Resilience of Agropastoral Households Affected by Large Scale Land Investments: The Case of Ethiopia

by Adugna Eneyew Bekele, Dusan Drabik, Liesbeth Dries, and Wim Heijman

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Abstract

Agropastoral societies in Ethiopia and elsewhere in Africa are facing challenges in their land use. The shifts of land towards large scale land investments have exacerbated the scarcity of pastures, thus affecting the resilience of pastoral systems. In this study, we assess how large scale land investments affect household resilience using data from the Living Standards Measurement Survey in Ethiopia. We estimate household resilience capacity by a multivariate two-step factor analysis and welfare resilience from net changes in welfare outcomes between two survey intervals. We assess the effect of large scale land investment on household resilience by using an ordered random effects regression model.

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Factors that enhance the resilience capacities of households include access to livestock markets, social safety nets, extension, mobility, and social services. About one-third of the study population has low resilience capacity, while more than half has low welfare resilience. Proximity to a large scale land investment significantly reduces households' likelihood of having high resilience capacity. Future resilience programs in agropastoral areas should mitigate the adverse effect of large scale land investments by enhancing livelihood diversification and households' access to communal pastures.

Keywords: factor analysis, random effects, pastoralism, resilience, Ethiopia

1. Introduction

Resilience becomes one of the economic development goals in recent years (Alfani, Dabalen, Fisker, & Molini, 2015; Tanner, et al., 2015). Resilience thinking provides a basis for understanding sustainable development and socio-ecological changes to avoid human crises (Pisano, 2012). Research on resilience in developing countries has grown in recent years (FAO, 2016; Levine, 2014). Increased livelihoods vulnerability to shocks and the quest for shock reduction heightened interest in resilience studies (Barrett & Constas, 2014; Speranza, Wiesmann, & Rist, 2014).

There is an extensive literature on resilience (Asmamaw, Mereta, & Ambelu, 2019; Atara, Tolossa, & Denu, 2020; Demeke & Tefera, 2010) and resilience to shocks (Asfaw, Maggio, & Palma, 2018; Carter, Little, Mogues, & Negatu, 2007; Koo, Thurlow, Eldidi, Ringler, & De Pinto, 2019; Mekuyie, Jordaan, & Melka, 2018). Large scale land investments (LSLIs) are expected to exacerbate households' vulnerability to shocks (Yengoh, Steen, Armah, & Ness, 2016; Zoomers & Otsuki, 2017). Agropastoralists mainly depend on livestock production in combination with some cropping activities. Livestock is grazed on extensive communal lands and mobility is the key strategy for maximizing feed availability (Nori & Scoones, 2019; Osman, Olesambu, & Balfroid, 2018). The conversion of communal land to LSLIs reduces households' ability to cope in times of crisis (Haller, Käser, & Ngutu, 2020). LSLIs increase community vulnerability to grazing scarcity (Beyene, 2016; McPeak & Little, 2017; Zaehringer, Wambugu, Kiteme, & Eckert, 2018) and land degradation (Bekele, Dries, Drabik, & Heijman, 2020; Semie, Silalertruksa, & Gheewala, 2019). Hence, LSLIs are expected to have an adverse effect on household resilience.

Agropastoralists in Africa, and particularly in Ethiopia, face economic, ecological, and societal challenges. The most significant challenge for pastoralism in eastern Africa is the fragmentation of pasturelands (Lind, Sabates-Wheeler, & Kohnstamm, 2016; Rufino, et al., 2013; Tsegaye, Vedeld, & Moe, 2013). Land scarcity and access constraints are the main sources of food insecurity in Africa (Moyo, 2007). Pastoralists in Ethiopia were historically marginalized in national policies (Gebremeskel, Desta, & Kassa, 2019; McPeak, 2001). In Ethiopia, all the land is controlled by the government, and the government has expanded LSLI into pastoral areas, for instance, with the establishment of large sugar and cotton plantations. In the Ethiopian Rift Valley, the Karrayu pastoralists have lost more than three fourths of their original pastureland, while 60% of the Afar rangelands were lost since the 1960s due to LSLI (Bekele, Dries, Heijman, & Drabik, 2021). These LSLIs have restricted the local use of former commons (land, water, and forests). Existing studies on the impact of LSLI in Ethiopia mainly focus on non-pastoral areas (Baumgartner, von Braun, Abebaw, & Müller, 2015; Debela, et al., 2020; Shete & Rutten, 2015; Wayessa, 2020), with exceptions of (Bekele, et al., 2020; Bekele, et al., 2021). Despite an increase in research on resilience in recent years, there is little agreement on what constitutes resilience in general and in pastoral areas in particular (Adelaja, et al., 2020; Levine, 2014). Moreover, resilience is dynamic and highly context-specific (FAO, 2016; Speranza, et al., 2014). The studies conducted on resilience in Ethiopia do not address these dynamics and the specific context of pastoral areas (Atara, et al., 2020; Kebede, Haji, Legesse, & Mammo, 2016; Weldegebriel & Amphune, 2017). The few studies on the resilience of pastoral communities in Ethiopia are either based on cross-sectional data without addressing the dynamic nature of resilience (Ambelu, et al., 2017; Mekuyie, et al., 2018); or for a specific project's impact evaluation (Frankenberger, 2015; McPeak & Little, 2017). Morover, the relation between resilience and LSLI has not yet been investigated. Therefore, this study aims at investigating the likely effect of proximity to LSLI on household resilience using panel data from the Living Standards Measurement Survey (LSMS) in Ethiopia.

3. Methodology

3.1. Data and study areas

The Living Standard Measurement Survey (LSMS) for Ethiopia provides comprehensive and high-quality data that was collected by the Central Statistics

Agency of Ethiopia in collaboration with the World Bank in 2012, 2014, and 2016. The main pastoral zones in four regions of Ethiopia, Oromia, Southern Nations Nationalities and Peoples (SNNP), Afar, and Somali are included. We use household- and community-level data for 2106 agropastoral households.

3.2. Measuring household resilience

Several methods have been proposed to measure resilience. The most widely used method is the indicator-based approach, which uses indicators to construct a resilience index (Alinovi, D'errico, Mane, & Romano, 2010; Alinovi, Mane, & Romano, 2009; Asmamaw, et al., 2019). In this approach, Resilience Index Measurement and Analysis (RIMA) developed by the FAO and Technical Assistance to Non-Governmental Organization (TANGO) developed by the US Agency for International Development (FAO, 2016; TANGO, 2018) are the most common.

Another common method is the welfare approach pioneered by the World Bank (Alfani, et al., 2015). In the welfare approach, resilience is interpreted as achieving the standard welfare level or recovering from the loss of welfare and rebounding to the original welfare level.

In our analysis, we use both the indicator-based and welfare-based methods and compare the results. In the indicator method, we adopt the resilience capacity dimensions of absorptive capacity, adaptive capacity, and transformative capacity (Smith & Frankenberger, 2018; TANGO, 2018). Figure 1 represents the three dimensions of livelihood resilience capacity.

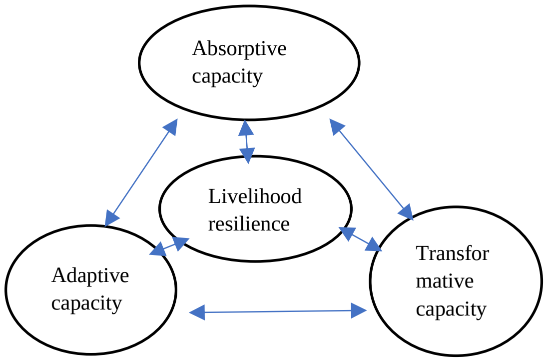

Figure. 1. Three-dimension components of livelihood resilience capacity

Household resilience capacity (RC) for household *i* at time *t* can be specified as follows:

$$RC_{it} = f(ABS, ADP, TRANS) \qquad (1)$$

For the welfare method, we use changes in welfare outcome indicators. Change in income, consumption expenditure, food intake (2200 kcal/day/adult) (EHNRI, 2000), and poverty (1.9 USD/day/adult) are used as welfare outcome indicators. The changes in welfare outcomes are reported as 1 (if positive), 0 otherwise. Our approach is supported by theoretical and empirical research (Ansah, Gardebroek, & Ihle, 2019; Arouri, Nguyen, & Youssef, 2015; Frankenberger, Constas, Nelson, & Starr, 2014; FSIN, 2015).

3.3. Empirical model

We use two-stage factor analysis to construct RC. In the first stage, we estimate ABS, ADP, and TRANS capacities by using the factor variance (Alinovi, et al., 2010). The variables that have a negative sign (reducing the capacity) contrary to expectation were excluded from the index (TANGO, 2018). The first factor with an eigenvalue greater than one and highest variance was used to construct the three resilience capacities. Second, the RC was estimated by aggregating ABS, ADP, and TRANS.

$$RC_{it} = \sum_c v_{it} F_{it} \qquad (2)$$

where F_{it} is the factor generated, v_{it} is the factor variance for each factor and c is the particular resilience capacity.

We classify households as treated (1 if the household is located at a distance of less than 150 km from a LSLI) and control (at least 150 km). We used the household coordinates to calculate the distance of each household to sugar plantations.

We use the ordered RE logit model to estimate the covariates of resilience capacity and the effect of resilience capacity on welfare resilience. We detect no problems with multicollinearity (Appendix Table 2).

From the standard RE model, let y_{it}^{*} be a latent variable of the i[th] household's resilience capacity status (RC) at time t:

$$y_{it}^{*} = \alpha + \lambda_t + \tau_{it}^{*}\beta + s_{it}^{*}\beta + (\tau_{it}^{*}s_{it}^{*})\beta + x_{it}'\beta + (u_i + \varepsilon_{it,}) \quad (3)$$

y_{it}^{*} is a function of the treatment RC_{it}, the shocks index s_{it}, treatment shock interactions $\tau_{it} * s_{it}$ and a vector x_{it} which includes demographic factors (age, gender and education status), livelihood strategy, agroecology and mobility covariates (Table 1), while λ_t represents the time effect, u_i is an individual effect, ε_{it} is the unobserved random effect: $\varepsilon_{it} \sim N(0, \delta^2)$. y_{it}^{*} is estimated by the maximum likelihood method with a set of cut-off points k which will be estimated simultaneously with β specified as:

$$y_{it} = \begin{cases} 1 \ \ if \ y_{i,t}^{*} \leq k_1 \\ 2 \ \ if \ y_{i,t}^{*} \leq k_2 \\ 3 \ \ if \ y_{i,t}^{*} \geq k \end{cases} \quad (4)$$

The probability of households falling into a particular resilience status can then be derived as:

$$p(y_i > j) = \frac{exp^{(x_i\beta_i - k_j)}}{1+exp^{(x_i\beta_i - k_j)}},\ \text{j} = 1,..,\text{J} \qquad (5)$$

where J is the highest resilience index while j=1 for less resilience, j=2 for moderate resilience and, j=3 for high resilience.

A first differenced model is fitted to estimate the effect of RC on WR. First-differencing eliminates individual effects and serial correlation (Baltagi, 2001) and yields a more robust model (Asfaw, et al., 2018; WFP, 2016).

$$\Delta\pi_{it} = \delta + \tau_{\text{it}}\beta + \Delta\text{RC}_{it}\beta + \Delta s_{it}\beta + \Delta(s_{it} * \text{RC}_{it})\beta + \Delta\text{Z}_{\text{it}}\beta + x_{it}\beta + u_{i,t} + \varepsilon_{it} \qquad (6)$$

where π_{it} indicates changes in welfare indicators, τ_i *is treatment*, Z_i *and* x_i are a vector of time varying and time invariant variables at time t, u_{it} the individual effects, and ε_{it} the random error.

4. Results and discussions

4.1 Household resilience

4.1.1. Household resilience capacity

Indexes of absorptive, adaptive, and transformative capacities are constructed using the first factor components from uniquely assigned indicators. Indicators that have a positive coefficient as hypothesized are included (Smith & Frankenberger, 2018). The Bartlett's score test and the Kaiser-Meyer-Olkin (KMO) test statistic indicate the fitness of the factor analysis. Social safety nets and the sale of livestock and other assets strongly contribute to household ABS (Table 1). The social safety nets include in-kind/cash transfers, cash assistances, receiving unconditional help from relatives, the government, and NGOs. In countries like Ethiopia where access to formal insurance schemes is lacking, social safety nets are the most common means of coping with adverse shocks. Likewise, saving and irrigation access contribute to the absorptive capacity, households with more savings and access to irrigation can better absorb disturbances. While absorptive practices can enable households to meet their short-term needs, they may compromise the long-term capacity (Keshavarz & Moqadas, 2021).

Table 1. Variables and factor loadings for absorptive capacity

Absorptive variables	Average	Factor loadings
Inverse CSI[i]	2.830	0.127
Safety nets	0.312	0.654
Saving	0.175	0.391
Credit	0.179	0.215
Migrate (labor, jobs)	0.033	0.199

Sale of livestock and other assets	0.245	0.648
Irrigation access	0.093	0.378
KMO	0.54	
% variance	17.33%	
Eigen value	1.193	
Bartlett test (chi2)	105.085***	
Alpha	0.180	

Source: Authors' calculations from LSMS data (2021)

Table 2 presents factors that contribute to the adaptive capacity of households. Access to livestock and crop extension, number of literate household members, adult labor, and size of the cultivated land highly contribute to the ADP. The income and number of income sources also contribute to the ADP of a household. Livestock size and herd diversification have the lowest contribution to the adaptive capacity. Enhancing household's access to extension, literacy programs, and alternative income sources can improve household adaptive capacities.

Table 2. Variables and factor loadings for adaptive capacity

Adaptive Variables	**Average**	**Factor loadings**
% literate of households' members	0.35	0.533
Number of adult workers	0.31	0.553
Land size (ha)	0.94	0.424
Tropical livestock units (TLU)	6.24	0.014
Number of income sources	1.46	0.269
Livestock diversity index	5.91	0.117
Annual income (ETB)	5329	0.251
Livestock extension	0.16	0.782
Crop extension	0.151	0.809
Soil quality	0.399	0.044

% forest land	9.21	0.077
% large farms	9.825	0.091
KMO	0.596	
% variance	57.61%	
Eigen value	2.189	
Bartlett test (chi2)	8311.92***	
Alpha	0.527	

Source: Authors' calculations from LSMS data (2021)

Table 3 shows the factor loadings on the transformative capacity of households. The availability of health centers, hospitals and pharmacies, phone services, micro-credit, and proximity to asphalt roads and primary schools enhance the household's transformative capacity. However, the study population has to travel 28 km to access large markets, 16 km to reach roads, and 18.9 km to go to secondary schools. Hence, investing in infrastructure and social services in agropastoral areas helps them transform their livelihoods.

Table 3. Variables and factor loadings for transformative capacity

Transformative variables	**Average**	**Factor loadings**
Availability of pharmacy	0.68	0.516
Availability of health post	0.79	0.427
Availability of water supply	0.28	0.209
Inverse distance to asphalt road (km)	48.4	0.408
Availability of large market	0.43	0.290
Inverse distance to primary school (km)	0.35	0.383

Inverse distance to secondary school (km)	18.9	0.084
Availability of hospital	0.32	0.731
Availability of micro-credit	0.068	0.287
Availability of phone services	0.076	0.403
KMO	0.53	
% variance	34.2%	
Eigenvalue	1.676	
Bartlett test (chi2)	2237.196***	
alpha	0.5079	

Source: Authors' calculations from LSMS data (2021)

Resilience capacity is estimated by aggregating the ABS, ADP, and TRANS capacities (Table 4). Only 39.1% of the potential resilience capacity is acquired by the study population. This is low and consistent with Melketo, et al. (2021). TRANS contributes the most to household resilience (0.588) followed by the ABS (0.356) and ADP (0.296) capacities. The ADP of the study population is lower than the ABS and TRANS implying the need for enhancing the communities adaptive capacities. Proximity to LSLI is associated with high vulnerability to shocks.

Table 4. Resilience capacities by LSLI proximity

		Treatment	
Resilience capacities	Total	Treated	Control
Absorptive	0.356	0.347	0.361*
Adaptive	0.296	0.288	0.30*
Transformative	0.588	0.588	0.587

RC	0.391	0.375	0.387*
Shock index	10.1	11.32	9.38***

Table 5 indicates that 28.58%, 47.72%, and 13.69% of the sample fall under low, moderate, and high resilience categories respectively. Consequently, lower percentages of treated households were in the moderate to high resilience category compared to control. This implies that proximity to LSLI is associated with lower resilience capacity.

Table 5 Household resilience status by treatment and shock exposure

Resilience capacity	RC Mean	%	Treatment Control	Treated
Low	0.216	28.58	27.00	31.28
Moderate	0.393	47.72	48.19	46.92
High	0.598	23.69	24.81	21.79
Total	0.391	100	100	100
F test	4793.7 ***		5.2*	

Source: Authors' calculations from LSMS data (2021)

4.1.2 Household welfare resilience

We estimate welfare resilience from changes in welfare outcomes between t and t-1; a positive change indicates resilience, while a negative change points to a lack of resilience. Households that able to maintain a positive gain in their welfare are defined as being resilient (1), 0 otherwise. About 41.75% of households have encountered a decline in total income, while above half suffer a loss in the consumption expenditure, food expenditure, and livestock between time t and t - 1. 46.98% of households experienced a worsening of food security. LSLI proximity was associated with declines in the average livestock, household education, and milk/day/lit. However, income and food intake increase by proximity to LSLI (Table 6).

Table 6. Growth or loss of welfare outcomes by LSLI proximity

Variables	Net change	Treatment		
		Treated	Control	% Loss
Total income	1700.1	2158.8	1433.9	41.75
Consumption expenditure	-137.1	-61.04	-181.2	51.27
Food expenditure	-220.8	-101.46	-290.14	51.64
Livestock (TLU)	0.566	.311	.715	51.71
Kcal/day/adult	160.5	326.7**	64.0	46.98
Number of assets	0.164	0.160	0.166	52.00
Average education	-0.077	-0.077	-0.076	69.31
Milk/lit/day	-.092	-.199	-.028	50.78
Poverty	16.22	17.43	15.52	8.07

Source: Authors' calculations from LSMS data (2021)

Welfare Resilience is estimated from changes in welfare outcomes namely income, food intake, consumption expenditure, and poverty. The study population achieved 36.2% of the WR status, while 54.0% of households fall under the low WR category

(Table 7). This implies that most households often fall into extreme poverty and food insecurity.

Table 7. Welfare resilience status of households by proximity to LSLI

	Welfare resilience		Treatment (%)	
Resilience	Score	%	Treated	Control
Low	0.19	53.96	51.29	55.52
Moderate	0.5	34.62	36.04	33.79
High	0.77	11.42	12.67	10.69
Total	0.362	100	100	100
F/chi2	4209.4***		2.62	

Source: Authors' calculations from LSMS data (2021)

Table 8 presents a household's resilience capacity by gender, livelihoods, and welfare outcomes. The result shows agropastoralists are significantly more resilient (0.386) than pastoralists (0.353). Both the absorptive and adaptive capacities are higher for agropastoralists than pastoralists. Male-headed households have significantly higher resilience capacity compared to female-headed households, while the transformative capacity does not exhibit a substantial variation.

The resilience index of food secure (at 2200 kcal/day/adult) households (0.359) was slightly higher than food-insecure households (0.349), but only significant for the adaptive capacity. Whereas the self-reported food security shows significant variations in absorptive capacity. The majority of the agropastoral households are living in extreme poverty (75.7%) at the 1.9 USD/day/adult poverty line[ii]. This is comparable to the average poverty of agropastoralists in Africa (77%) (de Haan, 2016). Non-poor households have slightly higher RC than poor households.

Table 8. Household resilience capacity by livelihoods and welfare outcomes

Welfare indicators		Absorptive	Adaptive	Transformative	RC
Livelihoods	Pastoral	0.336	0.25	0.594	0.353
	Agropastoral	0.361	0.304	0.584	0.386
	t-test	2.87***	7.91***	-1.29	4.67***
Gender	Men	0.358	0.324	0.583	0.396
	Women	0.347	0.181	0.596	0.319
	t-test	-1.25	-22.81***	1.69	-11.04***
Objective food security	>=2200 kcal	0.359	0.286	0.589	0.379
	<2200 kcal	0.349	0.302	0.581	0.379
	t-test	-1.2	2.48***	-1.19	0.02
Subjective food security	Food secure	0.363	0.292	0.585	0.381
	Food insecure	0.341	0.292	0.59	0.376
	t-test	-2.77***	0.09	0.77	-0.57
Poverty	Poor	0.357	0.294	0.584	0.389
	Non poor	0.356	0.299	0.595	0.395
	t-test	-0.12	-0.41	-1.48	-1.32

Source: Authors' calculations from LSMS data (2021)

4.3 The effect of LSLI proximity on household resilience

Table 9 presents the effects of LSLI proximity on resilience capacity controlling for confounders. The Wald and LR tests show that the model fits the data well. As expected, proximity to LSLI had an inverse correlation with resilience capacity. This implies that LSLI proximity reduced the likelihood of households becoming highly resilient. Likewise, shock intensity adversely affects the resilience capacity of agropastoral households. Households who pursue pure pastoralism were less resilient compared to those who practice livestock and cropping. Likewise, women-headed households were less resilient than those led by men, and households in warm semi-arid were less resilient.

Table 11. Ordered random effect regression on determinants of resilience capacity

VARIABLES	Coef.	se.	Coef.	se.
Treatment	-0.875***	0.275	0.193	0.115
Treatment*shock index	0.020	0.015	-	-
Shock index	-1.478**	0.757	-1.861	1.336
Livelihoods	-0.323***	0.135	0.146	0.127
Agro-ecology	0.912***	0.221	-0.014	0.113
Gender	0.689***	0.211	0.079	0.125
Age	0.003	0.005	0.089	0.466
Education level	-0.026	0.019	0.141	0.190
Mobility	0.102	0.154	0.661***	0.113
ΔRCI	-	-	1.11**	0.503
ΔRCI*shock index	-	-	0.035**	0.016
Year				
2014	0.255**	0.157		
2016	0.335**	0.228		
Cut1	-0.978	0.413		
Cut2	3.039	0.428		
sigma2_u	6.31	0.674		
LR test	555.44***			
Wald chi2(12)	51.54 ***			
Observations	2106			

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

Source: Authors' calculations from LSMS data (2021)

The findings in Table 9 also indicate resilience capacity increases the likelihood of households to improve income, per capita food intake, poverty, and WR between t and t-1 controlling for shocks and treatment. Hence, RC is a very good predictor of WR. The significant positive effect of the RC-shock interaction indicates RC helps households recover from shocks. No significant difference in food expenditure was observed by resilience capacity. Proximity to LSLI has a significant positive effect on food intake and poverty. This is because of relatively better access to roads, and markets near LSLI (Bekele, et al., 2021). A unit change in shock intensity would minimize the likelihood of growth in households' consumption expenditure. Herd mobility increases the likelihood of gain in income and consumption in the face of shocks.

6. **Conclusion**

This study assesses the effect of proximity to large scale land investment on household resilience in agropastoral areas of Ethiopia by using the LSMS panel data. A multivariate factor analysis was used to construct a resilience capacity, while an ordered RE regression was used to assess the association between LSLI proximity and resilience.

The finding shows that the study population has already a low level of resilience and LSLIs further lower their resilience capacity by limiting access to grazing and increasing household vulnerability to shocks. Therefore, enhancing access to communal grazing and shock adaptation strategies in pastoral areas affected by LSLIs is useful. The study identified access to livestock markets, social safety nets, extension, and social services to be the most important factors that enhance the resilience capacities of households. The study also assesses the predictive power of resilience capacity on welfare status. The result confirms that household resilience capacity is a good predictor of welfare resilience indicating our proposed welfare resilience to be a good indicator for measuring household resilience.

The study also revealed livelihood diversification, gender, and mobility as key determinants of resilience capacity. Men-headed households have higher resilience than women-headed ones. Strategies that aim to empower women in the study area would therefore be beneficial. Proximity to LSLI also influences livelihood transitions that may lead to the abandoning of pastoralism in the long-term. Households with mixed livelihoods and moving from pastoralism have higher resilience. This implies that enhancing livelihood diversification strategies into crop and non-farm enterprises would improve resilience outcomes. Besides the majority of the agropastoral households are living in extreme poverty which requires development strategies that target poverty reduction.

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Notes

[i] The LSMS data contains household coping strategies and how often (the frequency) of the use of each coping strategies for seven days period. We calculate the Coping Strategies Index (CSI) by using a universal severity weights for each coping strategies according to Maxwell and Caldwell (2008)

[ii] The USD values are converted at the constant exchange rate of 17.82, 19.68, and 21.l91 birr respectively for 2012, 2014, 2016.