

# The Dynamics Of Food Security In Sub-Saharan Africa

Degye Goshu, Mohammed Yimer

**Abstract:** This paper examines the dynamics of food supply per capita and undernourishment in Sub-Saharan Africa (SSA) for a panel of 42 countries. The dataset was constructed from the FAO and the World Bank global databases for four rounds in five-year intervals. Ordinal measures of national food supply status were generated from daily calorie supply per capita of SSA countries. Regional and inter-temporal dynamics of food supply status (very low, low, medium), transition rates, and the associated forces underpinning this dynamic process were analyzed and stylized by parametric and non-parametric measures. Economic and socio-demographic factors and regional heterogeneities determining the dynamics of food supply situation in SSA were identified by random-effects ordered probit model. The empirical findings indicate that the food supply level of SSA countries was enhanced by agricultural production and industrial value added, as a proxy for structural transformation. However, it was adversely affected by military expenditure, inflation level of consumer prices, proportion of rural population, age dependency ratio, and regional heterogeneities. The likelihood of SSA countries to face incidence of very low, low and medium calorie per capita supply was 23 percent, 61 percent and 16 percent, respectively. To improve the level of food supply per capita and thereby to reduce food poverty situation, SSA countries and other stakeholders need to focus on policies designed to enhance economic growth through agricultural production, creation of employment opportunities with structural transformation, enhancing health care services, improving their demographic structure through family planning, and controlling national and regional shocks and instabilities.

**Keywords:** Food supply, undernourishment, random-effects ordered probit, SSA.

## Introduction

Food security remains most fundamental challenge for human welfare and economic growth in Sub-Saharan Africa (SSA). Evidences by Maxwell and Slater (2003), Benson (2004), Mwaniki (2005), and Kidane et al. (2006) verify the underlying factors contributing to either insufficient national food availability or insufficient access to food by households and individuals. Unstable social and political environments that preclude sustainable economic growth, war and civil strife, macroeconomic imbalances in trade, natural resource constraints, underdeveloped agricultural sector, barriers to market access, effects of globalization, disease and infection, handicapping policies, poor human resource base, gender inequality, inadequate education, natural disasters, and the absence of good governance are the major challenges to food security in SSA. The physical availability of food is a function of productive agriculture, effective trade infrastructure, and efficient food aid logistics while economic access is a function of prices and incomes. Economic growth and social security policies are important in generating and preserving the entitlements to food. Calorie intake may be affected by the socio-demographic characteristics of households, the endowment of resources to produce own food, the factors affecting food production and the available off-farm income to purchase food from the market (Abele et al., 2007). The right of access to food in SSA is generally determined by availability of agricultural resources; increase in the demand for food as a result of the increase in population, increase in personal income, development of transportation and storage facilities, macroeconomic and socio-political stability; seasonal fluctuation in availability of food due to natural disaster, access to safe water, access to health care services, and access to sanitation facilities (Adeyemi et al., 2009).

Broad-based economic growth is suggested to reduce hunger and malnutrition in SSA (Benson, 2004; Zhang, 2004; World Bank, 2008). The potential intellectual and technical capacity of the population is dependent on improved nutrition and the effective utilization of such capacity. In this regard, agriculture is believed to be the leading candidate to bring about rapid growth and broad-based economic development in SSA and other less-advanced countries and regions. It holds a prominent place in these economies and constitutes the primary source of export earnings, employment, poverty reduction, stimulate development of rural non-farm activities, generate capital surplus, release labour for other sectors and provide a stable food supply at affordable prices, thus contributing to the competitiveness of the economy as a whole and acting as a major source of stimulus for the demand for goods and services of other sectors (Kidane et al., 2006). The food security benefits of food price stabilization policies through competitive and efficient trade and the efficiency gains from a shift to market orientation is the other possible policy imperative in SSA (Dorosh, 2009). Empirical evidences suggest that a rapid growth in staples production, together with more integrated regional markets, would reduce food prices for both consumers and producers in SSA (Diao et al., 2008). While policies promoting broad-based economic growth are fundamental to overall social development in SSA, the distribution of benefits of growth to the poorest and the most marginalized is strongly argued (Devereux and Sabates-Wheeler, 2004; UNICEF, 2008; Devereux, 2009). There is a need to initiate comprehensive social protection programs and interventions in order to provide income or consumption transfers to the poor, protect the vulnerable against livelihood risks, and enhance the social status and rights of the marginalized. Food security could be measured at national, household and individual levels (Radimer et al., 1990; Bickel et al., 2000; FAO, 2009). Measuring food security at the national level entails determining the amount of food available in the country and the extent to which it provides the recommended minimum calorie intake per person per day (FAO and WHO, 1985; FAO, 1996; Jacobs and Sumner, 2002). The central defining features of food security comprises adequacy of food availability, stability of supply, physical and economic accessibility of food, and quality and safety of food

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(Ruel, 2002, 2003; Swindale and Ohri-Vachaspati, 2005). Availability of food at national level is a necessary condition for achieving food security but it is not sufficient to ensure food security at household and individual levels (Smith and Subandoro, 2007). The percentage of populations that are food energy deficient is the indicator that has been used to monitor countries' progress in meeting international goals such as the Millennium Development Goal (MDG) of halving the proportion of people who suffer from hunger by 2015 (UN, 2009). The primary limiting factor in analysing food supply dynamics of countries is data availability for employing standard and robust methodologies. This study makes use of daily calorie supply per capita as the conventional outcome indicator of aggregate food availability at a national level. It could be measured based on consumption per equivalent male adult or consumption based on age and sex without converting into equivalent male adult, as first recommended by WHO and FAO (1985) and later improved by FAO (2001, 2008). The annual timeseries dataset on food supply and other development indicators available at the FAO and the World Bank global databases are recent experiences with limited samples and missing values. This study constructs a panel dataset of SSA countries over the period 1994-2009 for four rounds with five-year intervals. This method creates more data points and accounts for problems associated with analysis of simple timeseries or simple cross-sectional units. The study contributes to the empirical literature of food policy analysis in developing countries in general and in SSA in particular. Stylized facts on the food supply performance of SSA and the economic, socio-demographic and regional heterogeneities determining food supply levels of countries are documented. Following FAO and WHO (1985), Hoddinott (1999), Bouis and Hunt (1999), FAO (2001), and Smith and Subandoro (2007), countries were categorised into three based on their food supply levels as very low (less than 2050 kcal), low (between 2050 and 2500 kcal), and medium (between 2500 and 3000 kcal). The stylized facts generated from non-parametric analysis point out that most SSA countries have markedly exhibited increasing trends in their calorie supply, leading to declining prevalence of undernourishment. The mean regional and inter-temporal daily calorie supply in SSA over the years are increasing but significantly different across regions. The parametric model results, after controlling for country and regional fundamentals, suggest that food supply levels of countries are significantly associated with agricultural production, industrial GDP, military expenditure, inflation level, proportion of rural population, age dependency ratio, and regional heterogeneities. The remaining part of the paper is divided into three parts. First conceptual and analytical frameworks of the study are presented. Then, empirical findings are presented and discussed. Finally, some concluding remarks and policy implications are drawn.

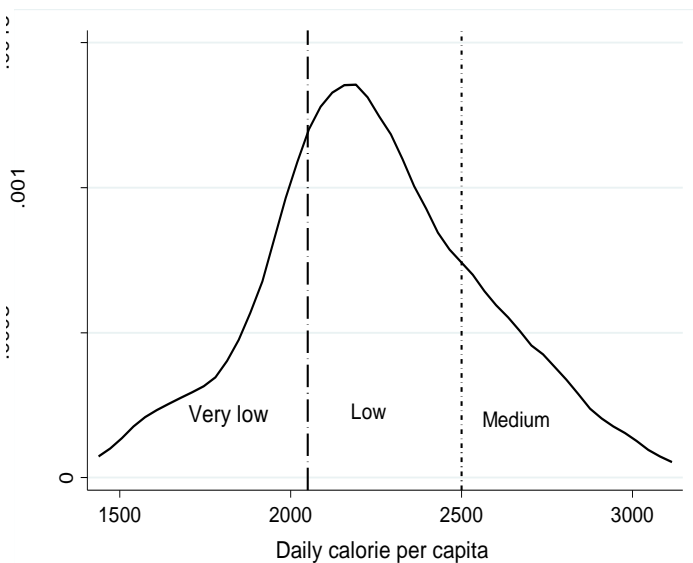
## 2. Conceptual and Analytical Framework

### 2.1. Conceptual framework

The current measure of food insecurity is based on the measure of undernourishment developed by FAO (Naiken, 2003). It is a direct measure of the diet quantity aspect of the definition of food security related to access to sufficient food for an active, healthy life. One of these groups of indicators is daily calorie supply per capita. FAO (2011) defines calorie

supply per capita as the amount of food available for consumption, measured in kilocalories (kcal) per capita per day. This figure is reached by dividing the total available food supply for human consumption by the population. The FAO global dataset tracks the calorie supply per capita in each country for calories available from crop products. This indicator shows the per capita supply of total calories and the split between calories from animal and vegetal products. While daily calorie supply per capita serves as a measure of calorie availability, the distribution of available food across a country's population per capita energy requirement are usually employed to predict estimates of the prevalence of undernourishment. Prevalence of undernourishment is the percentage of people in a population group or country who are food energy deficient. The prevalent of undernourishment estimated from this figure has been used to monitor progress toward the Millennium Development Goal of halving the proportion of people in extreme poverty and hunger by 2015. Percent of people severely food energy deficient is benchmarked at 2,050 kilocalories for a very low value of this indicator (Smith and Subandoro, 2007). The annual timeseries data on daily calorie supply per capita and the African development indicators used in this study were obtained from FAO and The World Bank (FAO, 2012; World Bank, 2012). Africa development indicators are the primary collection of such development indicators on Africa, compiled by the World Bank from official sources since 1960 (World Bank, 2014). It presents current and accurate global development data available, and includes national, regional and global estimates of indicators of development in SSA. Statistical information on these is crucial for conceptual and policy-planning tools based on facts and for providing improved support to policy implementation, monitoring of progress, and assessment of the results and impact of development initiatives in SSA (UNECA, 2012). In this study, country and regional fundamentals such as economic, socio-demographic and regional indicators were hypothesized to be potential sources of dynamics associated with national food availability in SSA over the years. A panel dataset of 42 SSA countries was constructed in four rounds with five-year intervals since 1994 (1994, 1999, 2004 and 2009). Accordingly, a database of 168 data points was generated for this purpose. Economic factors including agricultural production and industrial GDP were assumed to improve national food availability; while military expenditure and annual inflation level (as a proxy for economic access to food) were hypothesized to depress national per capita food supply. Socio-demographic factors like proportion of rural population, age dependency ratio and HIV prevalence rate were expected to adversely affect food supply per capita. Region-specific factors such as instability of social and political environments, war and civil strife, natural resource constraints, natural disasters, and the absence of good governance or weak democratic system were proxied by four regional dummies in SSA (Southern, Western, Eastern and Middle Africa). Western Africa, the most likely outcome comprising 16 countries, was used as a base category of regional comparison of food supply level. Most SSA countries are in a dynamic process to improve their food security situation. There are economic, socio-demographic, and regional heterogeneities influencing this dynamic process. The empirical knowledge on the factors determining the level of daily calorie per capita supply of countries from lower to higher category (very low, low, and medium) is relevant to food

security policy formulation and implementation. Moreover, the likelihood of countries falling in one of the three categories and the factors associated with this food supply situation is a central policy imperative. A sizeable literature on food policy analysis suggests the importance of stratifying daily calorie supply per capita into four distinct categories or levels (FAO and WHO, 1985; Bouis and Hunt, 1999; Hoddinott, 1999; FAO, 2001; Smith and Subandoro, 2007). Accordingly, the minimum cut-off point for daily calorie supply per capita is regarded as very low (below 2050). The other levels of food security situation measured by daily calorie supply per capita are low (between 2050 and 2500), medium (between 2500 and 3000), and high (3000 and above). Simplifying the food supply continuum into such small set of categories, each one representing a meaningful range of food supply situation, and explaining the proportion of countries falling in each of these categories is useful information both for policy and research purposes. The key strength of such categorical measures employed in this study is that it captures and distinguishes the various levels of food availability throughout the full range of the food supply continuum with which the phenomenon of food shortage is experienced in SSA. This feature is critical for accurately assessing the prevalence and likelihood of sufficient food availability. It enables to identify the masked heterogeneities in the mean value of food energy continuum and to characterize some commonalities of countries falling in each category of food supply situation. In addition, estimation problems related to endogeneity expected in linear panel estimators can easily be controlled by using nonlinear models of such categorical outcome measures. The distribution of daily calorie supply per capita in SSA depicted by the kernel density estimate is reported in Figure 1. The two vertical long and short dashes denote the threshold calorie levels separating very low or severe undernourishment (below 2050 kcal), low or moderate undernourishment and medium-to-high. The figure graphically illustrates the proportion of countries falling in each food supply category. For consistent and unbiased estimation of models of categorical outcomes, sufficient number of observations should fall in each category. The distribution clearly reflects the relevance of modelling the dynamics of daily calorie supply status in SSA using these ordinal outcome models.



**Figure 1:** Distribution of daily calorie supply per capita in SSA

Food availability, be it global, national, or at local community level, it is an essential and universal dimension of household and personal well-being (Bickel et al., 2000). Each stage of calorie supply level is assumed consisting of characteristic conditions and experiences of food sufficiency and of the proactive responses of countries to these conditions. Analyzing national and regional food energy supply per capita can help identify and comprehend this basic aspect of well-being of populations and to recognize population subgroups or regions which are exceptionally worse-off or better-off with the associated forces influencing this dynamic process.

## 2.2. Analytical framework

While many different models have been designed for ordinal outcomes introduced by McKelvey and Zavoina in 1975, this study employs the probit version of the ordinal regression model in terms of an underlying latent variable but which is extended to panel data estimators. Accordingly, the dynamics of food supply level and the factors associated with this dynamic process in SSA over the period can be estimated by ordered panel probit models (Arellano, 2003; Skrondal and Rabe-Hesketh, 2004; Pfarr et al., 2011; Rabe-Hesketh and Skrondal, 2012; Twisk, 2013). This paper employs the random-effects ordered probit estimator. The structural model of the random-effects ordered probit regression is presented as a latent variable model, where observed ordinal responses  $y_{it}$  are generated from the latent continuous responses (Kaiser and Spitz-Oener, 2000; Al-Sakka and ap Gwilym, 2009; Greene, 2012)

$$y_{it}^* = \mathbf{x}_{it} \boldsymbol{\beta} + v_i + \varepsilon_{it} \quad (1)$$

where  $y_{it}^*$  is a latent variable (food supply status) ranging from  $-\infty$  to  $\infty$ ;  $i$  is the observation (countries);  $\mathbf{x}$  is a vector of economic, socio-demographic, and regional dummies determining food supply levels;  $\boldsymbol{\beta}$  is a vector of unknown parameters to be estimated;  $v$  is the time-invariant country-specific random variable with unobservable country heterogeneity and assumed to be unrelated to any independent variable in the random-effects; and the  $\varepsilon_{it}$  are errors assumed to be independent of  $v_i$  (independent among time and countries) and distributed as standard normal with mean zero and variance one. The measurement model for ordered outcomes can be obtained by expanding the measurement model for binary outcomes by dividing the latent variable into  $J$  ordinal categories:

$$y_{it} = m_i \quad \text{if} \quad m_{i-1} < y_{it}^* < \tau_m \quad (2)$$

for  $m = 1$  to  $J$ .

Therefore, the latent variable could be measured as

$$y_{it} = \begin{cases} 1 \Rightarrow \text{very low calorie } (y_{it} < 2050) & \text{if } \tau_0 = -\infty \leq y_{it}^* \leq \tau_1 \\ 2 \Rightarrow \text{Low calorie } (2050 \leq y_{it} < 2500) & \text{if } \tau_1 = \tau_1 \leq y_{it}^* \leq \tau_2 \\ 3 \Rightarrow \text{Medium calorie } (y_{it} \geq 2500) & \text{if } \tau_2 = \tau_2 \leq y_{it}^* \leq \tau_3 = \infty. \end{cases} \quad (3)$$

The cutpoints (or the threshold parameters)  $\tau_1$  through  $\tau_{j-1}$  can be estimated. Thus, when the latent  $y^*$  crosses a cutpoint, the observed category of food supply level changes. The outcome will be in the second ordered category (low calorie supply) or higher if  $\tau_1 = \tau_1 \leq y_{it}^* \leq \tau_2$ . The outcome will be in the third ordered category (medium) or higher (not the first or second) if  $\tau_2 = \tau_2 \leq y_{it}^* \leq \tau_3$ .

### 3. Empirical Findings

#### 3.1. Description of variables

Supported by the burgeoning literature on food policy analysis, the economic, socio-demographic and regional factors hypothesized to influence food supply levels are described in Table 1. The mean values of these variables are reported by food supply level of countries in SSA. There are important differences in the mean values of the basic structural features of food supply situation in SSA countries across the three levels of food supply. Unlike the countries with relatively better food supply, countries with very low food supply are characterized by lower agricultural production, industrial GDP, high military expenditure (as a proxy for political instability and civil strife), high (or two-digit) inflation of consumer prices, high proportion of rural population, high age dependency ratio, and high HIV prevalence rate.

**Table 1:** Description of variables affecting food supply per capita levels in SSA

| Variables  | Mean values by levels of food supply |       |        |           |
|--|--------------------------------------|-------|--------|-----------|
|  | Very low                             | Low   | Medium | All (SSA) |
| Agriculture production index (2004-2006 = 100)         | 80.64                                | 93.70 | 99.16  | 91.51     |
| Industry, value added (% of GDP)                       | 24.21                                | 25.41 | 29.47  | 25.91     |
| Military expenditure (% of GDP)                        | 6.16                                 | 2.07  | 1.39   | 2.96      |
| Annual inflation (%)                                   | 51.85                                | 14.49 | 4.65   | 21.90     |
| Annual inflation level (1 if high (>10%), 0 otherwise) | 0.64                                 | 0.31  | 0.15   | 0.36      |
| HIV prevalence rate (population aged 15-24 years)      | 7.25                                 | 6.64  | 4.08   | 6.29      |
| Rural population (% of total population)               | 73.53                                | 66.58 | 52.32  | 65.51     |
| Age dependency ratio (% of working-age population)     | 91.05                                | 87.93 | 75.69  | 86.30     |
| Southern Africa  | 0.02                                 | 0.16  | 0.12   | 0.12      |
| Eastern Africa   | 0.67                                 | 0.30  | 0.12   | 0.36      |
| Middle Africa  | 0.24                                 | 0.12  | 0.09   | 0.14      |
| Western Africa   | 0.07                                 | 0.42  | 0.67   | 0.38      |

Agricultural production, as proxied by agricultural production index (based on 2004-2006 years), consistently varies from nearly 81 percent in countries of very low supply to 99 percent

in countries of medium supply, a difference of 19 percentage points increasing monotonically with food supply level of countries. This large and systematic difference across food supply levels markedly explains agricultural production as the major source of variation in food supply levels. Agricultural production therefore remains the central feature of food availability in SSA. Industrial GDP, as a proxy for structural transformation in SSA, is consistent with the implications of agricultural production. The mean difference between countries with very low and low food supply level is quite small but significantly large in countries with medium food supply. Industrial growth creates job opportunities and enables to withdraw idle labour force from primary activities (agriculture and related enterprises) to secondary and tertiary activities. This opportunity secures economic access to food by creating other sources of food. The mean military expenditure, as a percentage of GDP, in SSA is about 3 percent. This figure considerably varies from 1.4 percent in countries with medium food supply to 6.2 percent in those with very low food supply. This pattern of military expenditure in the study period could be explained by the incidence of war and civil strife experienced in Eastern Africa (including Rwanda, Uganda, Ethiopia, Eritrea, and Sudan) and Middle African (Angola, Chad, and Congo Republic). Occurrence of drought is the other factor negatively affecting food supply in these regions. Compared to Western Africa, food availability in Eastern, Middle and Southern Africa is generally worse-off in the study period. Inflation of consumer prices is becoming an increasingly important policy imperative of all economies. The mean annual inflation in SSA has been proportionally increasing with decreasing food supply levels, which is suggestive of the negative association between inflation and food availability. The annual inflation of consumer prices is about 52 percent in countries with very low food supply level, but it drastically and monotonically decreases in countries with low and medium food supply levels. However, there are consistent but less observed differences in the prevalence of HIV across food supply levels, the SSA mean being 6.3 percent. Percentage of rural population, as a proxy for urbanization usually accompanying structural transformation, is assumed to influence food supply levels negatively. The mean value is about 74 percent in countries of very low calorie supply level and consistently decreases to 67 percent and 52 percent, respectively, in countries with low and medium calorie supply. Age dependency ratio is high in SSA (86%), considerably varying from 76 percent in countries with medium food supply to 91 percent in those with very low food supply. This aggravates the mismatch between the supply of and the demand for food in SSA. The effects of regional heterogeneities in SSA countries on their food supply levels are captured by regional dummies. About 67 percent and 24 percent of the SSA countries facing incidence of very low food supply situation are found in Eastern Africa and Middle Africa, respectively. Western African countries are better-off in their food supply situation since 67 percent of SSA countries experiencing medium food supply are in this region, with only 7 percent facing incidence of very low food supply. But nearly 42 percent of SSA countries with low food supply situation are in Western Africa, 30 percent in Eastern Africa and 16 percent in Southern Africa.

### 3.2. Trends of food supply and undernourishment

Figure 2 traces the regional and inter-temporal mean values of daily calorie per capita supply and prevalence of undernourishment compared with the SSA mean over the years. The regional mean values of daily calorie supply per capita, compared to the SSA mean (2245 kcal) indicated by the horizontal broken line, are markedly different. Eastern and Middle SSA countries have relatively depressed calorie supply which is far below the SSA mean. However, as depicted by the consistent inter-temporal growth of daily calorie per capita over the period (1994-2009), food supply in Southern and Western SSA is far above this mean, which is suggestive of the substantial food supply difference between the two groups of regions. The mean SSA calorie per capita supply in 1994 (2142 kcal) was monotonically increased to 2354 kcal in 2009. Both spatial and inter-temporal variations in calorie supply have resulted in an aggregate mean food supply of 2245 kcal in SSA. The distribution of national food supply across populations could be revealed by estimating the percentage of population facing food insecurity and hunger. The dynamics of this alternative measure, prevalence of undernourishment, in SSA is depicted in the second panel of Figure 2. As indicated, there is a declining trend in the prevalence of undernourishment over the years. However, Eastern African countries exceptionally faced high level of undernourishment far above the SSA mean value (31.8%). The lowest prevalence rate of undernourishment is observed in Southern Africa which is consistent with the results from the dynamics of food supply situations in the regions.

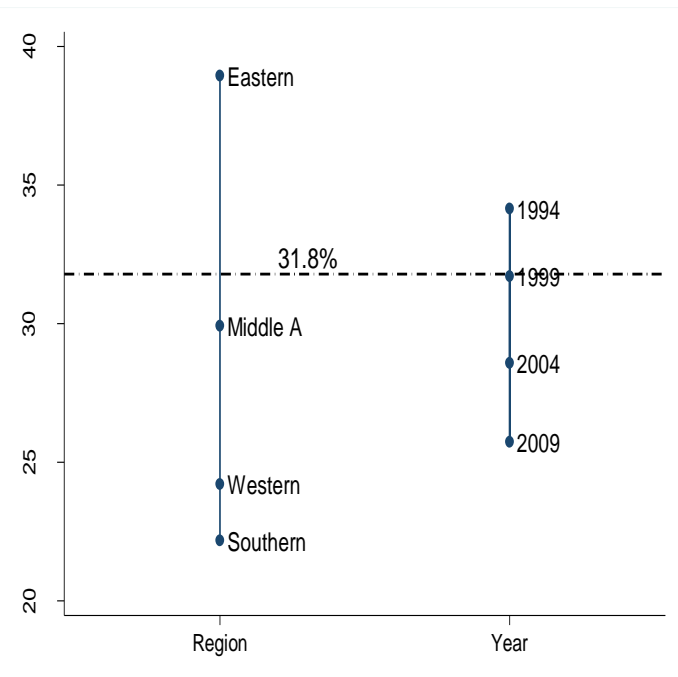
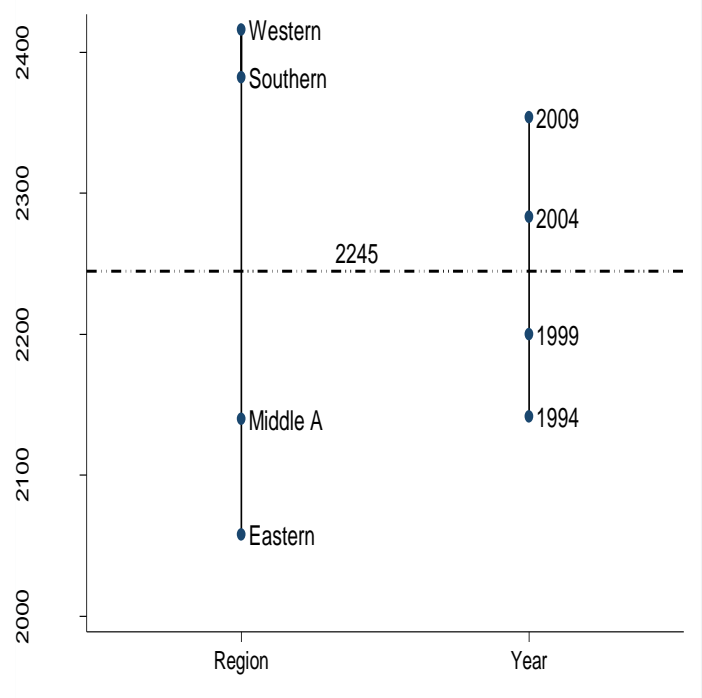


Figure 2: Regional and inter-temporal dynamics of calorie supply and undernourishment in SSA

The transition probabilities of countries in SSA from one food supply status to the other every year are reported in Table 2. The results point out that, each year, some 54 percent of the sample countries with very low food supply status remained in the same food insecurity situation for five years while the remaining 46 percent had a chance of achieving low food supply status. About 15 percent of the countries with low food supply shifted up to medium food supply situation while some 81 percent with low food supply situation remained in the same food security state and the rest 5 percent rather faced a downturn of their food supply situation.

Table 2: Transition probabilities between food supply status in SSA

| Level of daily calorie per capita | Very low | Low   | Medium |
|-----------------------------------|----------|-------|--------|
| Very low                          | 53.85    | 46.15 | 0.00   |
| Low                               | 4.48     | 80.60 | 14.93  |
| Medium                            | 0.00     | 5.00  | 95.00  |
| Overall (SSA)                     | 19.05    | 57.94 | 23.02  |

### 3.3. Dynamics of food supply levels

The dynamic forces behind differing food supply levels and prevalence of undernourishment in SSA were broadly mirrored in the non-parameter measures and descriptions of variables. However, results of the previous preliminary exploration using non-parametric measures might appear to be less clear-cut. The magnitude and extent of the association between the dynamic forces and food supply levels could not be revealed and the process could be less robust in suggesting unbiased pictures. Here, a nonlinear parametric measure is used in a way that permits to verify, with acceptable robustness, the statistical significance of estimates compared to empirical and a priori expectations. In order to provide the gauge of future food security prospects based on past experiences, the panel data estimators allow a better exposition of the topic and

enable to identify the link between food supply and the underpinning proximate determinants. The random-effects ordered probit model results of the dynamics of food supply levels are reported in Table 3. Out of 10 hypothesized factors of food supply level, nine are found to be statistically significant. After controlling for country and regional factors, the signs of all the parameter estimates are as expected. The estimated variance component is 3.85 with standard error 2.27. The likelihood-ratio test shows that there is enough variability between countries in favor of random-effects ordered probit regression over a standard ordered probit regression. The food supply levels of countries (very low, low, and medium) are significantly and positively associated with agricultural production and industrial GDP. The food supply status of SSA countries is enhanced by their crop production suggesting that own food production is an integral part of food security. Industrial value added, as a proxy for structural transformation of the economies, has enabled to improve the food security situation of countries. Agricultural production and productivity and its transformation is a very relevant policy imperative in improving food availability in SSA. Structural transformation is the defining characteristic of the development process itself defined by four interrelated processes: a declining share of agriculture in GDP and employment, the rapid process of urbanization as people migrate from rural to urban areas, the rise of a modern industrial and service economy, and a demographic transition from high to low rates of births and deaths. However, the speed and extent of sectoral shifts from agriculture to industry could be reflected by the willingness and ability of labor and capital to move toward higher-productivity sectors.

**Table 3:** Random-effects ordered probit model results of food supply status in SSA

| Variables                             | Coefficients | Standard errors |
|---------------------------------------|--------------|-----------------|
| Agriculture production index          | 0.04***      | 0.01            |
| Industry valued added                 | 0.08***      | 0.035           |
| Military expenditure                  | -0.16***     | 0.06            |
| HIV prevalence rate                   | -0.07        | 0.06            |
| Inflation level                       | -1.58***     | 0.57            |
| Rural population                      | -0.06*       | 0.04            |
| Age dependency ratio                  | -0.10***     | 0.04            |
| Southern Africa                       | -3.54**      | 1.86            |
| Eastern Africa                        | -3.34***     | 1.29            |
| Middle Africa                         | -6.15***     | 1.87            |
| Cut 1                                 | -13.79       | 4.54            |
| Cut 2                                 | -6.69        | 3.57            |
| Variance component ( $\sigma^2 - u$ ) | 3.85         | 2.27            |
| Wald $\chi^2(10)$                     |              | 20.70           |
| LR test, $\chi^2(1)$                  |              | 31.79           |
| Predicted mean probability:           |              |                 |
| Very low supply, Pr(y=1)              |              | 0.23            |
| Low supply, Pr(y=2)                   |              | 0.61            |
| Medium supply, Pr(y=3)                |              | 0.16            |

**Notes:** \*\*\*, \*\* and \* denote 1%, 5% and 10% significance levels, respectively.

Food supply status in SSA is adversely affected by military expenditure, inflation level, proportion of rural population, age dependency ratio, and region-specific heterogeneities in Eastern, Middle, and Southern Africa. Military expenditure has been depleting the resources available to food production. SSA countries need to allocate more proportion of their budget

to agricultural production and productivity in order to boost national food availability. Countries characterized by two-digit inflation levels of consumer prices have exhibited deteriorating food supply levels. These countries need to design and implement food price stabilization policies and measures in their effort to improve food security situations. The absence of structural transformation of the economies is partly reflected by more proportion of rural population, as a proxy for urbanization. Countries with more proportion of rural population faced deteriorating food supply levels. Age dependency ratio, associated with high births and deaths, is the other indicator of absence of structural transformation aggravating food shortages in SSA. To curb this problem, SSA countries require accelerated family planning interventions and improved and inclusive health care services. There is also a considerable difference in the daily calorie supply per capita attributable to regional heterogeneities. Due focus should be given to reduce regional shocks and instabilities since these could interfere with food production and budget allocation for food production. The effects of these region-specific heterogeneities, as proxied by the regional dummies, could possibly be explained by various shocks such as instability of social and political environments, war and civil strife, natural resource constraints, natural disasters, and the absence of good governance or weak democratic system (Benson, 2004; Mwaniki, 2005; Kidane et al., 2006). The predictions after random-effects ordered probit indicate that the likelihood of countries in SSA to fall in very low food supply category (less than 2050 kcal per day per capita) is 23 percent, while those falling in the low food supply category (between 2050 and 2500 kcal) is 61 percent. But the likelihood of SSA countries to obtain medium daily calorie supply (2500 kcal and above) is only 16 percent. The results suggest that SSA countries most likely obtain low daily calorie per capita supply. More focus and effort is required to move SSA countries to better food security situation.

#### 4. Conclusions and Recommendations

Food insecurity is an overriding problem of the SSA where the great majority of the population suffers from hunger and malnutrition. To address food insecurity problems in SSA, policy interventions require relevant empirical evidence on the national and regional dynamics of food supply. This study profoundly examines the dynamics of daily calorie supply per capita of 42 SSA countries in four rounds of five-year intervals (1994 to 2009) by using a panel data constructed from the global database of FAO and the World Bank. Generally, there is a positive trend of food availability and a declining trend of prevalence of undernourishment over time and across countries in SSA. The dynamics of food supply status of countries was significantly and positively associated with agricultural production and industrial value added suggesting that agricultural production and its transformation is the source of wellbeing in SSA. However, food supply levels were adversely affected by military expenditure, inflation level of consumer prices, proportion of rural population, age dependency ratio, and region-specific heterogeneities. Designing policies and initiating intervention strategies to control for such deterrents will improve food security situation in SSA. Accordingly, for sustained and increasing national food supply, SSA countries need to gear their policies and intervention strategies towards enhancing agricultural production and productivity, creation of job opportunities

absorbing the cheap and unemployed labour force, structural transformation of their economies through industrialization, and improving health care services. Efforts of countries, regions, and other stakeholders of development need to secure peace and stability by addressing problems of regional shocks and instabilities in order to reduce military expenditures which would otherwise be allocated for food production purposes. Reducing age dependency ratio through family planning is the other policy issue to be accounted for.

## References

- [1]. Abele, S., Twine, E and Legg, C. 2007. Food Security in Eastern Africa and the Great Lakes. Crop Crisis Control Project, USAID.
- [2]. Adeyemi, S.I., Ijaiya, G.T., Ijaiya, M.A., and Ijaiya, B.L. 2009. Determinants of the right of access to food in Sub-Saharan Africa. *African Journal of Food, Agriculture, Nutrition and Development*, 9(5), pp. 1146-1160.
- [3]. Alsakka, R., and ap Gwilym, O. 2009. Heterogeneity of sovereign rating migrations in emerging countries, *Emerging Markets Review*, 10, pp. 151-165.
- [4]. Arellano, M. 2003. *Panel Data Econometrics*. Oxford: Oxford University Press.
- [5]. Baltagi, B.H. (2008) *Econometric Analysis of Panel Data* (4th ed). New York: Wiley.
- [6]. Benson, T. 2004. Africa's Food and Nutrition Security Situation: Where Are We and How Did We Get Here? 2020 Discussion Paper 37, IFPRI, Washington, DC.
- [7]. Bickel, G., Nord, M., Price, C., Hamilton, W. and Cook, J. 2000. *Guide to Measuring Household Food Security*, United States Department of Agriculture (USDA).
- [8]. Bouis, H. And Hunt, J. 1999. Linking food and nutrition security: past lessons and future opportunities. *Asian Development Review*, 17 (1, 2), pp. 168-213.
- [9]. Breusch, T.S. and Pagan, A.R. 1980. The Lagrange multiplier test and its applications to model specification in econometrics. *Review of Economic Studies*, 47, pp. 239-253.
- [10]. Cameron, A.C. and Trivedi, P.K. 2009. *Microeconometrics Using Stata*. College Station, TX: Stata Press.
- [11]. Devereux, S. and Sabates-Wheeler R. 2004. *Transformative social protection*. Institute of Development Studies (IDS) Working Paper 232, England.
- [12]. Devereux, S. 2009. Why does famines persist in Africa? *Food Security*, 1(1), pp. 25-35.
- [13]. Diao, X., Headey, D. and Johnson, M. 2008. Toward a green revolution in Africa: what would it achieve, and what would it require? *Agricultural Economics*, 39 (supplement), pp. 539-550.
- [14]. Dorosh, P.A. 2008. Food Price Stabilization and Food Security: International Experience. *Bulletin of Indonesian Economic Studies*, 44(1), 93-114.
- [15]. FAO and WHO 1985. *Energy and Protein Requirements*. Technical Report Series 724. Geneva.
- [16]. FAO 1996. World Food Summit Plan of Action. Accessed on 16 August, 2014 from <<http://www.fao.org>>
- [17]. FAO 2001. Human Energy requirements. Report of a Joint FAO/WHO/UNU Expert Consultation. FAO Food and Nutrition Technical Report Series 1, Available at <http://www.fao.org/docrep/007/y5686e/y5686e00.htm>.
- [18]. FAO 2008. FAO Methodology for the Measurement of Food Deprivation: Updating the minimum dietary energy requirements. FAO Statistics Division, Rome.
- [19]. FAO 2009. *The State of Food Insecurity in the World: Economic Crisis-impacts and Lessons Learned*. Rome.
- [20]. FAO 2011 FAOSTAT Online Statistical Service. Rome: FAO. Accessed on 5 August, 2014 from <<http://faostat.fao.org/>>
- [21]. FAO 2012. FAOSTAT Statistical Database. Rome: FAO. Statistics Division, Accessed on 10 September, 2014 from <<http://faostat3.fao.org/home/index.html>>
- [22]. Greene, W.H. 2012. *Econometric Analysis* (7<sup>th</sup> ed.), New Jersey: Pearson Hall.
- [23]. Hoddinott, J. 1999. *Choosing Outcome Indicators of Household Food Security*. IFPRI, Washington, D.C.
- [24]. Hoechle, D. 2007. Robust standard errors for panel regressions with cross-sectional dependence. *Stata Journal*, 7, pp. 281-312.
- [25]. Hsiao, C. 2003. *Analysis of Panel Data* (2<sup>nd</sup> ed.). New York: Cambridge University Press.
- [26]. Jacobs, K. And Sumner, D.A. 2002. *The Food Balance Sheets of the Food and Agriculture Organization: A Review of Potential Ways to Broaden the Appropriate Uses of the Data*. Accessed on 15 July 2014 from <[ftp://ksph.kz/Chemistry\\_Food%20Safety/TotalDietStudies/FBS\\_Rev.pdf](ftp://ksph.kz/Chemistry_Food%20Safety/TotalDietStudies/FBS_Rev.pdf)>.
- [27]. Kaiser, U. and Spitz-Oener, A. 2000. Quantification of Qualitative Data Using Ordered Probit Models with an Application to a Business Survey in the German Service Sector. Discussion Paper 00-58, Centre for European Economic Research, Mannheim.

- [28]. Kidane, W., Maetz, M. and Dardel, P. 2006. Food Security and Agricultural development in Sub-Saharan Africa: Building a Case for more Public Support. FAO, Rome.
- [29]. Maxwell, S. and Slater, R. 2003. Food policy old and new. *Development Policy Review*, 21 (5-6), pp. 531-553.
- [30]. McKelvey, R.D. and Zavoina, W. 2010. A statistical model for the analysis of ordinal level dependent variables. *The Journal of Mathematical Sociology*, 4:1, pp. 103-120. DOI: 10.1080/0022250X.1975.9989847.
- [31]. Mwaniki, A. 2005. Achieving Food Security in Africa: Challenges and Issues. Cornell University, Discussion Paper.
- [32]. Naiken, L. 2003. FAO methodology for estimating the prevalence of undernourishment. In: *Measurement and assessment of food deprivation and under-nutrition*, 7-42. Rome
- [33]. Pfarr, C., Schmid, A. and Schneider, U. 2011. Estimating ordered categorical variables using panel data: A generalized ordered probit model with an auto-fit procedure. *Journal of Economics and Econometrics*, 54 (1), pp. 7-23.
- [34]. Rabe-Hesketh, S. and Skrondal, A. 2012. *Multilevel and Longitudinal Modelling Using Stata*. 3rd ed. College Station, TX: Stata Press.
- [35]. Radimer, K., Olson, C. And Campbell, C. 1990. Development of indicators to assess hunger. *Journal of Nutrition*, 120, 1544–1548.
- [36]. Ruel, M.T. 2002 Is Dietary Diversity an Indicator of Food Security or Dietary Quality? A Review of Measurement Issues and Research Needs. Food Consumption and Nutrition Division Discussion Paper 140, IFPRI, Washington, D.C.
- [37]. Ruel, M.T. 2003. Operationalizing diet diversity: A review of measurement issues and research priorities. *Journal of Nutrition*, 133 (11), 3911S–3926S.
- [38]. Skrondal, A. and Rabe-Hesketh, S. 2004. *Generalized Latent Variable Modelling: Multilevel, Longitudinal, and Structural Equation Models*. Boca Raton, FL: Chapman and Hall/CRC.
- [39]. Smith, L.C. and Subandoro, A. 2007. *Measuring Food Security in Practice*. International Food Policy Research Institute, Washington, D.C.
- [40]. Sosa-Escudero, W. and Bera, A.K. 2001. sg164: Specification tests for linear panel data models. *Stata Technical Bulletin* 61: 18–21. Reprinted in *Stata Technical Bulletin Reprints* 10: 307–311. College Station, TX: Stata Press.
- [41]. Swindale, A. and Ohri-Vachaspati, P. 2005. *Measuring Household Food Consumption: A Technical Guide*. Food and Nutrition Technical Assistance (FANTA) Project, Academy for Educational Development (AED), Washington, D.C.
- [42]. Twisk, J.W. R. 2013. *Applied Longitudinal Data Analysis for Epidemiology: A Practical Guide* (2<sup>nd</sup> ed.). Cambridge: Cambridge University Press.
- [43]. UN 2009. *The Millennium Development Goals Report 2009*. United Nations, New York.
- [44]. UNICEF 2008. *Social Protection in Eastern and Southern Africa: A Framework and Strategy for UNICEF*. Accessed on 10 March 2014 from <<http://www.unicef.org/socialpolicy>.
- [45]. United Nations Economic Commission for Africa (UNECA) 2012. *Working Document on the New Development Indicators Reflecting the Realities, Needs and Priorities in Monitoring Human and Social Development in Africa Beyond 2015*. Retrieved from <http://www.uneca.org/>.
- [46]. Wooldridge, J.M. 2002. *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.
- [47]. Wooldridge, J.M. (2009) *Introductory Econometrics: A Modern Approach* (4<sup>th</sup> ed.). Cincinnati, OH: South-Western.
- [48]. World Bank 2008. *Agriculture for Development*. World Development Report 2008, The World Bank. Washington, DC.
- [49]. World Bank 2012. Database. Accessed on 20 June, 2014 from <http://data.worldbank.org>.
- [50]. World Bank 2014. *Africa Development Indicators*. Available at <http://data.worldbank.org/data-catalog/africa-development-indicators>.
- [51]. Zhang, R. 2004. Food Security: Food Trade Regime and Food Aid Regime. *Journal of International Economic Law*, 7(3), pp. 565–584.