Available online at www.elixirpublishers.com (Elixir International Journal)

Economics

Elixir Economics 65 (2013) 19985-19989

ISSN: 2229-712X

Determinants of Food Security among the Rural Household of Malawi

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$$Min \sum_{i=1}^{n} w_i . x_i$$

$$s.t \; A_{(n+w)\times n} X_{n\times 1} \geq b_{(n+w)\times 1}$$

$$Min \sum_{i=1}^{n} w_i . x_i$$

$$s.t \;\; y = A_{n\times n} X_{n\times 1} \geq b_{n\times 1}$$

ARTICLE INFO

Article history:

Received: 30 October 2013;

Received in revised form:

2 December 2013;

Accepted: 12 December 2013;

Keywords

Food security,

Determinants,

Rural Households,

Malawi.

ABSTRACT

This study had tried to assess the determinants of the food security of rural people of Malawi. The study was based on data collected from Malawi Third Integrated Household Survey (IHS3) in 2010/11. Since the objective variable is dichotomous type the study employ logistic regression model for analysis. There was consideration of different economic as well as societal factors to check that whether they significantly affect the dependent variable one or not. Based on the regression result eight of the regressors are significant in affecting probability of households to be food secured. Variables like education participation of households, sex of household head and age square positively affect the probability of being food secured. Other variables like cassava production, emergency of shocks, participation in off farm activities and age of household head affect probability of being food secured in the opposite direction as to the expectations. TLU and Land holding are insignificant in affecting the probability of rural households in order to be food secured.

Introduction

Food security is defined as a 'situation when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food that meets their dietary needs and food preferences for an active and healthy life' (FAO, 2002). It is not narrowly defined as food availability, but whether the monetary and non-monetary resources at the disposal of the population are sufficient that allow everyone to access adequate quantities and qualities of food (Schmidhuber and Tubiello, 2007). All dimensions of food security are likely to be affected by different variables. Importantly, food security could depend on climate, socio-economic impacts, food production, economic growth, changes in international relations, stocks, food aid policy and others. There are different methods of measuring the food security status of households like kilocalorie, total wealth methods and others. This research uses the first one to assess the food security situation and core determinants of it in the rural Malawi.

This research used national data collected from the country for national purpose in their third integrated household survey. The survey considers the three regions of the country (North, Central and South). Though the data were collected as a national survey, but this research considers only the rural part of the country. The national data were collected from 12,271 but due to inconsistencies of the data and missing of many values of different observations and rejection of the urban households, the work considers only 10,021 of the rural smallholders.

Given this, the research had a **general objective** of assessing the food security status and identifying the main determinants of the food security situation of rural households in Malawi.

NB. Hypothesises of the research are directly related to the expectation about the explanatory variables that are mentioned here under. Thus, getting the same result as to the expectation means accepting the null hypothesis or else rejection of it.

Method of Data Analysis

Method of analysing data in order to address predefined objectives and to test hypothesis is dependent on the type of data collected by the researcher. Having this, the behaviour of the dependent variable is the main actor in the selection of the methodology and the specification of the model.

Firstly there was identification of the food security status of the rural households by having the kilocalorie intake of each households based on their consumption for seven days. The data obtained from the seven-day record and daily consumption was converted to kilocalorie using the Food Composition Table Manual (EHNRI, 1997). Since the kilocalorie method is per adult base there was also conversion of the adult equivalent of each rural households considered as a sample.

Followed by this, the kilocalorie data were divided with the adult equivalent to have kilocalorie per adult. Having this, kilocalorie per adult per day was calculated by dividing for the seven days. Based on the result obtained there was comparison with the minimum subsistence requirement per adult equivalent per day (2200 kcal). Households who consume below this minimum requirement (2200 kcal per adult equivalent per day) were categorized as food insecure and those households who consume above the threshold were considered as food secured. After identifying the households as food secured and insecure groups, the next step was identifying the demographic and socio economic variables that are assumed to have association with food security. In light of this, major demographic, socioeconomic and institutional variables were assessed to look into their relative importance in determining the state of food security at household level.

Having these two types of values for the objective variable the research generates a dichotomous type of dependent variable by providing a value of 1 for households who are food secured and 0 for the insecure ones. This dummy type of dependent variable forces the research to apply one of the bi-variate models. The dependent variable of this research is that of

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dichotomous type (0 or 1 type), which means the variable is that of a yes or no response. Thus, for such a type of dependent variable the logical and reasonable models are bi-variate ones. Appropriate models that accommodate all this aspect was tested to come up with feasible results.

Models, which include a ''yes'' or ''no'' type dependent variable frequently called dichotomous or dummy variable regression models. Such models approximate the mathematical relationships between explanatory variables and the dependent variable that is always assigned qualitative response variables (Gujarati, 1988; Feder *et al*., 1985; Pindyck and Runbinfeld, 1981). The four most commonly used approaches to estimate dummy dependent variable regression models are (a) the linear probability model (LPM), (b) the logit, (c) the Probit and (d) the Tobit model are applicable in a wide variety of fields (Gujarati, 1995). There may be application of linear probability model for such dichotomous type of variables but this model has its own limitations and it is not the appropriate for this research. The probability model, which expresses the dichotomous dependent variable (Y_i) as a linear function of the explanatory variables (X_i), is called linear probability model (LPM).

Difference between logistic and linear regression is reflected both in the choice of a parametric model and in the assumptions. Once this difference is accounted for, the methods employed in analysis using logistic regression follow the same general principles used in linear regression (Hosmer and Lemeshow, 1989). Due to econometric shortcomings like non-normality of the disturbances (U_i), heteroscedastic variances of the disturbances, non-fulfilment of $0 < E(Y_i/X_i) < 1$ and lower value of R^2, as a measure of goodness of fit, LPM failed to test the statistical significance of estimated coefficients in equations that have dichotomous dependent variables (Liao, 1994; Gujarati, 1995). In case of logit and probit, the estimated probabilities lie between logical limit 0 and 1 (Pindyck and Runbinfeld, 1981). They are the most frequently used models when the dependent variable happens to be dichotomous (Gujarati, 1988; Maddala, 1989; Liao, 1994).

In practice these models yield estimated choice probabilities that differ by less than 0.02 and could be distinguished, in the sense of statistical significance, only with very large samples (Aldrich and Nelson, 1984). Liao (1994), reported that the logit model has the advantage that these predicted probabilities could easily be arrived. It is also indicated that when there are many observations at the extremes of the distribution, then logit model is preferred over the probit one.

After reviewing the strength, drawbacks and assumptions of different models, the binary logistic regression model was employed to address the core objective of the study i.e. assessing determinants of food security at household level. Moreover, other qualitative and quantitative analytical techniques were used to describe and analyze the data to address the remaining objectives of this study. Following Aldrich and Nelson (1984), Hosmer and Lemeshow (1989), Gujarati (1995) the functional form of logistic model is specified as follows:

$\pi(x)=E(Y=f/x) =1$

$\Pi(x) = E(y = 1/x) = 1 + e^{-(Bo + B_i X_i)-1}$ ----------(1)

For ease of exposition, one can write (1) as:-

$$\Pi(x) = \frac{1}{1+e^{-zi}} \quad \text{----------(2)}$$

Where $\Pi(x)$ = is a probability of being food secure ranges from 0 to 1

Zi = is a function of n-explanatory variables (x) which can be expressed as:-

$Zi = B_o+B_1X_1 + B_2X_2 + \ldots\ldots\ldots\ldots + B_nX_n$----------(3)

Where

X_1=Age of household head
X_2=Sex of household head
X_3=Educational level of household head
X_4= Off-farm/non-farm income
X_5= Total cultivated land holding
X_6= Emergency of shock
X_7= Livestock ownership
X_8= Access to Credit
X_9= Total land holding
X_{10}= Having child outside of the country
X_{11}= Cultivation of cash crops
X_{12}= Religion of household head
X_{13}= Production of Cassava

Bo = intercept. Given this B_1, B_2..... B_n = are slopes of the equation in the model that show the marginal effect. The probability that a given household is food secure is expressed by (2) while, the probability for food insecure is:-

1- $\Pi(x)$ = ----------(4)

The **dependant variable** of the model, household food security status, is a dichotomous variable representing the food security situation. It will be represented in the model as 1 for food secured households and 0 for food insecure ones. The information to categorize households into two groups was obtained by comparing the household energy acquisition per day per adult, and the minimum level of energy required that is 2200 kcal/adult equivalent/day. Thus, this is the variable that is used for binary logistic regression.

Independent variables of the model: they are expected to have association with food security status and selected based on available literature and by the researchers at the time of exploring the national data. Thus, the following independent variables are selected in the model formulation. Given this, the expected sign and direction of the independent variables seems the following:-

Age of household head (agehh): This variable is continuous type. The older the household head the better he/she has social network as well as the more experienced on farming and weather forecasting. As a result, the chance for such household to be food secure is high. The research use both the normal and square value but in the case of the normal value the direction of relationship with dependent variable is indeterminate type. The research expected that the square of this variable has a positive relationship.

Sex of household head (hhsex):- Dummy variable taking 1 if the household head is male, 0 otherwise. Male-headed households are in a better position to pull labour force than the female headed household. Moreover, with regard to farming experience males are better than the female farmers, which would result into have food secured household.

Educational level of household head (highedu): Education equips individuals with the necessary knowledge of how to make living. Literate heads are very ambitious to get information and to adopt new things. So if the household head is literate he/she will be very eager to accept new technologies, working mechanisms, soil and water conservation practices including any other income generating activities.

Off and non Farm Income (offfar):- Income earned from those activities is an important variable, which determines household food security in the study area. In this regard, households engaged in those activities are better endowed with additional income and less likely to be food insecure.

Total land holding (landhec):- This variable represents the total landholding of the household measured in hectares. Total cultivated land owned by household is important resource for food production and is positively associated with food security condition. Thus, it is expected that size of cultivated land would have positive impact on food security.

Emergency of Shocks (negat): It is dummy variable, which exemplify existence of different unexpected shocks that could have negative effect on income and consumption behaviour of households which will reduce the possibility of being food secured.

Livestock holding (TLU):- This represents the livestock holding of the households as measured in Tropical Livestock Unit (TLU). Livestock has multiple benefits and is also perceived as a source of draft power, manure, and cash income from sale of milk, butter, egg and live animals. The household having larger size of livestock can have better food security status. Hence, it is expected that livestock holding will have positive impact on food security.

Credit Availability (credit):- It is dummy variable that takes value 1 if the household takes credit 0 otherwise. Credit serves as a means to boost production and expand participation of households in income generating activities. Thus, a household who have access to credit does initiate investment in farm and non-farm activities and enhance sustainable food security. Thus, it is hypothesized that households who have access to credit are expected to be food secure

Cultivation of cash crops (caltivat):- It is a dummy variable type. Practice of it is a source of additional income that can support the effort of being food secured. Thus it is expected to have a positive relationship with the probability of being food secured.

Production of Cassava (cassava):-this is also just treated as dummy variable. Since the crop is a special crop that is frequently recommended to be adopted by farmers who suffer from moisture stress in order to enhance their food self sufficiency, then adoption of this crop could enhance the probability of being food secured.

Having Child Outside of the Country (sonout):- It is one source of income for households and enhance the food security status.

Results and Discussion

Food Security Status of Households

The research had applied simple mathematics in STATA software to have the total adult equivalent of each rural households and total actual kilocalorie situation of households. For having the kilocalorie there was consideration of the different types of food items consumed by each household for seven days. After having the kilocalorie of each food items there was calculation of the total and per adult kilocalorie of households to compare the actual with the standard one that is 2,200 kilocalories per adult per day. Having this 7,753 (77.2%) of the total rural households (10,037) are food secured where as 2,284 (22.8%) of the households are insecure. This implies that the dependent variable had 7,753 ones (yes) and 2284 zeros (no).

Model Result

Due to data missing values for certain observations of few explanatory variables like land holding and Tropical Livestock Unit (TLU), in this study it has been forced to run two type of regressions.

The first regression was performed by including all of the potential variables but there was reduction in the number of observations from 10, 021 to 8688 due to missing values in TLU and land holding of households. Due to this, the study calls this regression the **full regression** (with whole variables). As the p-value (0.0000) of the model shows that the model is significant. From this regression result eight of the regressors are significantly affecting the probability of households being food secured. This means some of them significantly affect the probability of being food secured positively and the others significantly affect in the opposite direction, negatively.

Some of the significant variables are as to the expected sign that means the study would accept the **null hypothesis**. From these variables education participation of households, sex of household head and age square are positively affecting the probability of being food secured. This implies that if there is an increment in household heads participation in education by one unit then the probability of being food secured will increase by 4.3% (table 2). In the same way there will be increment in the probability of being food secured by 2.2% if a household becomes male headed. Given this, the effect of age square is not that much, which is 0.004% probability with increment of age of household head.

There are other variables like cassava production, emergency of shocks, participation in off farm activities and age of household head that affect the probability of being food secured in the opposite direction as to the expectations, and result into **rejecting the null hypothesis**. This circumstance may be the result of data inconsistencies and missing of too much data of some variables. This argument can be witnessed if there is consideration of the case of cultivation of cash crops which becomes significant when there is dropping of the TLU and land holding of households (see table 1 and 3).

To see the effect of considering missed observation on TLU and land holding the study had regressed after dropping them. The study runs the model after dropping the two variables (TLU and land holding) which have immense missing observations. Dropping of variables with a missing value automatically change the result of the model. As one can see from table 3 of the annex, the effect (being significant) of some variables like cultivation of cash crops and credit participation drastically changed. This circumstance may be the result of including the dropped households who were producer of the cash crops like coffee that have greater contribution for the food security situation. Much of the households with a missing value for TLU were producer of those crops and potential in increasing their being food secured. The marginal effect of variables (table 4), show that each participation of households in the production of cash crops would directly result into increasing the probability of being food secured by 6.6% which is significant and elastic type of response.

I both cases (full and after dropping regression) sending biological children outside affects the probability of households being food secured negatively and significantly. The result implies that when there is increment in the number of children going out there will be reduction in the probability of being food secured by 9.9%, which is very significant and too responsive change. This negative interaction of them may be due the economic dependency of households on agriculture that demand huge labour especially during harvesting and sowing seasons. If the agriculture of the rural farmers is purely dependent on family labour thus each and every reduction in the household labour will directly result into reduction in the productivity of agriculture which will solidly expose the household to food insecurity.

Table 1: Logistic regression result (full regression Result)(dependent variable FS)

Variables	Coefficients	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]
caltivat	-0.0885297	0.1653411	-0.54	0.592	-0.4125923 .2355329
highedu	0.2452466	0.0369713	6.63	0.000	0.1727842 .317709
offfar	-0.156566	0.0697559	-2.24	0.025	-0.2932851 -.0198469
sonout	-0.5697717	0.059182	-9.63	0.000	-0.6857663 -.4537771
credit	0.0754275	0.0769311	0.98	0.327	-0.0753547 .2262097
cassava	-0.3564766	0.0614031	-5.81	0.000	-0.4768244 -.2361288
negat	0.2152671	0.0519783	4.14	0.000	0.1133916 .3171427
TLU	--0.0101618	0.008715	-1.17	0.244	-0.0272428 .0069192
landhec	-0.0000357	0.0002331	-0.15	0.878	-0.0004926 .0004212
hhsex	0.1255151	0.0625209	2.01	0.045	0.0029763 .2480538
agehh	-0.0205572	0.0089246	-2.30	0.021	-0.0380491 -.0030653
Age2	0.0002321	0.0000904	2.57	0.010	0.0000548 .0004094
religin	0.061579	0.0462189	1.33	0.183	-0.0290084 .1521664
_cons	2.415604	0.4014873	6.02	0.000	1.628704 3.202505

Source; Own regression result, 2013.

Table 2: MFX with TLU and Land Holding (full regression)

Variables	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]	X
caltivat	-0.015385	0.02873	-0.54	0.592	-0.07170 0.0409	1.02705
highedu	0.042619	0.00637	6.69	0.000	0.03013 0.0551	1.38824
offfar	-0.027208	0.01211	-2.25	0.025	-0.05095 -.003464	1.82551
sonout	-0.09902	0.01017	-9.74	0.000	-0.1189 -0.07909	1.65078
credit	0.013108	0.01337	0.98	0.327	-0.01310 0.0393	1.87166
cassava	-0.061949	0.01064	-5.82	0.000	-0.08280 -0.0411	1.72571
negat	0.037409	0.00902	4.15	0.000	0.01974 0.0551	1.53499
TLU	-0.001766	0.00151	-1.17	0.244	-0.00474 0.0012	0.613256
landhec	-6.20e06	0.00004	-0.15	0.878	-.000086 0.00008	4.25446
hhsex	0.0218121	0.01086	2.01	0.045	0.00053 0.04309	1.24873
agehh	-0.0035724	0.00155	-2.31	0.021	-0.00661 -0.00054	43.1035
Age2	0.00004	0.00002	2.57	0.010	9.6e-06 0.00007	2136.68
religion	0.0107012	0.00803	1.33	0.183	-0.005036 .02644	3.04581

Source; Own regression result, 2013.

Table 3: **Logistic regression result (dropping TLU & Land holding) (dependent variable FS)**

Variables	Coefficients	Robust Std. Err.	z	P>|z|	[95% Conf. Interval]
caltivat	0.385339	0.101624	3.79	0.000	0.1861606 0.584518
highedu	0.262073	0.033907	7.73	0.000	0.195616 0.328529
offfar	-0.15540	0.065154	-2.39	0.017	-0.283098 -0.027701
sonout	-0.564783	0.0561349	-10.06	0.000	-0.6748052 -0.454761
credit	0.09679	0.238624	1.34	0.181	-0.0450508 0.238624
cassava	-0.28717	0.057701	-4.98	0.000	-0 .400263 -0.174078
negat	0.2334995	0.0488783	4.78	0.000	0.1376998 0.329299
hhsex	0.149248	0.058365	2.56	0.011	0.034855 0.263641
agehh	0.0236594	0.0084589	2.80	0.005	0.0402386 0.007081
Age2	0.000255	0.000086	2.97	0.003	0.000087 0.000424
religion	0.0604914	0.0438426	1.38	0.168	0.025439 0.146422
-cons	1.76530	0.3518763	5.02	0.00	1.075634 2.454964

Source; Own regression result, 2013.

Table 4: MFX after dropping TLU and Land

Variables	dy/dx	Std. Err.	z	P>|z|	[95% C.I.]	X
caltivat	0.0660286	0.01738	3.80	0.000	0.031959 0.100098	1.08003
highedu	0.0449066	0.00575	7.81	0.000	0.033636 0.05618	1.41672
offfar	-0.026628	0.01116	-2.39	0.017	-0.04850 -0.00476	1.82467
sonout	-0.096777	0.00951	-10.18	0.000	-0.11542 -0.07814	1.65682
credit	0.016585	0.0124	1.34	0.181	-0.00772 0.04089	1.87466
cassava	-0.049207	0.00987	-4.99	0.000	-0.06855 -0.02987	1.73815
negat	0.040011	0.00836	4.79	0.000	0.023632 0.056389	1.5228
hhsex	0.025574	0.00999	2.56	0.010	0.00599 0.045158	1.25207
agehh	-0.004054	0.00145	-2.80	0.005	-0.00689 -0.00122	42.9408
Age2	0.000044	0.00001	2.97	0.003	0.000015 0.000073	2122.2
religion	0.0103653	0.00751	1.38	0.168	-0.00436 0.025085	3.0481

Source; Own regression result, 2013.

The model result (table 1) also revealed that TLU and land holding are insignificant in affecting the probability of rural households in order to be food secured. This circumstance directly explains the condition what we have in **Ethiopia** especially in the eastern and pastoral regions. These regions are well known in their livestock possession and at the same time they are also known in their being food insecure. Households of these regions use their livestock as a measure of social statues rather than for economic values. They also do not consume their livestock whatever the food shortage is. Besides to this, the research also used kilocalorie method rather than wealth of household, which is directly related to consumable products more willingly than household's wealth possession. In connection with this, the rural society frequently consumes food items that contain low kilocalorie with huge roughage. These all imply that having plenty of livestock or land is not a warranty to be food secured.

Having all of the above the constant term of the two regression results is a significant and positive. This is an indicator of having many households who are food secured without incorporation of those determinates. This value of the model is a witness to the personal judgment method of measuring the food security status which says that 67.4% of the households were not bother about food shortage for the previous seven days (module of IHS3 question 01).

Summary and Conclusions

The study had tried to see the food security situation of rural households of Malawi based on data collected from the nation. It included 10, 0021 rural households from the three regions of the country. The study tried to see the food security condition of the rural households and contribution of different factors in affecting the probability of being food secure. There was usage of the kilocalorie method in connection with the adult equivalent to identify the food security situation. From different variables which have direct or indirect effect on food security of the rural households the research considers some of the economic, social and natural factors. To identify the determination power of the variables there was application of logit model as of having a dichotomous dependent variable. On these counts the research had reached up on the following conclusions and recommendations.

❖Majority of the rural households of Malawi are of food secured only 22.8% are insecure.

❖Increasing the access of education for household heads will directly improve the probability of having a food secured household which implies that the concerned party should provide attention on how to expand education to the rural part.

❖The government or any of the interested party should pay attention on how to reduce the going out of youths who are the motor of agriculture, which directly result into exacerbating the food insecurity of households.

❖There should be wisely allocation and efficient utilization of the livestock and land resource what households' possess to enlarge the probability of being food secured.

❖Given the above there must be initiation of households to adopt cash crops which have greater contribution for being food secured.

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