Consequences of Measurement Error in Food Insecurity Assessment Using Household expenditure

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ABSTRACT

Aim: The objective of the experiment is to highlight the implication of measurement error in formulation of strategies for addressing food insecurity.

Method and Materials: Using random sampling techniques and employing Fishers formula a total of 323 households were selected for the study. Informed by Engel's law of inverse relationship between total household expenditure and the expenditure share on food, plus adding a quadratic term in the equation, the study sort to estimate the magnitude of food insecurity in Mandera County. The study employed econometric models including ordinary least squares and using instrumental variable in generalized method of moment (GMM) techniques to quantitatively analyze data on quadratic Engel curve.

Results: In this study, measurement error reduced parameter reliability by 32% which led to underestimation of food insecurity by about 20%. The results demonstrated that microeconomic data are contaminated by measurement errors which reduce reliability of parameters.

Conclusion: Research concluded that household expenditure is not a perfect measure of the actual food insecurity situation. The fact that significant variance in total household expenditure is due to measurement error demonstrates the contamination ofmicroeconomic data.

Keywords: GMM, household expenditure, mandera, measurement error.

Introduction

Eradicating food insecurity continues to be a socio-economic public policy mirage in many countries. This challenge is complicated by insufficient diagnostic approaches to provide accurate information on severity, magnitude and underlying causes of food insecurity. Reliable information is significant in answering the following essential questions in addressing food insecurity, as pointed [1].

Identification and number of hungrypeople in the world are to be observed while microeconomic data is important in assessing food access, they are often contaminated by mis-measured variables that lead to biased and inconsistent parameter estimates resulting to erroneous conclusions in economic analysis [2].

Engel curves describe how household expenditure of a good varies with householdincome. Based on the family budgets Engel proposed that "the poorer the family,the greater income. Based on the family budgets Engel proposed that "the poorer the family, the greater the proportion of its total expenditure that must be devoted to the provision of food" i.e. as income increases, the share of expenditure for food declines, demonstrating the shares of income spent on food are inversely related to income levels[3].

This study employed the concepts of measurement error both in dependent and independent variables and account for this, the study uses instrumental variable approach [4, 5].

Methods and Materials

The study employed a working-Lesser single demand model, where the share of the food item is linear function of the log of the total household expenditure.

$w_{ih} = a_i + b_i ln\, x_h + u_{ih}$ 3.1

Applying budget shares that are higher than first degree polynomial, equation 3.1 is replaced by the following quadratic food share model

$W_h^* = \beta_0 + \beta_1 ln\, x_h^* + \beta_2 (ln\, x_h^*)^2 + \mu_h$...3.2

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μh is a mean zero error. Suggestion for some goods equation 3.9 (quadratic), is adequate specification than equation 3.1(linear) [6].
However, if the total expenditure (independent variable) is measured with error, likewise food share (dependent variable) is also measured with error[4]. This results to a compound error term εh is therefore expressed as

$$\varepsilon_h = \omega_h + \mu_h - \beta_1 ln\, v_h + \beta_2 (ln\, v_h)^2 - 2\beta_2\, (ln\, v_h ln\, x_h) \ldots\ldots\ldots 3.3$$

Assumption: $E(\mu_h) = E(\omega_h) = E(v_h) = 0$
This leads to the estimating model expressed as follows

$$W_h = \beta_0 + \beta_1 ln x_h + \beta_2\, (ln\, xh)^2 + \varepsilon_h \ldots 3.4$$

The second step involved developing the relationship of the structural and the reduced model to recover consistent estimates of the former by multiplying eq.3.4 by xh and using the household income, income squared and the interaction terms between income and log of income as instrumental variables, denoted as zh, results in the following moment conditions equation; to be estimated using GMM technique.

$$z_h x_h w_h^* = a_0\, E(z_h x_h) + b_1 E(z_h x_h\, ln\, x_h) + c_2 E(z_h x_h ln\, x_h)^2 + v_h \ldots\ldots\ldots 3.5$$

The following set of assumptions as identified [4] and provided the basis for the identification;
$E(x|z) \neq 0; E(\varepsilon_i|z) = 0; E(v_i) = 0$

Assumptions (i) and (ii) ensure the validity of the instruments and (iii) implies that measurement errors are independent of total expenditure. This means taking the conditional expectation with respect to z there is;

$$z_h x_h w_h^* = a_0\, E(z_h x_h) + b_1 E(zhx_h \log x_h) + c_2\, E(z_h x_h \log x_h)^2 + \rho_3 E(x_h \eta z) \ldots\ldots 3.6$$

η was estimated through a non-parametric regression of the observed log x on the instruments z in the following specification;

$$\text{Log } x = g(z) + \eta \ldots\ldots\ldots\ldots 3.7$$

GMM regression of equation 3.6, would consistently estimate the quadratic coefficient β2 (equation 3.4) being the coefficient of x log x2[5].

Therefore the parameters of the transformed model (3.5); a, b and c were estimated through GMM and the parameters of the Engel curve, equation 3.4 recovered by making the following relationships [5].

$$\beta_0 = a + bE(v_h log v_h) + c\, \{[v_h (log v_h)^2] - 2E[v log c]^2\} + \rho_i cov(v,\, log_v) \ldots 3.8$$

$$\beta_1 = b + 2cE\, [v_h log\, v_h] \ldots\ldots 3.9$$

$$\beta_2 = c \ldots\ldots\ldots\ldots 3.10$$

To estimate $E\,(v_h\, log\, v_h)$ and $E\,[v_h\, (log\, v_h)^2$ moments the study adopted the following equations as suggested [5]. Under log normality assumption and the fact that $E\,[V] = 1$ the following expression was used;

$$E(V log V) = \sigma^2 v/2 \ldots\ldots\ldots\ldots 3.11$$

$$Cov(V, log V) = \sigma^2 v \ldots\ldots\ldots\ldots 3.12$$

Assuming that v is log normally distributed, the ratio of 3.11and 3.12 a method of moments estimate for the variance of log v(σ^2_v) is obtained through

$$\sigma^2 v = log\, (\beta_{i0}/\beta_{i1}) \ldots\ldots\ldots\ldots 3.13$$

To estimate the magnitude of the bias the study exploited the following equation;

$$1 + var[v] = e^{\sigma^2 v} \ldots\ldots\ldots\ldots 3.14$$

Employing the argument, the magnitude of bias is approximately proportional to the variance of the measurement error[5]. Therefore assuming the log normality of v, the variance of the measurement error was estimated as follows;

$$1 - e^{\sigma^2 v} = var[v] \ldots\ldots\ldots\ldots 3.15$$

Results and Discussion

Food insecurity estimates with measurement error – Quadratic OLS regression results

The OLS regression was used to emphasize the significance of correcting for measurement error in the analysis of survey data. In the relationship between variables OLS assumes that the explanatory (independent) as well as dependent variables are measured without error [7].

However, as reviewed in the literature, microeconomic data is contaminated by measurement errors and therefore OLS estimators are both biased and inconsistent. Table 4.1 presents the estimated ordinary least squares (OLS) regression parameters for the Food share and household expenditure relationship.

Table 1: Food insecurity estimates with measurement error - OLS regression results

(Dependent Variable = Household expenditure on food)[1]	
Log of total household expenditure	0.4140(3.41)*
Square of log of the total household Expenditure	-0.0713(- 2.18)*
Log of household size	0.8804(2.61)*
Constant	-0.0544(3.03)*
R-Squared	0.8701
[2]Turning point (95% confidence interval)	1,216.60

Source: Computed from Field Survey, August 2012; t-test in parenthesis; * significant at 95% level.

The results display the quadratic relationship which justifies its application in this study. The turning point is estimated at Kshs. 1,216.60, which means that OLS regression food is considered a luxury beyond this level of expenditure.

Food insecurity estimates with corrected Measurement Error - GMM results

The measurement error corrected estimates are presented in table 2. From the table, the results are demonstrating presence of quadratic Engel curve relationship of the estimated model.

(Dependent Variable = Household expenditure on food)	
Log of total household expenditure	0.5876 (5.32)*
Square of the log of total household Expenditure	-0.0902(-5.01)*
Log of household size	0.3211(1.37)*
Constant	-0.2364(-2.80)*
[3]Turning point (95% confidence interval)	1762.5
P-value of the over-identifying restriction	0.1867
P-value of test for endogeneity	0.0005

*Source: Field Survey, August 2012 (t-test in parenthesis; *significant at 95% level)*

[1] $W_h = \beta_0 + \beta_1 \ln x_h + \beta_2 (\ln x_h)^2 + \varepsilon_h$; w_h is the household food expenditure; x_h is the total household expenditure.

[2]The value of x that defines the extremum of the relationship between w_h and x_h was derived using $\theta = -\beta_1/2\beta_2$. Where, θ is the maximum value of x with measurement error.

[3]The value of x that defines the extremum of the relationship between w_h and x_h was derived using $\theta = -\beta_1/2\beta_2$. Where, θ is the extremum value of x without measurement error.

The negative and significant coefficient of the square log of the household expenditure supports the use of quadratic relationship in this study. To test the validity of the instruments, the test of over-identifying restriction (p–values) was conducted and confirmed to be appropriately uncorrelated with the disturbance process. The calculated p-value of 0.1867 is larger than the preferred significant level of 0.05, thereby accepting the null hypothesis of the validity of the instruments.

The result of the Hausman test statistic shows the small *p*-value of (0.0005) which is less than the preferred at significant level of 0.05, indicates that OLS results are not consistent, and thereby rejects the exogeneity of the total household expenditure variable. But looking at the coefficients of the two equations, OLS coefficients are smaller which can be attributed to the effect of measurement error, which causes the coefficient of the X_h (household expenditure) to be biased downwards, that is smaller in magnitude.

The Engel curve of the corrected measurement error indicates that the food share turning point is at Kshs. 1,762.50. i.e. 81th percentile of the raw data, while OLS estimates the food share is at Kshs. 1,216.60. i.e. 61st percentile of the raw data.

Measurement error in household insecurity analysis

According to reliability theory a measure is reliable if it is consistent in its measurement, that is, the degree to which analysis provides dependable estimates[8]. In the present study the value of measurement error depicts the proportion of variability in the measure attributable to error. The results show that about 32% of the total variance in the total household expenditure is due to measurement error[1].

Analysis that don't account of measurement error imply that about 61% of households experience food insecurity, thereby underestimating the food insecurity situation in Mandera County by about 20%.

Conclusion

The results demonstrated that micro-economic data are contaminated by measurement errors which reduces reliability of parameters and if not addressed will result to under estimation of food insecurity. Therefore, a food-security strategy that relies on inaccurate information, leads to interventions are ineffective in addressing food insecurity. The study concluded that observed household expenditure is not a perfect measure of the actual food insecurity situation. The fact

[4] The variance of the measurement error was estimated using $1 - e^{\sigma 2v} = var[v]$. Where σ^2_v is the variance of log v, [$\sigma^2_v = \log(\beta_{i0}/\beta_{i1})$]; e is a constant (2.718282)

that significant variance in total household expenditure is due to measurement error demonstrates the contamination of microeconomic data. Measurement error leads to underestimation of the magnitude of food insecurity problem, thus a proportion of food poor population would be statistically overlooked and their wellbeing jeopardized. Therefore, a food-security strategy that relies on accurate information, leads to greater policy reliability and over-all openness to interventions and hence more effective in addressing food poverty.

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