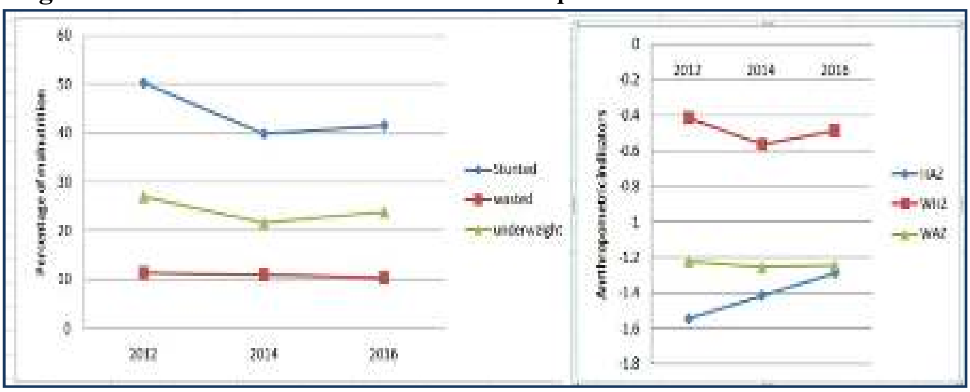
4. Results and Discussion

This part is basically devoted for result interpretation and analysis on inequalities in malnutrition based on different approach of measuring inequality and its dynamics. It also covers analysis on contribution of major factors incorporated for the inequalities prevalence using decomposition method.

4.1 Basic descriptive statistics

It is noteworthy to see first some basic descriptive statistics on major health and socioeconomic variables used in this study. Referring to Figure (1), from 2011/12 to 2015/16, one can observe that percentage of undernutritioned children in all indicators (on average) falls.

Figure 1: Trend of malnutrition and Anthropometric indicators across wave



As it is aforementioned, the final data used in this study is constructed from various individual, household and community level covered in all three survey waves. The health variable data is prepared from each individual's child's age, sex weight, and height, using Zanthro ado file with reference to WHO (2006) child growth standards.

Table 3: Summary statistics of variables used in regression for decomposition

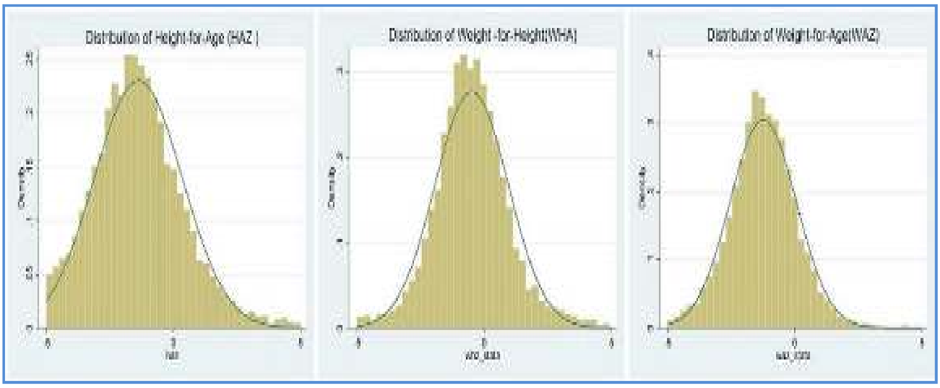
Variable	Obs	Mean	Std. Dev
Age_months	11061	45.73339	27.44576
Agesqr	11061	2844.744	2829.643
Ilness incidence	10835	.1728657	.3781486
Water_availability	11049	.4469679	.2758621
Toilet facility	11056	6.342438	1.205653
Health post	10819	1.105093	.3066873
mother education	10767	.4592737	.9098248
Household size	11061	6.23063	2.020077
Household size under 5 age	11061	1.504114	.8234286
HAZ	9011	-1.3873	1.73204
WHZ	8415	-.49157	1.43958
WAZ	9784	-1.24230	1.30505
Wealth index	11007	-.7662025	1.444134
Consumption per capita	10785	5278.117	4394.013

Finally, total of 11,061 individual observations from those three waves are considered for analysis. However, we use a balanced panel data with observations of 6087 individuals for measuring dynamic of inequalities over time using mobility indices. Then, outliers and normality tests are conducted for major socioeconomic variables.

Figure (2) shows an overview of distribution of child malnutrition indicators by their Z-score. Similarly, Figure 5 in appendix signifies that the distribution of wealth index is more concentrated to the left with negative sign which indicates that most of the households are poor. It also apparently shows that real annual consumption per adult equivalent is skewed to the right for the clear reason that consumption can't be negative in values.

Basically, the analysis of anthropometric data is used for the identification of undernourishment in a population or sub-population. Accordingly, a first step is to look at the distribution of the z-scores and the overall prevalence of undernourishment. When compared with the distribution of z-scores in the reference population, this provides a first impression of different dimensions of nutritional status in the population.

Figure 2: Distribution of Anthropometric indicators



Almost in all Z-scores (see, Figure 2), the distribution is skewed to the left which implies that many individuals are away from the median of the distribution. HAZ-score and WAZ-score are also positively correlated while HAZ and WHZ-score are negatively correlated.

4.2 Inequality in undernutrition

Before measuring inequality using complex approach, it is common to use simple approach which is helpful merely to look at the absolute mean difference of anthropometric score between two groups. In due respect, significant mean difference is exhibited between different groups considered in this analysis such as rural and small town, bottom 60 % and top 40 %, richest and poorest, male and female. This shows that the prevalence of malnutrition is disproportionately distributed across different groups.

Table 4: Mean difference of anthropometric indicator between two groups

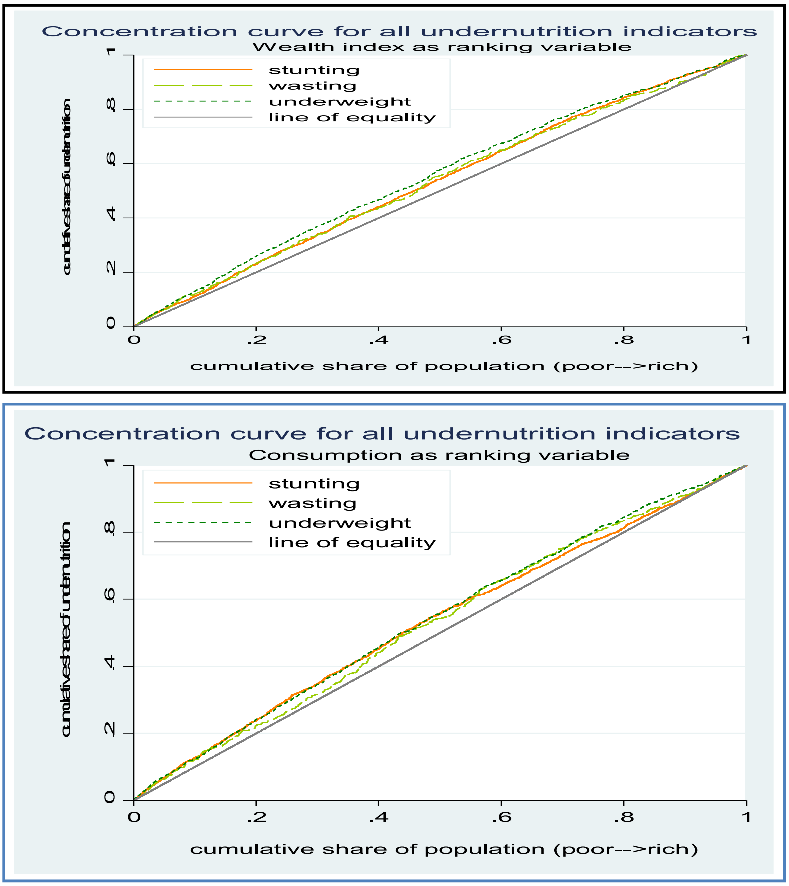
Groups	HAZ	WHZ	WAZ
Small town	-1.1(.064)	-.33 (.057)	-.84 (.048)
Rural	-1.4(.018)	-.50 (.016)	-1.2 (.013)
Deference (Small town -Rural)	.30** (.070)	.16*** (.061)	.42*** (.051)
Male	-1.4(.025)	-.47 (.022)	-1.2 (.018)
Female	-1.3 (.026)	-.51 (.022)	-1.1 .(018)
Deference(Male -Female)	-.06*(.036)	.04(.031)	-.08*** (.026)
Wealth index			
Poorest (1st quintile)	-1.5 (.062)	-.57 (.054)	-1.4 (.042)
Richest (5thquintile)	-1.1 (.079)	-.26 (.067)	-.86 (.058)
Difference (1st-5th)	-.44*** (.103)	-.31** (.089)	-.59*** (.072)
Non-poor (Top 40%)	-1.1(.031)	-.42 (.027)	-1.03 (.023)
Poor (Bottom 60%)	-1.4 (.022)	-.52 (.019)	-1.33 (.015)
Difference (40%-60%)	.30*** (.039)	.09*** (.033)	.29*** (.028)
Consumption			
Poorest (1stquintile)	-1.5 (.065)	-.61 (.056)	-1.4 (.045)
Richest (5thquintile)	-1.2 (.075)	-.27 (.064)	-.94 (.053)
Difference (1st-5th)	-.35** (.099)	-.34** (.085)	-.53*** (.069)
Non-poor (Top 40%)	-1.2 (.030)	-.45 (.026)	-1.1 (.021)
Poor (Bottom 60%)	-1.4 (.023)	-.51 (.019)	-1.3 (.016)
Difference (40%-60%)	.22*** (.038)	.06* (.032)	.20*** (.027)

Note: Significance level ***, ** and * is at 1%, 5% and 10% respectively and; Std. Errors are in parenthesis. Two-sample t test with equal variances (Ho: difference is zero ; H1: difference is different from zero

In terms of HAZ- malnutrition level, regions can be ranked from highest to lowest as Tigray, Amhara, SNNP, Oromia, and Other regions respectively while in WHZ- malnutrition level, it is as follows Tigray, Other regions, Amhara, Oromia, and SNNP respectively. Similarly, with WAZ- malnutrition level, it is given as Tigray, Amhara, Other regions, SNNP, and Oromia respectively (for details, see Table 17, in the appendix part).

Since pairwise comparisons ignore all other subgroups that are not being compared, it is common to employ multiple (complex) measures in the analysis of inequality. The most common and appropriate methods for measuring inequality magnitude and directions are thus concentration curves and index.

Figure 3: Concentration curves of undernutrition indicators



As it is illustrated in Figure (3), the concentration curves for each undernutrition indicators is located above the line of equality. These indicate that higher malnutrition level is disproportionately prevailed among the poor section of the population in both socioeconomic status (SES) ranking variables, i.e. pro- poor inequality in terms of malnutrition level.

Estimation and inference is via a regression approach, user-written stata command conindex, developed by O'Donnell et al. (2016) that allows for addressing the issue of sampling design, misspecification and for testing for differences in inequalities across population or sub-populations. For standard and generalized concentration index (CI), the health variable is negative of Z-score which is continuous and unbounded variables while in case of Erreygers and Wagstaff, it is binary which is bounded variables (either 0 or 1).

Table 5: Concentration indices (CI) of malnutrition prevalence by methods: Ranking variables -wealth index and consumption

Method/	Standard CI			Generalized CI		
	CIc-CIw			CIc-CIw		
Indicators	Wealth	Consumption	Difference	Wealth	Consumption	Difference
HAZ	-.040***	-.070***	-.024**	-.065***	-.114***	-.039**
	(.011)	(.012)	(.011)	(.019)	(.020)	(.017)
WHZ	-.028**	-.023***	.000	-.023**	-.019*	.000
	(.012)	(.013)	(.012)	(.010)	(.011)	(.010)
WAZ	-.061***	-.059***	.002	-.087***	-.084***	.004
	(.010)	(.010)	(.009)	(.014)	(.015)	(.015)
Observation	6087	6087	5133	6087	687	5133
	Erreygers-	**Normalized**	**CIc-CIw**	**Wagstaff-**	**Normalized**	CIc-CIw
	Wealth	**Consumption**	**Difference**	**Wealth**	**Consumption**	**Difference**
Stunting	-.093***	-.111***	-.054**	-.107***	-.132***	-.059**
	(.024)	(.025)	(.023)	(.028)	(.029)	(.025)
Wasting	-.028**	-.031***	-.009	-.083**	-.092***	-.025
	(.012)	(.012)	(.014)	(.036)	(.035)	(.037)
Underweight	-.132***	-.108***	.007	-.172***	-.140***	.010
	(.022)	(.021)	(.025)	(.029)	(.024)	(.032)
Observation	6087	6087	5133	6087	6087	5133

Note :Significance level ***, ** and * is at 1% , 5% and 10% respectively and; Std. Errors (in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units).

As it is shown in Table (5), the concentration indices for each malnutrition indicators and socioeconomic status (SES) ranking variables vary across the methods employed for computing those indices. In all approaches and SES ranking variables, the concentration indices are significant with negative value which exhibit higher malnutrition in all indicators is disproportionately observed in poor part of the population. While employing different SES ranking variables, the difference in the concentration indices is only found significant in case of Height-for-age Z-score (HAZ). Using standard method, for example, in HAZ, -0.040 and -0.070 of concentration index (CI) for wealth index and consumption are scored respectively. It signifies that relatively higher inequality is measured using consumption as ranking variable.

Using Wagstaff method, for example, in stunting, -0.093 and -0.111 of concentration index (CI) for wealth index and real annual total consumption per adult equivalence are observed respectively. With the same method, in terms of SES ranking variables altering, the highest CI and thus inequality, in each malnutrition indicators is relatively recorded in case of wealth index. From these results, we can also infer that in all SES ranking variables, higher inequality of malnutrition is concentrated in poor part of the society.

Table 6: Concentration indices of malnutrition prevalence by region: Ranking variables -wealth index and consumption

Regions	Height-for-Age (HAZ)		Weight-for-Height(WHZ)		Weight-for-Age (WAZ)	
	Wealth	Consumption	Wealth	Consumption	Wealth	Consumption
Tigray	-.029**	-.053**	-.001	.021	-.050***	-.038*
	(.021)	(.022)	(.025)	(.042)	(.016)	-.017
Amhara	-.036*	-.019*	-.069***	-.036	-.052**	-.017
	(.023)	(.014)	(.025)	(.025)	(.021)	(.013)
Oromia	-.035**	-.039**	-.036*	-.028	-.047***	-.040**
	(.015)	(.016)	(.022)	(.021)	(.013)	(.016)
SNNP	-.054***	-.057***	-.010	-.038	-.057***	-.067**
	(.010)	(.019)	(.020)	(.028)	(.013)	(.020)
Other	-.052**	-.017	-.040	.006	-.053***	-.015
Regions	(.023)	(.023)	.028	(.019)	(.016)	(.015)
Difference	1%	1%	1%	1%	1%	1%

Note: Significance level: ***, ** and * is at 1%, 5% and 10% respectively; and Std. Errors (in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units).

Another concern of this study is examining malnutrition inequalities using spatial dimensions and across other groups considered in this analysis. For each malnutrition indicators, concentration index (CI) is computed for each regions, male-female, rural-urban and then compares them to see the existence of significant difference between those groups considered. Thus, our results signify that significant inequality of malnutrition difference is shown across regions. We also recognize same result across lower administrative areas such as provinces (Zones), districts (Woredas) and Kebeles (lowest administrative units). For instance, in Height-for-Age Z-score (HAZ) with wealth index as ranking variable, the highest and lowest inequality of malnutrition is seen in

SNNP (CI=-0.054) and Tigray (CI=-0.029) regions respectively. However, when real consumption per adult equivalence is taken in to account as ranking variable, the highest and lowest malnutrition inequality is observed in SNNP and Other regions respectively. As it is displayed in Table 6, in case of the other malnutrition indicators such as Weight-for-Height Z-score (WHZ) and Weight-for-Age Z-score (WAZ), analysis of inequality could be different. In terms of sex-wise, except in consumption as ranking variables for WHZ and WAZ, the difference is insignificant. Similarly, inequality difference is almost insignificant while we consider rural-urban. In short, regardless of its significance, malnutrition inequality varies across considered groups in each indicator while we alter ranking socioeconomic status (SES) variables[7] 13.

Table 7: Concentration indices of malnutrition prevalence by sex and rural small town:

Ranking variables -wealth index and consumption

Groups	Height-for-Age (HAZ)		Weight-for-Height (WHZ)		Weight-for-Age (WAZ)	
	Wealth	Consumption	Wealth	Consumption	Wealth	Consumption
Male	-.044***	-.051***	-.041**	-.038**	-.061***	-.051***
	(.011)	(.012)	(.014)	(.015)	(.010)	(.011)
Female	.049***	-.044***	-.021	.018	-.047***	-.023*
	(.011)	(.011)	(.015)	(.016)	(.011)	(.012)
Difference	not sign	not sign	not sign	5%	not sign	5%
Small town	-.090**	-.002	.024	.009	-.073*	-.026
	(.034)	(.034)	(.052)	(.045)	(.044)	(.032)
Rural	-.043***	-.048***	-.031***	-.019	-.049***	-.044***
	(.009)	(.009)	(.012)	(.013)	(.009)	(.009)
Difference	not sign	5%	not sign	no sign	no sign	no sign

Note: Significance level: ***, ** and * is at 1%, 5% and 10% respectively; and Std. Errors (in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units).

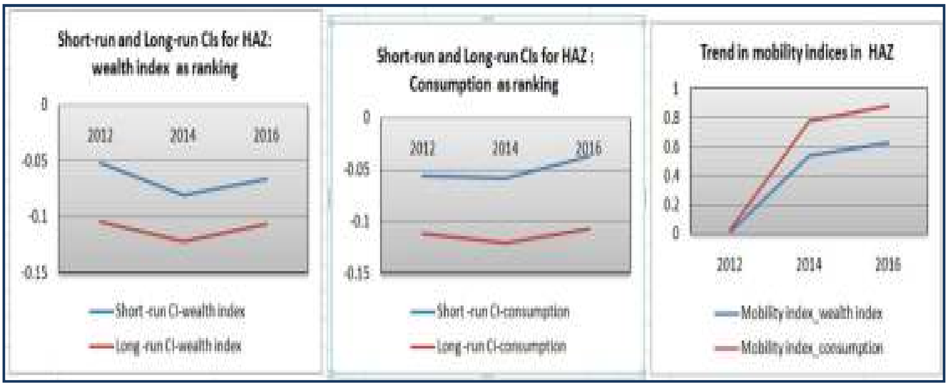
4.3 Mobility indices and SES-related inequality in children undernutrition

The basic argument here is that taking on concentration index of each cross sectional data or weighted average of them hides the effect of time on

[7] 13We also computed concentration index while the health variable is binary outcome (stunted, wasted, and underweighted. The results are almost similar.

inequality and fail to see dynamics of SES related inequality. It is either by the short-run concentration index (CI) underestimates or overestimates the long-run CI. This again leads to wrong inequality measurement inference. As we can discern from Figure 4, there is apparent trends in short-run and long-run concentration indices. This is a clear indication for existence of health -related SES mobility indices. Similar results are obtained for other malnutrition indicators (WHZ and WAZ).

Figure 4: Trends in Short-run and Long-run Concentration indices, and mobility indices



Results from Table (8) show us that in both malnutrition indicators and socioeconomic status (SES) ranking variables, the mobility indices are positive which implies that short-run (cross-sectional) CI overestimates the long-run (longitudinal data) CI. Hence, the results exhibit that the long-run SES related inequality in malnutrition declines while longitudinal data is considered, rather than using the weighted average of the cross sectional concentration indices. For example, in case of Height-for-age Z-score (HAZ) with wealth index as ranking variable, the mobility index is 0.54 and 0.63 for second and third wave respectively. It can be interpreted as the short-run measure overestimates long-run pro-poor inequality by 54 % and 63 % over respected waves for HAZ -malnutrition with wealth index as ranking variable i.e., SES related inequality in HAZ -malnutrition decreases by 54 % and 63 % over respected waves.

Table 8: Concentration and mobility indices for each undernutrition indicators: Ranking variables -wealth index and consumption

Wave	Wealth			Consumption		
	CIt	CIT	MT	CIt	CIT	MT
Height-for-Age	Z-score					
2011/12	-.052	-.052	0	-.056	-.056	0
2013/14	-.080	-.041	.54	-.058	-.063	.24
2015/16	-.066	-.040	.63	-.037	-.070	.25
Weight-for-Height	Z-score					
2011/12	-.046	-.046	0	-.038	-.038	0
2013/14	-.046	-.052	.24	-.018	-.019	.59
2015/16	-.040	-.028	.65	-.038	-.023	.61
Weight-for-Age	Z-score					
2011/12	-.073	-.073	0	-.059	-.059	0
2013/14	-.072	-.074	.30	-.055	-.056	.34
2015/16	-.066	-.061	.52	-.048	-.059	.41

Note: CIt is CI at time t (each wave) or short-run CI and CIT is long-run CI (for longitudinal data). MT is mobility index for each wave.
If MT >0, CIt overestimates CIT while MT <0, CIt underestimates CIT ; and MT =0 , no change in inequality .

Similarly, for real annual consumption per adult equivalent as ranking variable, it makes long-run SES-related health inequality greater than what we could infer from the cross sectional measures or it declines by 24 % and 25 %, as reflected by the mobility index (MT) of 0.24 and 0.25 in second and third wave respectively. These results and analyses strengthen our initial argument that examining SES related inequality using cross-sectional data masks the effect of dynamics on inequality over time (fails to see the correct long-run CI and thereby inequality). In general, Table 8 illustrates that the health-related income mobility index and shows that, by the last (third) wave, the short run measure over estimates long run inequality by around 63 % and 25 %, 65 % and 61 %, and 52 % and 41 % for HAZ, WHZ and WAZ respectively while wealth index and consumption are considered as ranking variable. Therefore, employing longitudinal perspective rather than weighted average of cross-sectional data is justifiable to see the dynamic of inequality in child malnutrition. However, Allanson et al. (2010) question the value of the Jones and Lopez (2004) index to health policymakers and proposes an alternative index of income-related health mobility, based on a decomposition of the change in the short run concentration index over time, that measures whether the pattern of health changes is biased in favour of those with initially high or low incomes.

Table 9: **SES-related health mobility and Health-related SES mobility index from Wave 1(2011/12), based on Allanson et al. (2010) approach**

SES ranking variable		**Wealth-**	**index**		**Consum-**	**ption**
Health indicator/Wave	2011/2012	2013/14	2015/16	2011/12	2013/14	2015/16
HAZ						
Average health ($\bar{y}$)	1.83	1.64	1.43	1.83	1.64	1.43
Concentration Index (CI)	-.043	-.084	-.062	-.056	-.072	-.068
Average health change ($\overline{\Delta y}$=$\bar{y}^f$-$\bar{y}^s$)	-	-.228	-.457	-	-.228	-.457
Concentration Index of health changes ($CI^{\Delta s}$)	-	.0743	-.051	-	-.013	-.136
Change in inequality ($CI^f - CI^s$)	-	-.041	-.019	-	-.016	-.012
SES-related health mobility (M^H)	-	-.023	-.008	-	-.008	-.002
Progressive Index (P=$CI^s - CI^{\Delta s}$)	-	-.117	.008	-	-.043	.080
Scale factor (Q=$\overline{\Delta y}/\bar{y}^f$)	-	-.139	-.320	-	-.139	-.320
Health-related SES mobility (M^R)	-	-.018	-.011	-	-.008	-.014
WHZ						
Average health ($\bar{y}$)	.77	.82	.89	.77	.82	.89
Concentration Index (CI)	-.071	-.036	-.001	-.043	.002	-.042
Average health change ($\overline{\Delta y}$=$\bar{y}^f$-$\bar{y}^s$)	-	.016	.102	-	.016	.102
Concentration Index of health changes ($CI^{\Delta s}$)	-	-.203	.299	-	-.343	.170
Change in inequality ($CI^f - CI^s$)	-	.035	.070	-	.041	.001
SES-related health mobility (M^H)	-	.059	.049	-	.045	.001
Progressive Index (P=$CI^s - CI^{\Delta s}$)	-	.132	-.37	-	.39	-.213
Scale factor (Q=$\overline{\Delta y}/\bar{y}^f$)	-	.019	.114	-	.019	.114
Health-related SES mobility(M^R)		-.024	.021	-	0	0
WAZ						
Average health ($\bar{y}$)	1.35	1.40	1.42	1.35	1.40	1.42
Concentration Index (CI)	-.080	-.078	-.051	-.060	-.055	-.067
Average health change ($\overline{\Delta y}$=$\bar{y}^f$-$\bar{y}^s$)	-	.025	.052	-	.025	.052
Concentration Index of health changes ($CI^{\Delta s}$)	-	.173	.712	-	-.168	.467
Change in inequality ($CI^f - CI^s$)	-	.002	.029	-	.005	-.007
SES-related health mobility (M^H)	-	.023	.034	-	.006	.008
Progressive Index (P=$CI^s - CI^{\Delta s}$)	-	-.253	-.792	-	.108	-.527
Scale factor (Q=$\overline{\Delta y}/\bar{y}^f$)	-	.017	.036	-	.017	.036
Health-related SES mobility (M^R)	-	-.021	-.005	-	-.001	-.015

Note. $M^H = CI^{fs} - CI^{ss}$. CI^{ss} and CI^{ff} are the CI's in periods s and f respectively, and CI^{fs} is the CI obtained when health outcomes in the final period are ranked by SES in the initial period. $M^R = CI^{ff} - CI^{fs}$. CI^{ff} and CI^{fs} are the CI's in periods f, and CI^{fs} CI obtained when health outcomes in the final period are ranked by SES in the initial period. $CI^{\Delta s}$ represents mean health change ranked by initial rank (the concentration coefficient of health changes ranked by initial period income).

Based on Allanson et al. (2010) approach, the decomposition of change in inequality (concentration index) between Wave 1 and each subsequent wave, as illustrated in Table (9) provides us both SES-related health mobility and health-related SES mobility indices. Sign of the index of SES-related health mobility, MH is both positive and negative for given time spans, in each malnutrition indicator. When it is positive, it implies that differences in relative health changes experienced on average by individuals with different initial levels of SES had the effect of reducing socioeconomic inequalities in health. While, negative sign of MH has regressive effect which indicates that differences in relative health changes had the effect of rising socioeconomic inequalities in health. Put it differently, when decomposing the initial and final concentration indices, health changes are found to be biased against those in the lower (upper) end of the SES rankings as the SES-related health mobility index is negative (positive) respectively.

Similarly, the sign of health related SES mobility index, MR is mixed. Positive sign indicates that those who moved up the income ranking tended to be healthier in the final period compared to those who moved down. And the reverse is true while it bears negative sign. In other words, the positive/negative/ values on the health-related SES mobility index suggest that the healthy are more upward/downward/ mobile respectively.

Specifically, in case of HAZ, the sign of both SES related health mobility index (MH) and health related SES mobility index (MR) are negative in both wealth index and consumption. It implies that individuals face regressive effect ($MH < 0$) from health change as well as progressive effect from SES ranking change ($MR < 0$) and the counter balance effect leads to a cumulative effect of no change in inequality change. In other word, persistence of SES inequality in HAZ occurs in the long-run. This result doesn't confirm results we obtained from mobility indices computed based on Jones and Lopez (2004) approach. Similarly, results on WAZ show that $MH>0$ and $MR<0$. This indicates that individuals face progressive effect in both indices. Thus, it has a cumulative effect of reducing effect on inequality in the long-run which confirms results we obtain based on Jones and Lopez (2004) approach. However, for WHZ (short -run indicator), there is no clear trend over subsequent waves to put any concluding remarks.

4.4 Decomposing inequality of undernutrition

Since the Equation (6) used for decomposing the concentration index (CI) requires linearity of the underlying regression model, for our decomposition, we employ negative of each child Z-score as malnutrition level which is continuous variable against the relevant covariates[8]. The regression results in random as well as other alternative estimator are given in the appendix, Table 18 and 19. The coefficients are presented along with robust standard errors that are adjusted for clustering to enumeration areas (primary sampling units) due to the use of panel survey data. Decomposition results based on the alternative estimator, fixed effect is also attached at the appendix part, Table 20 and 21[9].

[8] Alternatively, using binary outcomes as dependent variables (stunted, wasted and under-weighted option), we also estimate our regression model by OLS and pooled probit and results are more or less similar.

[9] Though specific results based on those alternative estimators are different from that of random effect, the contribution of socioeconomic factors to the observed inequalities in malnutrition is still dominant.

Table 10: Decomposition of child malnutrition inequality (CI): Ranking variable Wealth index

Regressors (k)	HAZ				WHZ				WAZ			
	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution
Age	.006*(.002)	.17	-.03	.00(.11)	-.014***(.002)	-.81	-.03	.02(-.72)	.007***(.002)	.24	-.03	.01(.12)
Age-square	-.001*(.000)	-18	-.05	.01(-.20)	-.000(.000)	.50	-.05	-.03(.82)	-.000(.000)	-.06	-.05	.00(-.05)
Sex	.077**(.035)	.02	.02	.00(-.01)	-.018(.025)	-.01	.02	-.00(.01)	.089***(.025)	.03	.02	.00(-.01)
Illness Incidence	.103**(.040)	.01	.05	.00(-.01)	.107***(.032)	.02	.06	.00(-.03)	.180***(.030)	.02	-.05	.00(-.02)
Water Availability	-.057(.055)	-.01	.19	-.00(.03)	.045(.038)	.01	.19	.00(-.07)	.008(.043)	.00	.19	.00(-.00)
Toilet type	-.002(-.016)	.-.01	-.02	.00(-.00)	.034***(.013)	.26	-.02	-.01(.17)	.037***(.013)	.16	-.02	-.00(.07)
Health post	-.141** (.067)	-.09	-.00	.00(-.00)	.011(.058)	.01	.00	4.3(-.00)	-.078(.058)	-.06	-.00	.00(-.00)
Mother educ	.110***(.022)	-.03	.32	-.01(.20)	-.024* (.015)	-.01	.31	-.00(.11)	-.074***(.018)	-.02	.32	-.01(.13)
Household size	-.016 (.010)	-.06	.01	-.00(.01)	.001(.008)	.01	.01	.00(-.00)	-.006(.008)	-.03	-.01	.-00(.00)
Household size U5	-.039(.025)	-.03	-.01	00(-.00)	.001 (.018)	-.00	-.00	4.6(-.00)	-.049**(.020)	-.05	-.00	.00(-.00)
Rural-urban	yes	.02	-.01	-.00(.01)	yes	.13	-.01	-.00(.05)	yes	.16	-.01	-.00(.04)
Region variation	yes			-.003(.08)	yes			.00(-12)	yes			-.00(.03)
Wealth index	- -.045***(.016)			-.01(.30)	-.039(.011)			-.03(.91)	-.045***(.013)			-.02(.30)
Quntile 1		.02	-.80	-.02(.34)		.03	-.80	-.02(.70)		.02	-.80	-.02(.30)
Quntile 2		.01	-.40	-.01(.12)		.01	-.39	-.01(.17)		.01	-.40	-.00(.06)
Quntile 3		.01	.02	.00(-.00)		.01	.01	.00(-.00)		.01	.01	.00(-00)
Quntile 4		.02	.42	.01(-.16)		-.00	.41	-.00(.04)		.01	.41	.00(-.06)
Residual				-.022(.45)				-.004(.13)				-.021(.42)
Observation	8,686				8,132				9,426			
R2	0.03				0.046				0.052			

Note: Significance level: ***, ** and * is at 1%, 5% and 10% respectively; and Std. Errors (in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units). Under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution. Each figure is rounded to two digits only. Hence, point zero doesn't mean that it is actually zero, it is rather rounded value

Each column under each malnutrition indicators in Table (10) and (11) presents elasticity of each regressor with respect to the health variable considered, concentration index of each regressor, contributions to the overall concentration index as well as percentages contribution of the overall concentration index which is given in parenthesis.

Comparatively, our findings indicate that there is very limited contribution of the legitimate factor (such as age) in all malnutrition inequalities which signify that almost all are due to illegitimate factors such as wealth index, illness toilet facility etc. In Height-for-age Z-score (HAZ) and Weight-for-age Z-score (WAZ), wealth index and mother's education are the major contributors of socioeconomic related inequality in children undernutrition. For example, wealth index and mother's education contribute 30 % and 20 %, 91 %, and 11 % in case of HAZ and WAZ respectively while in Weight-for-Height Z-score (WHZ), the loin share is taken by wealth index (30 %) and toilet facility (17 %). Of course, the contribution of unexplained (residual) of the econometric model is higher for HAZ and WAZ. It accounts 45 %, 13 %, and 42 % of total contribution in case of HAZ, WHZ and WAZ respectively. The contribution of other factors such toilet facility is nil for HAZ while it is 17 % and 7% for WHZ and WAZ respectively. Similarly, the contribution of sex, health facility and household size is almost zero in all malnutrition indicators. Illness incidence contributes 1 %, 3 %, and 2 % in case of HAZ, WHZ, and WAZ consecutively.

The contribution of mother education varies across malnutrition indicators. It is higher (20 %) in case of the long-run malnutrition indicator, low HAZ (stunting). Here, the possible reason could be due to the fact that effect of formal education is more pronounced on long-run than short -run indicator (Ambel et al., 2015). However, in case of short-run malnutrition indicator (low WHZ or wasting) and composite malnutrition indicator (low WAZ or underweight), mother education level accounts for 11 % and 13 % of the total contribution of observed inequalities in malnutrition.

While we change our socioeconomic ranking variable from wealth index to real annual total consumption per adult equivalent, we observe different result. As in wealth index case, our results indicate that contribution of legitimate factor (such as age) is a very insignificant which signify that almost all is due to illegitimate factors such as consumption, illness toilet facility etc. In HAZ and WAZ, consumption and mother's education represent as the major contributors of socioeconomic related inequality in children undernutrition. For example, contribution of consumption and mother's education account for 48 % and 15 %, 71 % and 21 %, 42 %, and 13 % in case of HAZ, WHZ, and WAZ respectively. In a similar fashion, the contribution of other factors such as toilet facility, illness, sex, water availability and health facility is almost zero in all malnutrition indicators. Household size contributes 6 %, 5 %, and 4 % in case of HAZ, WHZ and WAZ consecutively. The contribution of unexplained (residual) of the econometric model also accounts for 28 %, 33 %, and 31 % of total contribution in HAZ, WHZ and WAZ respectively.

Table 11: Decomposition of child malnutrition inequality (CI): Ranking variable Consumption

Regressors (k)	HAZ				WHZ				WAZ			
	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution
Age	.006**(.003)	.19	.01	.00(-.02)	-.015***(.002)	-.82	-.00	.00(-.15)	.008***(.002)	.27	.01	.00(-.03)
Age-square	-.000 (.000)	-18	.01	-.00(.04)	-.000(.000)	.53	-.00	-.00(.08)	-.000(.000)	-.07	.01	-.00(.02)
Sex	.080**(.035)	.02	-.00	-.00(.00)	-.016(.025)	-.01	.00	-.00(.00)	.091***(.026)	.03	.00	.00(-.00)
Illness Incidence	.108***(0.041)	.01	-.00	-.00(.00)	.111***(.032)	.02	.00	.00(-.00)	.189***(.031)	.02	-.01	-.00(.00)
Water Availability	-.072 (.056)	-.01	.05	-.00(.01)	.036 (.038)	.01	.04	.00(-.03)	-.003(.043)	-.00	.04	-.00(-.00)
Toilet type	.001(.017)	.00	-.00	-.00(.00)	.039***(.012)	.29	-.00	-.00(.05)	.040***(.013)	.18	-.00	-.00(.01)
Health post	-.137**(.067)	-.09	.01	-.00(.01)	.009(.061)	.01	.01	.00(.02)	-.083(.056)	-.06	.01	-.00(.01)
Mother educ	-.111***(.021)	-.02	.26	-.01(.15)	-.027* (.016)	-.01	.26	-.00(.21)	-.074***(.017)	-.02	.25	-.01(.13)
Household size	-.024**(.010)	-.09	-.03	.00(-.06)	-.003(.008)	-.02	-.03	.00(-.05)	-.012(.008)	-.05	-.03	.00(-.04)
Household size U5	-.032 (.025)	-.03	-.01	.00(-.01)	.001 (.019)	.00	-.00	-.00(.00)	-.045**(.020)	-.05	-.01	.00(-.01)
Rural-urban	yes	.04	-.01	-.00(.01)	Yes	.15	-.00	-.00(.05)	yes	.17	-.01	-.00(.02)
Region	yes			-.01(.12)	Yes			.00(-.27)	yes			-.00(.07)
variation Consumption	-.126***(.033)			-.02(.48)	-.029(.023)			-.01(.71)	-.099***(.024)			-.02(.49)
Quntile 1		.02	-.80	-.02(.36)		.01	-.80	-.01(.54)		.02	-.80	-.02(.42)
Quntile 2		.02	-.40	-.01(.13)		.01	-.40	-.00(.24)		.01	-.40	-.01(.13)
Quntile 3		.01	.00	.00(-.00)		.02	.01	.00(-.02)		.02	.01	.00(-00)
Quntile 4		.00	.40	.00(-.01)		.00	.41	.00(-.05)		.01	.40	.00(-.05)
Residual				-.013(.28)				-.006(.33)				-.014(.31)
Observation	8,505				7,973				9,229			
R2	0.039				0.045				0.052			

Note: Significance level: ***, ** and * is at 1% , 5% and 10% respectively; and Std. Errors (in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units). Under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution. Each figure is rounded to two digits only. Hence, point zero zero doesn't mean that it is actually zero, it is rather rounded value

In both SES ranking variables, the contribution of the residuals of the econometric model is large enough as the contributions of the regressors, an indication of the presence of systematic unobserved heterogeneity which will have to be tackled with more sophisticated econometric specifications.

Table 12: Decomposition of child malnutrition inequality (CI): Over all contribution by related groups Ranking variables -wealth index and consumption

Categories	HAZ- Score		WHZ- Score		WAZ- Score	
	Wealth	Consumption	Wealth	Consumption	Wealth	Consumption
Wealth/consumption	-.01(.30)	-.02(.48)	-.03(.91)	-.01(.71)	-.02(.30)	-.02(.49)
Health -care	-.001(.02)	-.00(.02)	-.00(.07)	-.00(.02)	-.00(.05)	-.00(.02)
Family size	-.00(.01)	.00(-.07)	.00(-.00)	.00(-.05)	-.00(.00)	.00(-.05)
Mother educ	-.01(.20)	-.01(.15)	-.00(.12)	-.00(.21)	-.01(.13)	-.01(.13)
Time variant	-.02(.43)	-.03(.60)	-.04(1.2)	-.01(.82)	-.03(.56)	-.03(.57)
Regional variation	-.003(.08)	-.01(.12)	.00(.-12)	.00(-.27)	-.00(.03)	-.00(.07)
Rural-urban variation	-.00(.01)	-.00(.01)	-.00(.05)	-.00(.05)	-.00(.04)	-.00(.02
Time invariant	-.003(.08)	-.01(.12)	.00(-.06)	.00(-.22)	-.00(.06)	-.00(.09)
Residual	-.022(.45)	-.013(.28)	004(-.13)	-.006(.33)	-.021(.42)	-.014(.31)

Note: under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution. Each figure is rounded to two digits only. Hence, point zero zero doesn't mean that it is actually zero, it is rather rounded value.

In terms of related groups, the contributions of time variant factors (all socioeconomic variables) strongly dominate that of time invariant (fixed variables like place of residence). The contribution of regional variation in both wealth index and consumption is 8 % and 12 %, 12 % and 27 %, and 3 % and 7 % for HAZ, WHZ and WAZ respectively. Similarly, rural-urban variation contributes 1 % and 1 %, 5 % and 5 %, 4 % and 2 % respectively. Though it varies from one malnutrition to other malnutrition indicator, the contribution of regional as well as rural-urban related variation to the inequality is thus smaller by large compare to socioeconomic related variation. These imply that in both socioeconomic status ranking variables, the bulk of inequality in malnutrition is caused by inequality in socioeconomic status in which it disfavors the poor in both cases.

4.5 Decomposing poor- non-poor differences in child undernutrition

Before we estimate our decomposition equation, we first test null of no differences in mean dependent variables, covariates, and regression coefficients between the two groups while allowing sample weights and clustering. As result, we observe significant difference in all attributes to mean outcome difference for HAZ and WAZ. While the results are insignificant for WHZ. In our estimation, we consider different cases like three-fold decomposition (endowments, coefficients and interactions), two-fold decomposition (with poor or non-poor coefficients as the reference) and two-fold decomposition with pooled coefficients as the reference (with group or without group variable included in the pooled model). Coefficients, means and predictions for both poor, rich and pooled are also computed. Decomposition results that show how each covariates explain the non-poor-poor gap in undernutrition can be provided upon request.

Table 13: Three fold decomposition of mean difference of child undernutrition between poor (bottom 60 %) and non-poor (top 40 %)

Variables /undernutrition levels	HAZ	WHZ	WAZ
Overall differential			
Mean prediction for Rich (R)	-1.21***	-.429***	-1.10***
	(.060)	(.051)	(.050)
Mean prediction for Poor (P)	-1.52***	-.530***	-1.35***
	(.056)	(.042)	(.041)
Row Difference(R-P)	.305***	.100*	.249***
	(.073)	(.059)	(.056)
due to Endowments(explained) -E	.265*	.039	.313***
	(.146)	(.118)	(.097)
due to Coefficients(unexplained) -C	.188*	.025	.097
	(.105)	(.079)	(.079)
due to Interactions (CE)	-.147	.036	-.162
	(.167)	(.130)	(.113)
Observations(N)	8686	8132	9426

Note: Significance level: ***, ** and * is at 1% , 5% and 10% respectively and Std. Errors(in parenthesis) are adjusted for each clusters in ea_id (enumeration areas or primary sampling units)

Our Blinder-Oaxaca decomposition analysis is conducted to decompose the poor - non-poor differences in child malnutrition outcomes into two components; one that is explained by differences in the level of the determinants (covariate effects), and another component that is explained by differences in the effect of the determinants on the child nutritional status (coefficient effects). Results show that the poor- non-poor gap in child malnutrition is significant in all indicators. The explained and unexplained (coefficient) effects are only significant in case of HAZ and WAZ while interaction effects are insignificant in all indicators. Our results also show that the explained (covariate) effect is dominant while the coefficients effects are relatively low in the all malnutrition indicators. SES variables such as wealth index, consumption, and mother education inequality between poor and non-poor households explains most of the malnutrition gap between the two groups. Results are robust to the different decomposition weighting schemes.

Table 14: Summary of decomposition results: Decomposition results of the poor-non-poor gap in malnutrition with different weighting schemes

D	0	1	0.5	.276	*
HAZ					
Unexplained	0.040	0.188	0.114	0.081	0.066
Explained	0.265	0.117	0.191	0.224	0.239
% unexplained	13.2	61.6	37.4	26.6	21.7
% explained	86.8	38.4	62.6	73.4	78.3
WHZ					
Unexplained:	0.061	0.025	0.043	0.051	0.027
Explained	0.039	0.075	0.057	0.049	0.074
% unexplained	61.0	25.1	43.1	51.1	26.7
% explained	39.0	74.9	56.9	48.9	73.3
WAZ					
Unexplained	-0.065	0.098	0.016	-0.020	0.026
Explained	0.314	0.152	0.233	0.269	0.223
% unexplained	-26.0	39.2	6.6	-8.0	10.3
% explained	126.0	60.8	93.4	108.0	89.7

Note: D in 4th column = relative frequency of high group , * reference: pooled model over both categories

4.6 Robustness of results

It is common and expected to conduct appropriate sensitivity analysis on results obtained to check their robustness either internally or externally. While we conduct test of dominance of concentration curve against 45 degree line and Lorenz curve, we find that in all SES ranking variables and malnutrition indicators, concentration curve dominates 45 degree line and Lorenz curve at the default multiple comparison approach decision rule, 5 % significance level, 19 equally spaced quintiles points and rule mca(less strict option). Hence, our results confirm that the concentration curves in all SES ranking variables and malnutrition indicators dominate the 45-degree line and Lorenz curve (lies above). This implies that in all SES and malnutrition indicators, the concentration curve lies above the line of equality, i.e, pro-poor health outcome distribution. However, the results become non dominance of concentration curve over that of 45 degree line and Lorenz curve at the other option, 5 % significance level, 19 equally spaced quintile points and rule iup (more strict option). This reflects the fact that the two curves overlap toward the bottom of the SES variable distribution. Further tests on dominance of concentration curve for stunting against wasting, stunting against underweight, and wasting against underweight are conducted. Differences between the cumulative shares of the health and living standards variables at each quintile are also tested.

Although the concentration index is an appropriate method for measuring inequalities in the health sector, it has implicit in it a particular set of value judgments about aversion to inequality. Accordingly, we apply Wagstaff (2002) extended concentration index (sensitivity to poverty), which allows attitudes to inequality to be made explicit, and to see how measured inequality changes as the attitude to inequality changes. We thus find that inequality rises in all malnutrition indicators when we increase inequality aversion parameters/distributional sensitivity parameter[1]. This assures our results on malnutrition inequalities (with negative sigh of concentration index) are pro

[1] As inequality aversion parameters/distributional sensitivity parameter, the more weight is attached to health of poor individuals in the distribution and the weight attached to the health of people who are above the 55th percentile decreases.

poor[2] irrespective of the inequality aversion parameters (for details, see Table 15).

Table 15: Extended and Symmetric Concentration indices (CI) of malnutrition prevalence by methods

Method	HAZ		WHZ		WAZ	
v, β parameters	1.5	5	1.5	5	1.5	5
Ranking variable -Wealth index						
Extended CI(v)	-.029	-.094	-.019	-.068	-.033	-.112
Symmetric CI(β)	-.038	-.073	-.028	-.043	-.047	-.076
Generalized extended CI(v)	-.327	-.290	-.107	-.106	-.310	-.293
Generalized symmetric CI(β)	-.252	-.486	-.094	-.144	-.262	-.425
Ranking variable -Consumption						
Extended CI(v)	-.026	-.120	-.014	-.022	-.027	-.101
Symmetric CI(β)	-.045	-.060	-.016	-.034	-.040	-.065
Generalized extended CI(v)	-.297	-.370	-.082	-.035	-.256	-.264
Generalized symmetric CI(β)	-.303	-.399	-.054	-.114	-.225	-.366

Note: v= inequality risk aversion parameter, β = degree of sensitivity to extremity or symmetric parameter. If V =1.5 ➔ more weight to rich, and V =5➔ more weight to poor, if β =1.5 ➔ more to middle classes, and β = 5➔ more to extreme classes.

We also apply the normalised concentration indices proposed by Wagstaff (2005) and Erreygers (2009a) by specifying the Wagstaff and Erreygers option while our health variable becomes binary outcome (stunting, wasting and underweight), for details, see Table (5). Our results on malnutrition inequalities are still same, i.e. pro-poor. We also test our results using another alternative of attitude to inequality, i.e. symmetric concentration index or `sensitivity to extremity.

The choice between the symmetric and extended indices is normative. The symmetric index gives equal weight (but with an opposite sign) to individuals that are equally far apart from the pivotal individual with median rank, while

[2] In terms of sign concentration index, results using standard concentration index with regular parameters are same as while we alter inequality aversion parameters above regular parameters. In both option, inequalities in malnutrition are pro-poor.

the extended index prioritizes the lower regions of the ranking (income) distribution. Erreygers et al. (2012) argue that the symmetric index is more concerned about the association between income and health, while the extended concentration index puts priority on the income distribution, and only then analyzes health differences within the prioritized region of the income distribution (ODonnell, 2016).

To refine results, using decomposition method (as indirect method), our results on inequality in malnutrition measured by respected concentration indices for all indicators and SES variables are standardized for age and gender, for details on the results, see Table (15)[3]. Most surveys used for analysis of health sector inequalities in developing countries have complex sample designs. Hence, in our all estimations, we consider appropriate sampling weights to adjust the point estimates for difference in sample size and stratification, and thus for national representative inference. Robust standard errors are also adjusted for each cluster in enumeration areas (primary sampling units).

Table 16: Decomposition of child malnutrition inequality-Over all inequality by related groups: Ranking variables -wealth index and consumption

Categories	HAZ- Score		WHZ- Score		WAZ Score	
	Wealth	Consumption	Wealth	Consumption	Wealth	Consumption
All SES inequality	-.045	-.050	-.033	-.016	-.054	-.044
Age-sex standardized CI	-.049	-.047	-.030	-.018	-.050	-.045
Legitimate inequality	.004	-.0009	-.003	.001	-.003	.0007
Illegitimate inequality	-.027	-.034	-.034	-.011	-.030	-.031
Residual	-.022	-.013	.004	-.006	-.021	-.014

Note: under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution

With respect to external validation of our results, we try to see some previous studies findings that can be compared. One study that supports our findings in

[3] As such, by incorporating various confounding variables, all computed concentration indices are standardized using indirect methods (see O'Donnell et al. 2008 Chapter 8 for details).

dynamics of inequality (not in sign) is by Jones and Lopez (2004) in which they demonstrate that over the long-run, represented by a period of 9 years, adverse mental health is more concentrated among the poor. Individual dynamics increase the absolute value of the concentration index of health on income by 10 %. Similarly, for Australia, Samuel (2015) shows that socioeconomic related health inequalities have indeed increase over the given period.

There are some evidences that concentration indices for health outcome are more sensitive to the living standards measure. In due respect, for 19 countries, Wagstaff and Watanabe (2003) test the sensitivity of the concentration index for child malnutrition to the use of household consumption and a wealth index as the living standards ranking variable. For each of underweight and stunting, the difference between the concentration indices is significant (10 %) for 6 of 19 comparisons. This suggests that in the majority of countries, child nutritional status is not strongly correlated with inconsistencies in the ranking of households by consumption and wealth. In a similar fashion, Lindelow (2006) demonstrates that substantial and significant differences between the concentration indices (CI) for a variety of health services in Mozambique using consumption and an asset index as the living standards measure. In the case of consumption, the concentration index indicates statistically significant inequality in favor of richer households for all services. He also notes that with households ranked by the asset index rather than consumption, the inequality is greater for all services except health center visits, for which the concentration index indicates inequality in utilization in favor of poorer households. Like our study, he argues that the choice of welfare indicator can have a large and significant impact on measured socioeconomic inequalities in a health variable which it depends on the variable examined.

Specifically, Ambel et al. (2015) is a similar work in Ethiopia to our study. Using recent four cross sectional surveys of Demographic and Health Surveys (DHS) implemented in 2000, 2005, 2011, and 2014, they investigate the dynamics of inequalities, employing concentration curves for different years. They find that substantial improvements in health outcomes and health services. Although there still exists a considerable gap between the rich and the poor, the study finds some reductions in inequalities of health services. However, our evidence is different from it, in using longitudinal data and alternative welfare measures, consumption as measure of dynamics of inequality in child undernutrition.

5. Concluding Remarks

This study provides new evidence on child undernutrition inequalities in Ethiopia using longitudinal perspective and look at the dynamics of inequality using mobility indices. In all concentration index computing approaches and SES ranking variables, the concentration indices are significant with negative value. This implies that in either of short-run or long-run inequality estimates, the burden of unequal distribution of undernutrition remains on the poor. While employing different SES ranking variables, the difference in the concentration indices is only found significant in case of Height-for-age Z-score (HAZ). Using standard method, for example, in HAZ, -0.040 and -0.070 of concentration index (CI) for wealth index and consumption are scored respectively. It signifies that relatively higher inequality is measured using consumption as ranking variable.

In Ethiopia, undernutrition can best be described in the country as a long term year round phenomenon due to chronic inadequacies in food combined with high levels of illness in under-five children. Although Ethiopia has already achieved a remarkable progress in reducing under-five mortality in the last decades, undernutrition among children is still a common problem in this country. Thus, socioeconomic inequalities in health outcomes have been of focus in academia and policy spheres for a while now. This study provides new evidence on child undernutrition inequalities in Ethiopia using longitudinal perspective and look at the dynamics of inequality using mobility indices. In all concentration index computing approaches and SES ranking variables, the concentration indices are significant with negative value. This implies that in either of short-run or long-run inequality estimates, the burden of unequal distribution of undernutrition remains on the poor. While employing different SES ranking variables, the difference in the concentration indices is only found significant in case of Height-for-age Z-score (HAZ). Using standard method, for example, in HAZ, -0.040 and -0.070 of concentration index (CI) for wealth index and consumption are scored respectively. It signifies that relatively higher inequality is measured using consumption as ranking variable. This assures the argument of the choice of welfare indicator can have a large and significant impact on measured socioeconomic inequalities in a health variable which it depends on the variable examined. For spatial inequality in malnutrition, concentration index (CI) is also computed for each region and rural-urban. Thus, our results signify that significant difference in inequality of undernutrition is shown across regions while not significant in case of male -female and rural-urban. In this regard, our findings may be helpful in prioritizing resources to reduce inequality and in designing region specific suitable interventions to address such inequity issues. Our inequality results are robust to different measurement scale, inequality aversion parameters/distributional sensitivity parameters, symmetric concentration index or 'sensitivity to extremity, and normalization of concentration index. Those results are also standardized for age and gender.

Results on the health-related SES mobility indices computed using Jones and Lobez (2004) show that, by the last (third) wave, the short run measure overestimates long run inequality by around 63 % and 25 %, 65 % and 61 %, 52 % and 41 % for HAZ, WHZ and WAZ respectively while wealth index and consumption are considered as ranking variable. Put it differently, this reveals that dynamics decrease the absolute value of the concentration indices of child malnutrition by those given figures. However, results on mobility indices computed based on Allanson et al. (2010) approach show that in case of HAZ, the sign of both SES related health mobility index (MH) and health related SES mobility index (MR) are negative in both wealth index and consumption. It implies that individuals face regressive effect (MH < 0) from health change as well as progressive effect from SES ranking change (MR < 0) and the counter balance effect leads to a cumulative effect of no change in inequality change. In other word, persistence of SES inequality in HAZ occurs in the long-run. Similarly, results on WAZ show that MH >0 and MR<0. These indicate that individuals face progressive effect in both indices. Thus, it has a cumulative effect of reducing effect on inequality in the long-run which confirms results we obtain based on Jones and Lopez (2004) approach. While, for WHZ (short -run indicator), there is no clear trend over subsequent waves to put any concluding remarks. Therefore, employing longitudinal perspective rather than weighted average of cross-sectional data is justifiable to see the dynamic of inequality in child malnutrition.

Our findings also indicate that there is very limited contribution of the legitimate factor (age) in all malnutrition inequalities which signify that almost all are due to illegitimate factors such as disparity in wealth index, consumption, illness, toilet facility etc. In Height-for-age Z-score (HAZ) and Weight-for-age Z-score (WAZ), wealth index and mother's education are the major contributors of socioeconomic related inequality in children undernutrition. While in Weight-for-Height Z-score (WHZ), the loin share is taken by wealth index (30 %) and toilet facility (17 %). While we change our socioeconomic ranking variable from wealth index to real annual total consumption per adult equivalent, our results indicate that contribution of legitimate factor is a very insignificant which signify that almost all is due to illegitimate factors such as consumption, illness toilet facility etc. In HAZ and WAZ, consumption and mother's education represent as the major contributors of socioeconomic related inequality in children undernutrition. Though it varies from one undernutrition to other malnutrition indicator, the contribution of regional as well as rural-urban related variation to the inequality is thus smaller by large compare to socioeconomic related variation. Those major contributors to the inequality (mother's education level, wealth index and consumption expenditure) are also found statistically significant (with expected sign). Results on Oaxaca decomposition shows that the explained and unexplained (coefficient) effects are only significant in case of HAZ and WAZ while interaction effects are insignificant in all indicators. Our results also show that the explained (covariate) effect is dominant while the coefficients effects are relatively low in the all malnutrition indicators. SES variables such as wealth index, consumption, and mother education inequality between poor and non-poor households explains most of the malnutrition gap between the two groups. These imply that in both socioeconomic status ranking variables, the bulk of inequality in malnutrition is caused by inequality in socioeconomic status in which it disfavors the poor in both cases. This calls for enhancing the policy measures that narrow socioeconomic gaps between groups in the population and targeting on early childhood intervention and nutrition sensitive.

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Appendix

Figure 5: Socioeconomic distribution by household(normalized)

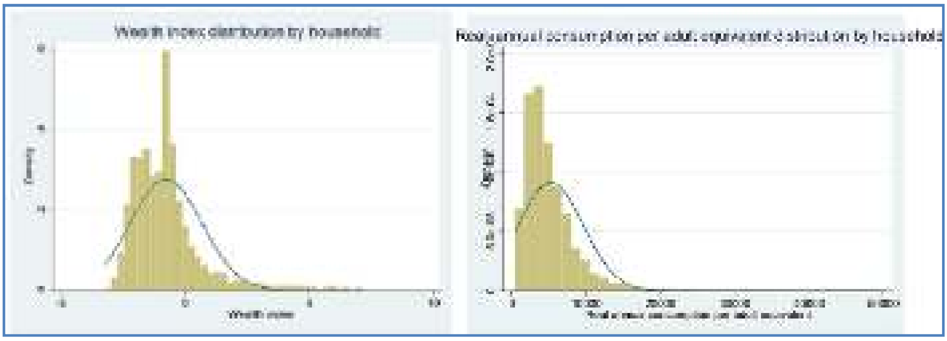

Table 17: Prevalence of stunting, wasting and underweight by region and rural/urban

Groups	Stunting	Wasting	Underweight
Rural -urban			
Rural	3,214 (30.90)	1,007(9.68)	2,479(23.83)
Small town	183(22.56)	58 (7.15)	122(15.04)
Regions			
Tigray	351(35)	131(13.06)	326 (32.50)
Amhara	624(33.91)	171 (9.29)	449 (24.40)
Oromia	637(26.91)	181 (7.65)	458 (19.35)
SNNP	1,050(33.35)	231(7.34)	707(22.46)
Other Regions	735(25.75)	351(12.30)	661(23.16)

Note: All values in parentheses are in percentage. Others includes samples from Afar, Somalie, Gambelia, Benshangul Gumuz, Harari and Dire Dawa which are all together nationally representative

Table 18: Decomposition of child malnutrition inequality (CI): Ranking variable Consumption

Regressors (k)	HAZ				WHZ				WAZ			
	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution
Age	.006**(.003)	.17	-.02	.01(.11)	-.015***(.003)	-.85	-.03	.03(-.76)	.006***(.003)	.21	-.03	.01(-.11)
Age-square	-.000** (.000)	-11	.05	-.01(-.12)	-.000*(.000)	.51	-.05	-.03(.83)	.000(.000)	.01	.05	-.00(.01)
Sex	.433**(.114)	.13	.02	.00(-.06)	. 131*(.076)	.08	.02	.00(-.05)	.327***(.081)	.12	.02	.00(-.04)
Illness Incidence	.142**(.055)	.01	.05	.00(-.02)	.122***(.043)	.02	.06	.00(-.04)	.160***(.038)	.02	.05	.00(-.02)
Water Availability	-.019 (.067)	-.00	.19	-.00(.01)	.055 (.049)	.02	.19	.00(-.09)	.025(.054)	.00	.19	.00(-.01)
Toilet type	.012(.023)	.05	-.02	-.00(.02)	.004(.018)	.03	-.02	-.00(.02)	.037**(.015)	.16	-.02	-.00(.07)
Health post	-.144*(.084)	-.09	.00	-.00(-.00)	.006(.076)	.01	.00	2.5(-.02)	-.059(.070)	-.05	-.00	-.00(-.00)
Mother educ	-.033(.058)	-.01	.32	-.00(.06)	-.033 (.034)	-.02	.31	-.01(.16)	-.004(.040)	.00	.32	.00(.01)
Household size	-.042(.027)	-.16	.01	-.00(-.03)	.031(.023)	.23	.01	.00(-.04)	.001(.018)	-.01	.01	.00(-.00)
Household size U5	.037 (.038)	-.03	-.01	.00(-.01)	.023 (.032)	-.04	-.00	-.00(-.00)	-.096***(.026)	-.10	-.00	.00(-.00)
Wealth index	0.114***(.033)			-.05(-1.12)	-.028(.022)			-.02(.75)	.062***(.021)			-.03(-.58)
Quntile 1		-.04	-.78	-.04(-.80)		.02	-.80	-.01(.53)		-.03	-.80	.02(-.43)
Quntile 2		-.04	-.40	-.02(.38)		.01	-.40	-.00(.07)		.03	-.40	.01(-.23)
Quntile 3		-.02	.02	-.00(.01)		.01	.01	.00(-.00)		-.02	.01	-.00(.00)
Quntile 4		-.01	.41	.00(-.06)		-.01	.41	-.00(.15)		-.01	.42	-.00(.08)
Residual				.094(2.07)				-.007(.22)				08(1.7)
Observation	8,686				8,132				9,426			
R2	**0.025**				**0.025**				**0.040**			

Note: under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution. Each figure is rounded to two digits only. Hence, point zero zero doesn't mean that it is actually zero, it is rather rounded value

Table 19: Decomposition of child malnutrition inequality (CI): Ranking variable Consumption

Regressors (k)	HAZ				WHZ				WAZ			
	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution	β_k	Elasticity	CI	Contribution
Age	.003(.003)	.08	.01	.00(-.01)	-.014(.003)	-.81	-.00	.00(-.15)	.005*(.002)	.17	.01	.00(-.02)
Age-square	-.000 (.000)	-10	.01	-.00(.02)	-.000**(.000)	.53	-.00	-.00(.08)	.000(.000)	.00	.01	.00(-.00)
Sex	.453***(.115)	.14	-.00	-.00(.00)	-.119(.080)	.07	.00	.00(-.01)	.332***(.079)	.12	.00	3.7(-.00)
Illness Incidence	.149***(.055)	.01	-.00	-.00(.00)	.129***(.043)	.02	.00	.00(-.00)	.163***(.038)	.02	-.00	-.01(-.00)
Water Availability	-.029 (.069)	-.00	.05	-.00(.00)	.052 (.048)	.01	.04	.00(-.04)	.027(.057)	-.00	.04	.00(-.00)
Toilet type	.004(.023)	.01	-.00	-.00(.00)	.010(.017)	.07	-.00	-.00(.01)	.036**(.016)	.16	-.00	-.00(.00)
Health post	-.163*(.090)	-.10	.01	-.00(.01)	.009(.080)	.01	.01	.00(-.00)	-.079(.075)	-.06	.01	-.00(.00)
Mother educ	-.015(.0561)	-.00	.26	-.00(.02)	-.032(.034)	-.02	.26	-.00(.24)	-.000(.039)	-.00	.26	-5.2(.00)
Household size	-.047* (.028)	-.18	-.03	.01(-.12)	0.031(024)	-.23	-.03	-.01(.47)	-.007(.019)	.03	-.03	-.00(.02)
Household size U5	-.028* (.040)	.01	-.01	.00(-.00)	-0.20(0.34)	-.03	-.01	-.00(-.01)	-.088***(.026)	-.09	-.01	.00(-.02)
Consumption	-.103**(.044)			-.02(.39)	.004(.029)			.00(.15)	-.028(.031)			-.01(.11)
Quntile 1		.02	-.80	-.01(.30)		-.01	-.80	-.01(.31)		.01	-.80	-.00(.10)
Quntile 2		.01	-.40	-.00(.09)		.00	-.40	.00(-.06)		-.00	-.40	.00(-.01)
Quntile 3		.01	.00	.00(-.00)		.02	.01	.00(-.01)		.01	.01	.00(-00)
Quntile 4		.00	.40	.00(-.01)		-.01	.41	.008(.23)		-.00	.41	-.00(.02)
Residual				-.033(.69)				-.01(.56)				-.040(.89)
Observation	8,505				7,973				9,229			
R2	0.018				0.027				0.037			

Note: under each malnutrition indicators, in the contribution column, the figure in parenthesis represents the percentage contribution. Each figure is rounded to two digits only. Hence, point zero zero doesn't mean that it is actually zero, it is rather rounded value