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The Validity of the Törnqvist-Wold Hypothesis

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Abstract

Contrary to Engel's Law, we find that the Engel curve is upward sloping in the very poor households in Tanzania, indicating that the total expenditure elasticity for food in the very poor households is elastic. Food expenditure is classified as necessities because own-price elasticity for the food category as a whole is inelastic that is verified by the same cross-section data. Based on the above findings regarding the inverse U-shaped Engel curve, we consider the characteristics of necessities and luxuries utilizing not only total expenditure elasticity but own-price elasticity. This is important to target transfer payments to maintain the standard of living and support the most vulnerable population. Because of price increases in necessities, the standard of living decreases. When we have information regarding the price elasticity of demand, it is possible to fine tune subsidies and distribution of necessities to mitigate the negative impact of inflation and shortages.

Keywords: Engel's Law, upward sloping Engel curve, Törnqvist-Wold hypothesis
JEL Classification: C31, D12

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1. Introduction

In recent literature regarding empirical analysis of consumer behavior, the use of micro-data prevails both in developed and developing countries. We report a variety of empirical findings, using micro-data in Tanzania and applying nonparametric and parametric approaches. Based on theoretical and empirical findings, we propose a hypothesis regarding definition of luxuries and necessities utilizing the elasticities of demand for total expenditure, own- and cross-prices, and verify the validity of Törnqvist-Wold's hypothesis in light of past empirical observations.

In economics one of the enduring truths is Engel's Law; i.e. the ratio between food and total expenditure decreases *monotonically* as total expenditure increases. But does Engel's Law hold for developing countries where absolute poverty is endemic? We tested the validity of Engel's Law using cross-sectional micro-data in Tanzania. Applying a nonparametric approach to the micro-data set, our results suggest an inverse U-shaped Engel curve. In addition, we estimated the quadratic almost ideal demand (QUAID) system to the micro-data set. Our estimations indicate that we obtained the inverse U-shaped Engel curve for both nonparametric and parametric approaches. [(1)]

Our findings regarding the inverse U-shaped Engel curve raise questions about Engel's Law regarding the tendency of a monotonically downward sloping curve. Based on Engel's Law, the share of food to total expenditure decreases monotonically, indicating that total expenditure elasticity is inelastic. Our finding, however, indicates that in some range of total expenditure, as total expenditure increases the share of food to total expenditure actually increases, indicating that the total expenditure elasticity for food is elastic. Thus, Engel's Law may not be valid in developing countries where absolute poverty is endemic.

What do we know from standard textbooks about total expenditure elasticity of demand? When it is greater than unity, the commodity is classified as a luxury good. When it is less than unity, the commodity is classified as a necessary good. The tendency of the Engel curve in Tanzania is different from that found in developed countries. When the level of total expenditure is low, the total expenditure elasticity of food is elastic but as total expenditure increases the total expenditure elasticity of food becomes inelastic. How can we explain this variation that food category is classified as luxury goods in very poor households while it is classified as necessary goods in poor and non-poor households?

Regarding the definition of necessary and luxury goods we have different definitions using own-price elasticity, namely when it is inelastic, the commodity is classified as a necessary good. However, when it is elastic, the commodity is classified as a luxury good.

If a commodity indicates elastic total expenditure elasticity and inelastic own-price elasticity, is the commodity classified as a necessary good or a luxury good? We derive the relationship among total expenditure, own-price and cross-price elasticities in consumer demand theory. We introduce the theoretical relationship between total expenditure, own-price and cross-price elasticities, and propose the Törnqvist-Wold hypothesis and an Alternative hypothesis. The Törnqvist-Wold hypothesis suggests that, *as a rule, income elascticities of necessities are smaller than their price elasticities, whereas income elasticities of luxuries are greater than their price elasticities*. (Wold and Juréen (1953)) On the other hand, the Alternative hypothesis against the Törnqvist-Wold hypothesis suggests that, *income elascticities of necessities are greater than their price elasticities, whereas income elasticities of luxuries are smaller than their price elasticities*. In theory, we have two possibilities regarding the relationship between total expenditure and own-price elasticities in conjunction with the characteristic of cross-price elasticities.

We checked the plausibility of the Törnqvist-Wold hypothesis in the real world by estimating demand functions using Tanzanian micro-data set. Regarding estimating demand functions using cross-section data, Deaton (1987, 1988, 1990) conducted a series of interesting analyzes. He devised a method to change cross-section data into time-series data. He divided the national market into regional markets in the cross-section data for a particular year.

The observation period of cross-section data is one year, but sampling households report their monthly consumption expenditure and they are rotated. We converted the cross-section data into time-series data by using micro-data from the cross-section data. We estimated the Working-Lesser type demand functions including total expenditure and prices for nineteen commodities within the food category using the Tanzanian data. There are twenty-one regions in Tanzania. We segmented markets by region and by month. Therefore, we have the market data for quantities demanded, their corresponding prices and average household total expenditure for 252 sample points.

To conduct double-checking on the estimating results for nineteen commodities, two types of complete demand systems were estimated. One is the linear expenditure system (LES) demand function and the other is quadratic expenditure system (QES) demand function. Both specifications have the property of committed expenditure introduced by Stone (1954) and indicated by the parameters of the model. Usually, own-price inelastic goods are classified as necessary goods, and the parameter, γ_i, in the LES determines the characteristics of goods whether necessary or luxury goods.

After estimating the demand functions for nineteen commodities we checked the possibility of the Törnqvist-Wold hypothesis regarding the distinction between luxuries and necessities related to total expenditure and own-price elasticities. As mentioned above, we have two possibilities for the definition of luxuries and necessities regarding the relationship between total expenditure and own-price elasticities in conjunction with cross-price elasticities. We evaluate the empirical validity of the Törnqvist-Wold hypothesis.

Based on the above empirical findings, we further tested the validity of our present conclusion that the Törnqvist-Wold hypothesis is reasonable, referencing different empirical results obtained by Deaton (1987, 1988, 1990) and by Maki (1998, 2002). Deaton (1987, 1988, 1990) used household survey for Cote d'Ivoire and Indonesia. In Deaton (1987) the data is derived from five categories of food expenditure. In Deaton (1988) total expenditure and price elasticities for eight categories of food are analyzed. In Deaton (1990) using Indonesian household survey, he estimated total expenditure, own- and cross-price elasticities for eleven clusters of food. Maki (1998, 2002) used household data of eight broader items within total expenditure such as Food, Clothing, Gross rent, Household equipment and operation, Medical care, Transport, Education, and Miscellaneous goods and services for Japan and of seven broader items such as Food, Housing, Household operation, Apparel, Transportation, Other goods and Other services for New Zealand. Finally we propose our conclusion regarding the definition of luxuries and necessities based on empirical findings that the Törnqvist-Wold hypothesis is reasonable based on the real world observations.

The structure of the present paper is the following. Section 2 explains the data used for the analysis, how to define the adult equivalence scale, how to estimate the food poverty line based on caloric measure, and how to derive the basic needs poverty line. This section also reports the movement of Engel's coefficient regarding three categories of households: the very poor, poor and non-poor households. We calculated averages of Engel's coefficient for total expenditure classes that are divided into deciles (ten classes) for the very poor, poor and non-poor households, respectively. Then we tested whether or not the downward sloping tendency of the Engel's coefficient is observed.

Using the entire sample of the household survey, we estimated the Engel curve applying nonparametric regression. And we estimated it parametrically based on utility maximizing behavior of households. We specify the QUAID system that is a generalization of almost ideal demand (AID) system proposed by Deaton and Muellbauer (1980).

Section 3 focuses on estimating the Working-Lesser type demand functions for nineteen commodities within the food category to obtain total expenditure and own-price elasticities. Using the same cross-section data, we estimated demand functions for finely classified commodities in the food category considering monthly and regional variations in prices.

Section 4 conducts a double check for the relation between necessary goods and own-price elasticity in conjunction with the subsistence level derived from the model. As testing models, we specified two types of complete demand systems: the LES and the QES.

Section 5 considers the theoretical relationship among total expenditure, own-price and cross-price elasticities. This section explains the Törnqvist-Wold hypothesis for luxuries and necessities. The Törnqvist-Wold hypothesis is a tool to define whether a good is classified as a necessity or luxury.

We proved that we have two possibilities theoretically regarding the relationship between total expenditure and own-price elasticities. The important point of empirical analysis is to determine what is reasonable to explain real world observations.

Section 6 evaluates the empirical findings by Deaton (1987, 1988, 1990) and Maki (1989, 2002). This section evaluates luxuries and necessities by the Törnqvist-Wold hypothesis and the Alternative hypothesis. We confirmed that the Törnqvist-Wold hypothesis is better than the Alternative. Finally, section 7 concludes the present analysis.

2. Data used for the analysis

We use the *2007 Tanzania Household Budget Survey* (HBS). The survey was conducted by the National Bureau of Statistics in Tanzania. The total number of the sample households exceeds 10,000.

We explain the methodology of obtaining the food poverty line and the basic needs poverty line after defining the adult equivalence scale in Tanzania. Table 1 indicates the adult equivalence scale defined by the 2007 HBS

Table 1 Adult Equivalence Scale

Age groups	Sex Male	 Female
0-2	0.40	0.40
3-4	0.40	0.48
5-6	0.56	0.56
7-8	0.64	0.64
9-10	0.76	0.76
11-12	0.80	0.80
13-14	1.00	1.00
15-18	1.20	1.00
19-59	1.00	0.88
60-	0.80	0.72

The adult equivalence scale is an adjustment technique that takes into account the difference of caloric intake among the members in a household by age and sex. For males, depending on the age, it ranges between 0.40 and 1.20. While for females the range is between 0.40 and 1.00.

We explain the measurement of the food poverty line derived by the Bureau of Statistics. The Bureau constructs a food basket representing foods typically consumed by the poorest 50 percent of households. Among food categories, alcoholic drinks and related items are excluded. The food poverty line is derived under the condition that the sum of calories obtained by food consumption expenditures per adult equivalence scale is 2,200 calories per day. The level is defined by the Food and Agriculture Organization (FAO) of the United Nations as the minimum necessary for survival.

To estimate the basic needs poverty line, the Bureau uses diary-based data for food consumption expenditures and recall-based data for non-food consumption expenditures. After calculating the share, say α, of the food expenditure to the total of food and non-food expenditures in the poorest 25 percent of all households, the basic needs poverty line is obtained as the value of the food poverty line multiplying by the reciprocal of α. (2)

The 2007 HBS cross-section data distinguishes between three household types: the very poor, poor, and non-poor households according to the level of total expenditure adjusted by the adult equivalence scale as estimated by the Bureau. The very poor households are defined as their adjusted total expenditure being below the food poverty line. The poor households are those whose adjusted total expenditure is between the food poverty line and the basic needs poverty line. The non-poor households are those whose adjusted total expenditure is above the basic needs poverty line. Table 2 indicates the results for the averages of total expenditure, Engel's coefficient and its standard error, and the minimum and maximum of the Engel's coefficient in each total expenditure class.

Table 2 Movement of Engel's coefficient from the lowest to the highest total expenditure classes

(a) Very poor households (sample size: 968)

Class No.	Sample size	Total expenditure TS	Engel's coefficient (%)	Standard error (%)	Min (%)	Max (%)	*t*-value
V1	97	3648.2	59.72	20.82	0.20	94.76	
V2	97	5420.9	64.00	18.09	6.73	96.56	0.48
V3	96	6317.8	63.70	15.71	11.94	90.75	-0.03
V4	97	7027.4	62.05	19.23	2.08	91.87	-0.18
V5	97	7707.8	63.52	15.62	15.73	93.61	0.16
V6	97	8246.2	63.49	15.31	12.53	86.73	-0.003
V7	97	8722.7	65.66	14.63	22.36	95.92	0.23
V8	96	9165.9	60.20	17.20	13.62	93.32	-0.60
V9	97	9618.0	64.76	17.30	9.27	91.76	0.50
V10	97	10026.7	62.11	17.51	5.34	91.40	-0.29

(b) Poor households (sample size: 1,096)

Class No.	Sample size	Total expenditure TS	Engel's coefficient (%)	Standard error (%)	Min (%)	Max (%)	*t*-value
P1	110	10457.4	61.53	14.52	10.30	89.78	-0.06
P2	109	10868.2	64.59	17.35	11.15	91.80	0.35
P3	110	11269.5	65.07	16.83	6.10	94.90	0.05
P4	109	11698.2	64.27	14.47	12.81	89.58	-0.09
P5	110	12108.1	63.62	15.73	6.62	96.47	-0.07
P6	110	12457.0	63.74	14.43	12.45	92.37	-0.04
P7	109	12808.1	64.16	14.04	20.03	89.30	0.10
P8	110	13171.1	66.11	13.65	14.81	92.15	0.27
P9	109	13512.3	63.22	17.63	10.04	90.61	-0.38
P10	110	13849.0	66.50	14.76	9.17	90.86	0.37

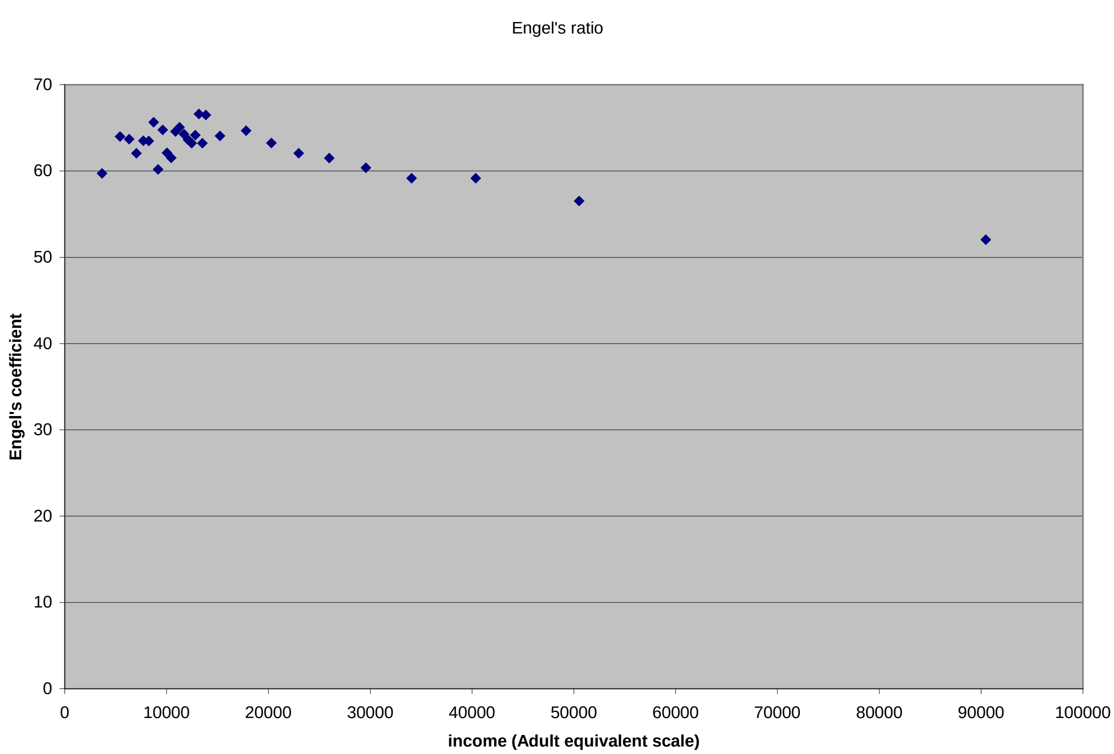
(c) Non-poor households (sample size: 8,342)

Class No.	Sample size	Total expenditure TS	Engel's coefficient (%)	Standard error (%)	Min (%)	Max (%)	*t*-value
N1	834	15248.2	64.08	14.37	3.59	94.58	-0.37
N2	834	17799.1	64.68	14.99	2.72	93.49	0.19
N3	835	20296.4	63.26	15.68	3.40	95.57	-0.45
N4	834	22972.4	62.05	14.97	12.33	92.24	-0.39
N5	834	25969.5	61.50	15.97	7.84	95.18	-0.18
N6	834	29577.4	60.39	16.27	4.83	94.72	-0.37
N7	834	34070.5	59.16	16.15	8.34	94.19	-0.42
N8	835	40356.5	59.17	16.87	4.97	95.28	0.003
N9	834	50521.9	56.53	17.73	4.79	97.25	-0.93
N10	834	90470.3	52.05	20.70	2.80	96.28	-1.68

About 10 percent of the households are classified as very poor households while about 80 percent are categorized as non-poor households. In the original book by Engel, the Engel's coefficient for Belgian workers' households in the low income class was 70.89 percent, 67.37 percent for middle income class and 62.42 percent for high income class. The Engel's coefficient in the HBS ranges between 52.05 percent and 66.50 percent.

The change in the Engel's coefficient due to total expenditure level is indicated in Figure 1. In the total expenditure levels less than TS20,000 there is no clear downward sloping trend regarding the Engel's coefficient, while there is a downward sloping tendency after the total expenditure level exceeding TS20,000.

Figure 1 Scatter between Engel's coefficient and total expenditure



Using the values included in Table 2, it is possible to test whether or not two population means of the Engel's coefficient are equal between two adjacent total expenditure classes. The hypothesis and alternative hypothesis are:

H_0: $\mu_1 - \mu_2 = 0$

H_A: $\mu_1 - \mu_2 \neq 0$

where μ_1 and μ_2 are population means of the i-th and (i+1)-th total expenditure classes, respectively. The *t*-test statistic is obtained by the following equation,

$$t = \bar{x}_1 - \bar{x}_2 - (\mu_1 - \mu_2) / \sqrt{((n_1 - 1)s_1^2 + (n_2 - 1)s_2^2)} \cdot \sqrt{((n_1 n_2(n_1 + n_2 - 2))/(n_1 + n_2)} \quad (1)$$

where $\bar{x}_1$ and $\bar{x}_2$ are means of the Engel's coefficient for the i-th and (i+1)-th total expenditure classes, respectively; s_1^2 and s_2^2 are their standard errors and n_1 and n_2 are their sample size. The *t*-value is indicated in the last column of Table 2.

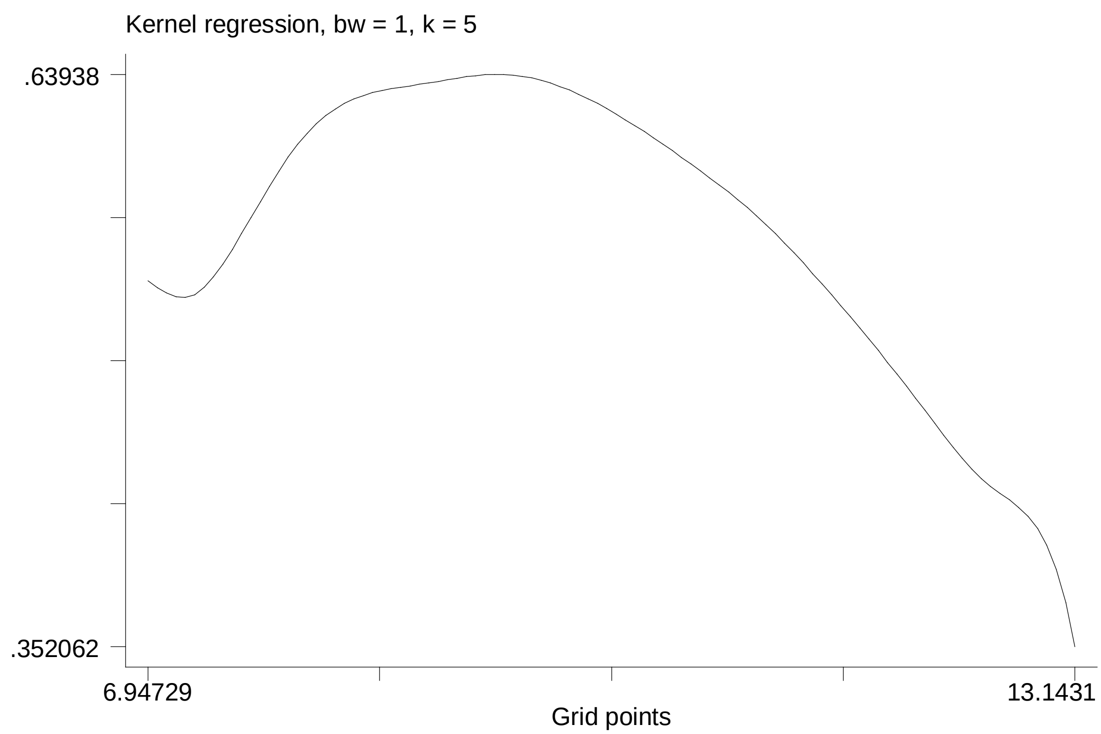
Examining the *t*-values for the hypothesis of $\mu_1 - \mu_2 = 0$ is rejected between the 9th deciles and 10^{th} deciles of the non-poor households at the significance level of 10 percent (the critical value is 1.645), indicating that the Engel's Law works. Based on this method, we don't find that the Engel curve is inverse U-shaped. We now use the nonparametric regression method to further examine the tendency of the Engel curve in Tanzania.

Applying kernel weighted nonparametric regression

$$w_i = \mu(\ln x_i) + \varepsilon_i \quad (2)$$

where w_i is the Engel's coefficient at the i-th total expenditure household, x_i is the corresponding total expenditure and ε_i is stochastic disturbance term, the Engel curve is obtained graphically as indicated in Figure 2.

Figure 2 Nonparametric regression



Note: Greene (2008)

Though the movement of the food share obtained by the classified data indicated in Figure 1 may be flat as total expenditure increases, the tendency of the Engel curve derived by the nonparametric regression has a hump among the very poor households.

The Engel curve was estimated parametrically based on utility maximizing behavior for households. We specify the QUAID system proposed by Banks, Blundell and Lewbel (2002). The specification of the QUAID system share equation is:

$$w_{ij} = a_j + b_j \ln x_i + c_j (\ln x_i)^2 \quad (3)$$

The total expenditure elasticity of demand, η_{ij}, for the j-th commodity at the i-th household in the QUAID system is:

$$\eta_{ij} = (a_j + b_j + (2*c_j + b_j) \ln x_i + c_j(\ln x_i)^2)/w_{ij} \quad (4)$$

When the parameter, c_j, is negative, the quadratic form has the maxima regarding the food share, w_j, at the point of the total expenditure level of $\ln x_i = - b_j/(2*c_j)$, and the maximum share is:

$$w_j* = a_j – b_j^2/(4*c_j) \quad (5)$$

We also calculate the effective range of the total expenditure for the estimated QUAID system between $x_{min} = \exp((- b_j + \sqrt{}(b_j^2 – 4*a_jc_j))/(2*c_j))$ and $x_{max} = \exp((- b_j - \sqrt{}(b_j^2 – 4*a_jc_j))/(2*c_j))$, respectively. [(3)]

Because of Walras' Law, the number of estimating equations is one in the two-commodity classification for food and non-food expenditures. From now on we drop the suffix j without any loss of generality. The QUAID system food share functions are estimated by the OLS and quantile regression methods.

The estimation results are reported in Table 3 for the OLS regression and the quantile regression for the three cases, namely the first quintile (Q_1), the second quintile (Median) and the third quintile (Q_3). [(4)]

The parameter, c, is negative as indicated in Table 3 and therefore the quadratic form has the maximum of the food share at the level of $x_i = \exp(-b/(2*c))$. We find that the maximum percentage of total expenditure spent on food is among the very poor households for4 the OLS regression.

Table 3 Estimation results: the QUAID system

	OLS	Quantile		
		Q_1	Median	Q_3
a (intercept)	-1.577	-2.953	-2.455	-0.3714
t-value	(-6.7)	(-8.3)	(-7.7)	(-1.5)
b	0.4825	0.7620	0.6656	0.2524
t-value	(10.4)	(10.9)	(10.6)	(5.4)
c	- 0.026	- 0.0413	- 0.0355	- 0.0141
t-value	(-11.5)	(-12.0)	(-11.5)	(-6.1)
r^2	0.0463	0.0457	0.0224	0.0110
White's test	224.5			
(P-value)	(0.000)			
H_0: $b_{Q1} = b_{MED} = b_{Q3}$, $c_{Q1} = c_{MED} = c_{Q3}$			38.23	
P-value			(0.000)	
max of food share (%)	64.14	55.83	66.20	75.32
its total expenditure (TS)	9850.1	10077.3	11712.8	7415.1
min total expenditure (TS) (food share = 0)	70.1	255.3	156.2	5.0
max total expenditure (TS) (food share = 0)	1382958	397622	878012	10901125

Note: Cameron and Trivedi (2005), Koenker and Bassett (1978) and Koenker (2005)

Table 4 reports the total expenditure elasticity at different total expenditure levels from TS5,000 through to TS1000,000.

Table 4 Total expenditure elasticity of demand at different total expenditure levels: the QUAID system

Total expenditure levels (TS)	5,000	10,000	15,000	20,000	30,000	50,000	80,000	100,000
OLS	1.056	0.998	0.965	0.940	0.904	0.851	0.791	0.757
Quantile								
Median	1.095	1.016	0.973	0.941	0.894	0.824	0.742	0.694
Q_1	1.107	1.001	0.940	0.894	0.822	0.707	0.550	0.443
Q_3	1.014	0.988	0.973	0.961	0.945	0.922	0.899	0.887

The interesting observation here is that total expenditure elasticity is elastic at the level of less than TS10,000. This means that additional total expenditure is disproportionately spent on food rather than non-food expenditures in the very poor households. As a result, the food share increases with total expenditure for the very poor households below the threshold of TS9,850.1 for the OLS regression and that of TS11,712.8 for the median regression.

Food category is usually classified as necessary goods and its total expenditure elasticity is inelastic. But in the lowest total expenditure levels among the very poor households, food items are necessary goods though the total expenditure elasticity is elastic. Contrary to Engel’s Law, the Engel curve in Tanzania is inverse U-shaped. And after the maximum of the Engel’s coefficient, it monotonically decreases as total expenditure increases. This behavior is well described by the specification of the QUAID system.

3. Estimating demand functions for nineteen commodities in the food category

The main objective of demand analysis consists in calculating the elasticity of demand for total expenditure, own-price and cross-prices. The estimating equation is specified as the Working-Lesser type demand functions:

$$w_{ik} = a_i + b_i \ln x_k + c_i \ln p_i + \sum_{j \neq i} d_{ij} \ln p_j \quad (6)$$

where w_{ik} is budget share for the i-th commodity of the k-th household, x_k is the total expenditure adjusted by the adult equivalence scale for the k-th household, p_i is the price of i-th commodity, and p_j is the price of j-th commodity ($j \neq i$), and a_i, b_i, c_i and d_{ij} ($j \neq i$) are parameters of the i-th commodity to be estimated.

In the above specification we calculate the elasticity of demand for total expenditure, own price and cross prices, respectively as,

Total expenditure elasticity: $1 + b_i / w_i$

Own-price elasticity: $c_i / w_i - 1$

Cross-price elasticity for j-th commodity: d_{ij} / w_i

where w_i is the average share of the i-th commodity. From the above equation, we understand that when parameter b_i is positive, the commodity indicates total expenditure elastic and *vice versa*, and when parameter c_i is positive, the commodity is price inelastic and *vice versa*, and when parameter d_{ij} is positive, the commodity is classified as a substitute and when parameter d_{ij} is negative, the commodity is classified as a complement.

The estimating equation includes not only total expenditure and own-price but also the cross prices of commodities. After estimating this specification when the estimate of other price of commodity is not significant statistically, we excluded such cross prices from the estimating equation. Table 5 indicates the estimation results.

Table 5. Estimation results

Variable	Rice (1)	Wheat (2)	Burns (Wheat) (3)	White maize attains (4)	Maize flour white (5)
linc1r	-.00709***				
lp1	.0066***				
lp4	-.00181**	-.00219		-.00862*	-.00654***
lp11	.00096*				
linc2r		-.00119			
lp2		.00157			
lp6		.00616**			-.00748**
lp8		-.00088			
linc3r			-.0102**		
lp3			.00607	.0142**	
lp5			-.00102		.00852**
linc4r				-.0162***	
lp7				.00058	
lp9				-.00848*	
lp14				-.0102*	
lp18				.0138**	
linc5r					-.00544***
_cons	.0426***	-.0235	.068	.129	.106***
r2_a	.272	.0337	.0461	.222	.162
rmss					
ll	1001	910	695	482	853

legend: * $p<0.05$; ** $p<0.01$; *** $p<0.001$

Variable	Beef with bones (6)	Fresh chilled or frozen fish (7)	Dried small fish (8)	Fresh cow milk (9)	Sunflower oil (10)
linc6r	-.00826***				
lp4	-.00249**				
lp6	.0125***				
lp10	.00055			-.00661	
lp12	-.0015				
lp13	.00315**			.00209**	
lp14	.00011				
linc7r		-.00227			
lp7		.00477***			
lp19		-.00443*		.00193*	-.0298**
linc8r			-.00476*		
lp8			.00361		
linc9r				-.00148***	
lp9				.00296***	
linc10r					.00487
_cons	.00246	.028	.0296	-.0263**	.224*
r2_a	.484	.121	.015	.192	.0511
rmss					
ll	843	649	715	1078	408

legend: * p<0.05; ** p<0.01; *** p<0.001

Variable	Oranges (11)	Broad beans (12)	Beans (dried) (13)	Tomatoes (14)	Cooking bananas (plantains) (15)
linc11r	-.00128***				
lp6	.00152*				
lp11	.00154***		.00138*		
linc12r		-.00622***			
lp12		.00599***			
linc13r			-.0054***		
lp10			.00343***		
lp13			.00206		
linc14r				-.00095*	
lp4				-.00025	
lp5				.00073	
lp9				2.2e-05	
lp14				.00175***	

lp19				.0002	-.00423
linc15r					-.0058**
lp1					.00019
lp15					.00412**
_cons	-.00535	.0291	.0122	-.00372	.0735
r2_a	.17	.158	.296	.162	.0496
rmss					
ll	1139	911	799	1263	739

legend: * p<0.05; ** p<0.01; *** p<0.001

Variable	Brown sugar (16)	White sugar (17)	Tea (18)	Coca cola (19)
linc16r	-.00048			
lp4	-.00222*			
lp9	.0015			
lp11	.00092			
lp16	.0166***			
lp17	-9.8e-05	.00631		
lp18	-.00012		.00571*	
linc17r		-.00337		
lp13		-.00731		
linc18r			-.00011	
lp1			.00755	
lp14			-.00323	
lp15			.00292	
linc19r				-.00322*
lp10				.00359
lp19				.00649*
_ cons	-.107***	.0461	-.09	-.0328
r2_a	.342	.0113	.0191	.0666
rmss				
ll	925	648	710	677

legend: * p<0.05; ** p<0.01; *** p<0.001

The estimated elasticity of demand using the final specification is indicated in Table 6. The right-hand two columns classify the commodity as necessary or luxury goods defined by total expenditure elasticity and own-price elasticity, respectively.

Table 6 Elasticity of demand

	Total Expenditure Elasticity	Price elasticity	Necessary or Luxury goods(defined by total expenditure)	Necessary or Luxury goods(defined by own-price)
(1) Rice	0.53	-0.34	Necessary	Necessary
(2) Wheat	1.05	-0.61	Luxury	Necessary
(3) Burns (wheat)	0.39	-0.45	Necessary	Necessary
(4) White maize attains	0.59	-1.47	Necessary	Luxury
(5) Maize flour white	0.14	0.30	Necessary	
(6) Beef with bones	0.42	-0.15	Necessary	Necessary
(7) Fresh, chilled or frozen fish	0.95	-0.72	Necessary	Necessary
(8) Dried small fish	0.66	-0.68	Necessary	Necessary
(9) Fresh cow milk	0.58	-0.36	Necessary	Necessary
(10) Sunflower oil	1.32	-2.30	Luxury	Luxury
(11) Oranges	0.66	-0.53	Necessary	Necessary
(12) Broad beans	0.18	-0.36	Necessary	Necessary
(13) Beans dry	0.15	-1.04	Necessary	Luxury
(14) Tomatoes, round	0.82	-0.58	Necessary	Necessary
(15) Cooking bananas, plantains	0.04	-0.46	Necessary	Necessary
(16) Brown sugar	0.58	-0.31	Necessary	Necessary
(17) White sugar	0.29	-2.03	Necessary	Luxury
(18) Tea	1.95	-0.30	Luxury	Necessary
(19) Coca cola	0.42	-0.32	Necessary	Necessary

Table 6 indicates that almost all commodities are necessary goods evaluated by total expenditure elasticity and own-price elasticity. When we pick up luxury goods regarding total expenditure elasticity, there are three commodities such as Wheat (2), Sunflower oil (10) and Tea (18). Regarding own-price elasticity there are four commodities that are classified as luxury goods: White maize attains (4), Sunflower oil (10), Beans (dried) (13), and White sugar (17). Sunflower oil (10) is both a total expenditure elastic and own-price elastic commodity, while for Wheat (2), White maize attains (4), Beans (dried) (13), White sugar (17), and Tea (18), show mixed elasticities. [(5)]

4. The LES and the QES

We estimated the demand functions that don't satisfy adding-up, homogeneity or symmetry conditions. We estimate two types of complete demand system demand functions to check the magnitude of elasticity of demand derived from the previous analysis.

As we are interested in the estimation of committed expenditure for food, we have to specify the complete demand system that relies on the concept of committed expenditure. In order to satisfy the characteristics, we specified the LES proposed by Stone (1954) and the QES proposed by Howe, Pollak and Wales (1979). The specification of the LES is,

$$p_i q_i = p_i \gamma_i + \beta_i (x - \sum_j p_j \gamma_j) \quad (i = 1, 2, \ldots, n) \qquad (7)$$

where total expenditure in the model is defined as total food expenditure, q_i's are the quantity of i-th food category, p_i's are the corresponding prices and β_i's and γ_i's are parameters to be estimated. That of the QES is,

$$p_iq_i = p_i\gamma_i + \beta_i(x - \sum_j p_j\gamma_j) + (\alpha_i p_i - \beta_i\sum_j p_j\alpha_j)\prod p_j^{(2\beta j)}(x - \sum_j p_j\gamma_j) \quad (i = 1, 2, \ldots, n) \quad (8)$$

When γ_i is positive in the LES and the QES, the commodity is classified as necessary goods and in the LES the sign of γ_i directly connected with own-price elasticity either inelastic or elastic:

if $\gamma_i > 0$, the item is price inelastic,

if $\gamma_i < 0$, the item is price elastic.

The estimated results of γ_i's for the LES and the QES are indicated in Table 7.

Table 7 Estimation Results

(a) LES demand functions

Parameter	Estimate	P-value		Commodity
γ_1	.282063	[.000]	Necessary	Rice
γ_2	.022184	[.365]	Necessary*	Wheat
γ_3	.068855	[.000]	Necessary	Burns (wheat)
γ_4	-.249906	[.342]	Luxury*	White maize attains
γ_5	.224813	[.191]	Necessary*	Maize flour white
γ_6	.192492	[.000]	Necessary	Beef with bones
γ_7	.093179	[.000]	Necessary	Fresh, chilled or frozen fish
γ_8	.026159	[.179]	Necessary*	Dried small fish
γ_9	.159059	[.000]	Necessary	Fresh cow milk
γ_{10}	-1.36502	[.000]	Luxury	Sunflower oil
γ_{11}	.052135	[.000]	Necessary	Oranges
γ_{12}	.130072	[.001]	Necessary	Broad beans
γ_{13}	.065806	[.017]	Necessary	Beans dry
γ_{14}	.072771	[.000]	Necessary	Tomatoes, round
γ_{15}	.330486	[.000]	Necessary	Cooking bananas, plantains
γ_{16}	.079478	[.000]	Necessary	Brown sugar
γ_{17}	-.123191	[.276]	Luxury*	White sugar
γ_{18}	-.119646E-02	[.937]	Luxury*	Tea
γ_{19}	.141212	[.000]	Necessary	Coca cola

Note: * indicates statistically insignificant

(b) QES demand functions

Parameter	Estimate	P-value		Commodity
γ_1	.070871	[.186]	Necessary*	Rice
γ_2	.039669	[.110]	Necessary*	Wheat
γ_3	.115262	[.000]	Necessary	Burns (wheat)
γ_4	.480078	[.037]	Necessary	White maize attains
γ_5	.099774	[.435]	Necessary*	Maize flour white
γ_6	.391498	[.000]	Necessary	Beef with bones
γ_7	.080583	[.000]	Necessary	Fresh, chilled or frozen fish
γ_8	.087420	[.000]	Necessary	Dried small fish
γ_9	.317509	[.000]	Necessary	Fresh cow milk
γ_{10}	-.529502	[.000]	Luxury	Sunflower oil
γ_{11}	.029980	[.285]	Necessary*	Oranges
γ_{12}	.160310	[.000]	Necessary	Broad beans
γ_{13}	.154329	[.002]	Necessary	Beans dry
γ_{14}	.081003	[.004]	Necessary	Tomatoes, round
γ_{15}	.345633	[.000]	Necessary	Cooking bananas, plantains
γ_{16}	.162922	[.000]	Necessary	Brown sugar
γ_{17}	.128512	[.129]	Necessary*	White sugar
γ_{18}	-.021229	[.069]	Luxury*	Tea
γ_{19}	.276885	[.000]	Necessary	Coca cola

When we check the value for γ_i's in the LES, commodities such as White maize attains (4), Sunflower oil (10), White sugar (17), and Tea (18) show a minus sign, indicating that the own-price elasticity for the commodity is elastic. One the other hand, commodities such as Sunflower oil (10) and Tea (18) are negative at the parameter γ_i in the QES. This result does not contradict the result obtained by the Working-Lesser type demand functions that indicate price elastic commodities such as White maize attains (4), Sunflower oil (10), Beans (dried) (13), and White sugar (17). Thus we can conclude that almost all the food categories are classified as necessary goods and own-price inelastic goods.

5. The Törnqvist-Wold's hypothesis regarding necessities and luxuries

According to Wold and Juréen (1953), when own-price elasticity is inelastic, the item is classified as a necessity. In their book they classified necessities and luxuries using the relationship combining own-price and total expenditure elasticities following Törnqvist:

Törnqvist groups the commodities into "necessities" and "luxuries", with price elasticity below and above unity, respectively. This leads to the conclusion that, *as a rule, income elasticities of necessities are smaller than their price elasticities*, *whereas income elasticities of luxuries are greater than their price elasticities*. (Wold and Juréen (1953), p.115)

This phenomenon is explained in the following manner. Regarding elasticities of demand, we have the following two important characteristics in a complete demand system whose demand functions indicate homogeneity of degree zero:

(I) the sum of total expenditure elasticity, own-price elasticity and cross-price elasticities for an i-th item is equal to zero.

$$Eq_i/Ex + Eq_i/Ep_1 + \dots + Eq_i/Ep_i + \dots + Eq_i/Ep_n = 0. \qquad (9)$$

where $Eq_i/Ep_j = \partial \log q_i/\partial \log p_j$ ($j = 1, \dots, n$), and $Eq_i/Ex = \partial \log q_i/\partial \log x$.

(II) Taking the expenditure for weights, the average of demand elasticities with respect to the price of a fixed commodity equals the minus of the proportion between the expenditure for the i-th item and total expenditure.

$$\sum_j (p_j q_j)(Eq_j/Ep_i) / \sum_j (p_j q_j) = -(p_i q_i)/x. \qquad (10)$$

For the two-commodity (Food and Non-food) case, we obtain the following equation system from (I)

$$Eq_1/Ex + Eq_1/Ep_1 + Eq_1/Ep_2 = 0,$$

$$Eq_2/Ex + Eq_2/Ep_1 + Eq_2/Ep_2 = 0. \qquad (11)$$

Commodity 1 (Food) is assumed that its own-price elasticity is inelastic, namely it is classified as a necessity according to the Törnqvist-Wold hypothesis. And we focus on the characteristic of commodity 1 to derive the Törnqvist-Wold hypothesis. We obtain the following equation system from (II):

$$(p_1q_1)(Eq_1/Ep_1) + (p_2q_2)(Eq_2/Ep_1) = -(p_1q_1)$$

$$(p_1q_1)(Eq_1/Ep_2) + (p_2q_2)(Eq_2/Ep_2) = -(p_2q_2) \qquad (12)$$

From the second equation of (12) we obtain:

$$Eq_1/Ep_2 = -((p_2q_2)/(p_1q_1))(Eq_2/Ep_2 + 1) \qquad (13)$$

Let us consider the following two cases: one is that commodity 2 (Non-food) is own-price elastic and the other is that it is own-price inelastic. When the commodity 2 is own-price elastic, cross-price elasticity, Eq_1/Ep_2, is positive and therefore $Eq_1/Ex + Eq_1/Ep_1 < 0$, when substituting Eq_1/Ep_2 into the first equation of (11). This leads to the Törnqvist-Wold's hypothesis, *as a rule, income elasticities of necessities are smaller than their price elasticities.*

When the commodity 2 is own-price inelastic, cross-price elasticity, Eq_1/Ep_2, is negative and therefore $Eq_1/Ex > - Eq_1/Ep_1$. This leads to the counter-conclusion of the Törnqvist-Wold's hypothesis that *income elasticities of necessities are <u>larger</u> than their price elasticities.*

It is not difficult to verify the Törnqvist-Wold's hypothesis in the two-commodity case. However, when we extend to n-commodity case, it becomes much complex than the two-commodity case to verify the Törnqvist-Wold's hypothesis. Let us expand to the n-commodity case. From the first characteristics:

$$Eq_i/Ex + Eq_i/Ep_i = -(Eq_i/Ep_1 + Eq_i/Ep_2 + \dots + Eq_i/Ep_n) \quad (14)$$

When the sum of total expenditure elasticity and own-price elasticity is negative, $Eq_i/Ex < - Eq_i/Ep_i$, the following inequality is satisfied,

$$\sum_{j \neq i} Eq_i/Ep_j > 0. \quad (15)$$

[6]

This indicates that the sum of the cross-price elasticities for the i-th commodity is positive. And the i-th commodity is classified as a necessity according to the results obtained in the two-commodity case. On the other hand, when total expenditure elasticity is greater than the absolute value of own-price elasticity, $Eq_i/Ex > - Eq_i/Ep_i$, the following inequality is satisfied,

$$\sum_{j \neq i} Eq_i/Ep_j < 0. \quad (16)$$

[7]

This indicates that the sum of the cross-price elasticities is negative. And the i-th commodity is classified as luxuries. However, we cannot obtain the exact relationship between cross-price elasticities, Eq_i/Ep_j ($j \neq i$, $j = 1, 2, \dots, n$), and own-price elasticity, Eq_j/Ep_j ($j \neq i$, $j = 1, 2, \dots, n$), mathematically. We also have difficulty in estimating the cross-price elasticities stably using the demand function for the i-th commodity. For these reasons, we examine the validity of the Törnqvist-Wold's hypothesis empirically using the empirical results obtained by the real world observations. The above condition is indicated in Table 8 and Figure 3.

Table 8 The classification between necessities and luxuries based on the Törnqvist-Wold hypothesis and the alternative hypothesis

(a) Törnqvist-Wold hypothesis

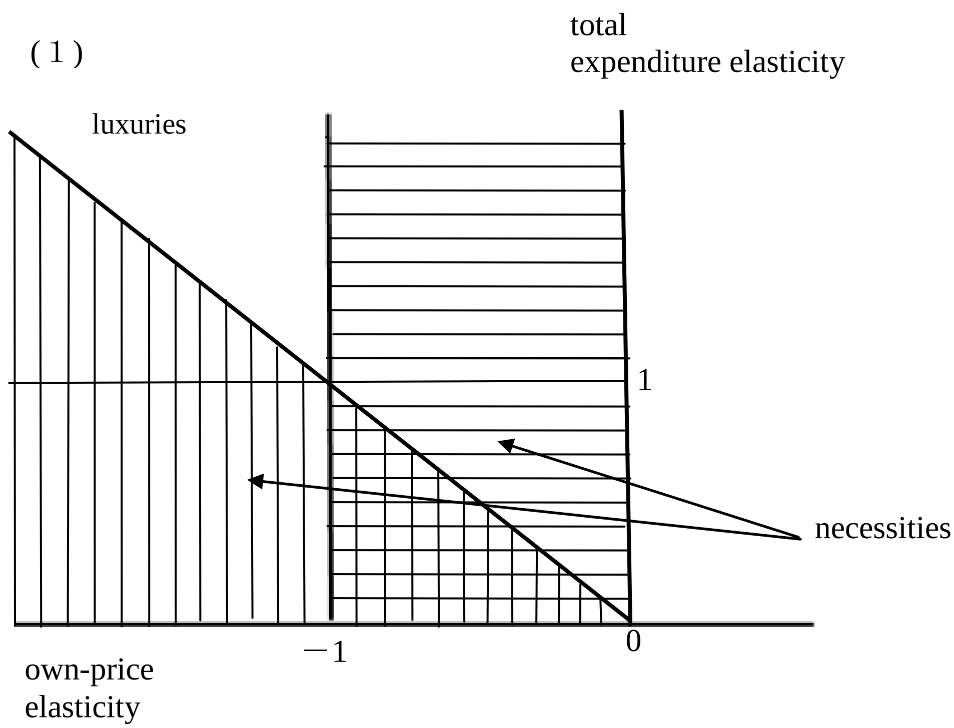
(1)	-1 < Own-price elasticity < 0	necessities
(2)	Own-price elasticity < -1	
(2.a)	total expenditure elasticity < absolute value of own-price elasticity	necessities
(2.b)	total expenditure elasticity > absolute value of (own-price elasticity	luxuries

(b) Alternative hypothesis

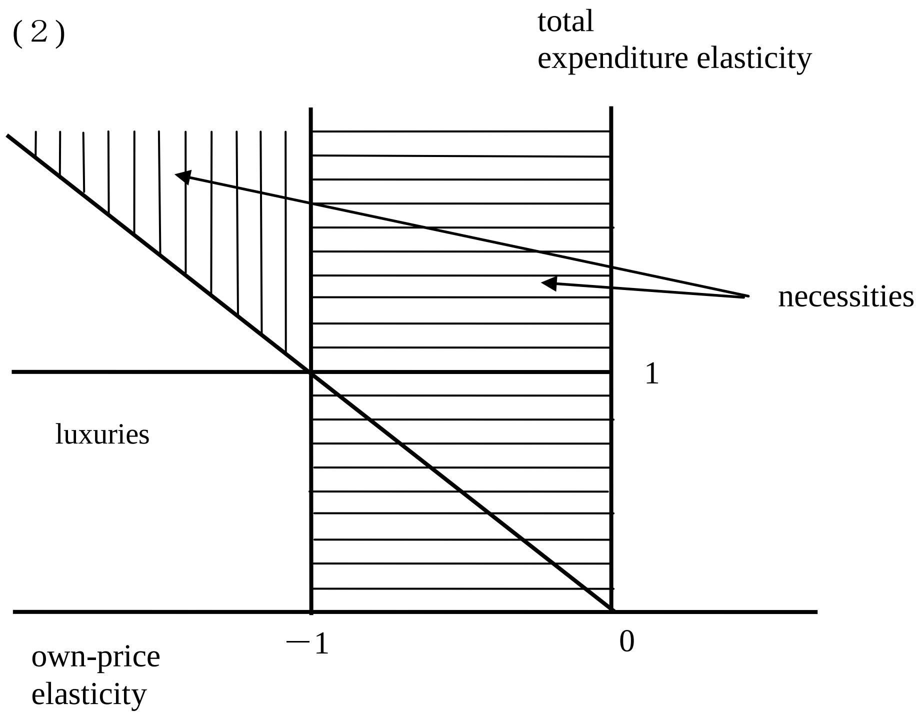
(1)	-1 < Own-price elasticity < 0	necessities
(2)	Own-price elasticity < -1	
(2.a)	total expenditure elasticity < absolute value of own-price elasticity	luxuries
(2.b)	total expenditure elasticity > absolute value of (own-price elasticity	necessities

Figure 3 Graphic Representation of Necessaries and Luxuries

(1) Necessaries and Luxuries based on the Törnqvist-Wold hypothesis



(2) Necessaries and Luxuries based on the Alternative hypothesis



From Figure 3, we understand the characteristics of the Törnqvist-Wold's hypothesis the category of necessities includes not only own-price inelastic goods but also some luxury goods whose total expenditure elasticities are smaller than their own-price elasticities.

6. Comparisons of empirical findings conducted by Deaton (1987, 1988, 1990) and Maki (1998, 2002) regarding the validity of the Törnqvist-Wold hypothesis

We checked the magnitude between total expenditure elasticity and own-price elasticity whose elasticity is elastic in order to classify the commodity as either a necessity or luxury according to the Törnqvist-Wold hypothesis and the Alternative hypothesis. Table 9 indicates that in Tanzania almost all commodities are necessities based on the Törnqvist-Wold hypothesis. In contrast, four commodities such as White maize attains (4), Sunflower oil (10), Beans (dried) (13), and White sugar (17) are classified as luxuries based on the Alternative hypothesis.

Table 9 Necessities or luxuries based on elasticity of demand: The Törnqvist-Wold hypothesis vs the alternative hypothesis

	Total Expenditure Elasticity	Price elasticity	Törnqvist-Wold hypothesis	Alternative hypothesis
(1) Rice	0.53	-0.34	Necessities	Necessities
(2) Wheat	1.05	-0.61	Necessities	Necessities
(3) Burns (wheat)	0.39	-0.45	Necessities	Necessities
(4) White maize attains	0.59	-1.47	(Necessities)	(Luxuries)
(5) Maize flour white	0.14	0.30		
(6) Beef with bones	0.42	-0.15	Necessities	Necessities
(7) Fresh, chilled or frozen fish	0.95	-0.72	Necessities	Necessities
(8) Dried small fish	0.66	-0.68	Necessities	Necessities
(9) Fresh cow milk	0.58	-0.36	Necessities	Necessities
(10) Sunflower oil	1.32	-2.30	(Necessities)	(Luxuries)
(11) Oranges	0.66	-0.53	Necessities	Necessities
(12) Broad beans,	0.18	-0.36	Necessities	Necessities
(13) Beans dry	0.15	-1.04	(Necessities)	(Luxuries)
(14) Tomatoes, round	0.82	-0.58	Necessities	Necessities
(15) Cooking bananas,				

plantains	0.04	-0.46	Necessities	Necessities
(16) Brown sugar	0.58	-0.31	Necessities	Necessities
(17) White sugar	0.29	-2.03	(Necessities)	(Luxuries)
(18) Tea	1.95	-0.30	Necessities	Necessities
(19) Coca cola	0.42	-0.32	Necessities	Necessities

We compare the present estimation result with the existing observations reported by Deaton (1987, 1988, 1990) and Maki (1998, 2002) in Tables 10 (a), (b), (c), (d) and (e).

Table 10 Comparison of the present analysis with the past findings

(a) Total and price elasticities for particular commodities in Cote d'Ivoire (From Table 3 in Deaton (1988))

	Total Expenditure Elasticity	Price elasticity	Törnqvist-Wold hypothesis	Alternative hypothesis
Meat	1.305	-0.739	Necessities	Necessities
Cereals	1.091	-1.076	(Luxuries)	(Necessities)
Starches	0.840	-0.847	Necessities	Necessities
Fresh fish	0.682	-1.575	(Necessities)	(Luxuries)
Other fish	0.536	-1.189	(Necessities)	(Luxuries)

(b) Total and price elasticities for particular commodities in Cote d'Ivoire (From Table 4 in Deaton (1988))

	Total Expenditure Elasticity	Price elasticity	Törnqvist-Wold hypothesis	Alternative hypothesis
Beef	1.56	-1.91	(Necessities)	(Luxuries)
Fish	0.74	-1.31	(Necessities)	(Luxuries)
Imported rice	0.73	-1.40	(Necessities)	(Luxuries)

Domestic rice	0.73	-1.02	(Necessities)	(Luxuries)
Maize	0.52	-1.19	(Necessities)	(Luxuries)
Yams	1.00	-1.49	(Necessities)	(Luxuries)
Plantain	0.95	-1.41	(Necessities)	(Luxuries)
Cassava	0.85	-0.91	Necessities	Necessities

(c) Own-price elasticities for Java, Indonesia (From Tables 5a and 5b in Deaton (1990))

	Total Expenditure Elasticity	Price elasticity	Törnqvist-Wold hypothesis	Alternative hypothesis
Rice	0.490	-0.424	Necessities	Necessities
Wheat	1.567	-0.692	Necessities	Necessities
Maize	0.088	-0.822	Necessities	Necessities
Cassava	0.139	-0.325	Necessities	Necessities
Roots	0.709	-0.953	Necessities	Necessities
Vegetables	0.670	-1.113	(Necessities)	(Luxuries)
Legunews	0.850	-0.954	Necessities	Necessities
Fruit	1.385	-0.953	Necessities	Necessities
Meat	2.296	-1.091	(Luxuries)	(Necessities)
Fresh fish	1.082	-0.762	Necessities	Necessities
Dried fish	0.566	-0.239	Necessities	Necessities

(d) Elasticities of demand for total expenditure and prices in Japan (From Table 5 in Maki (1998))

	Total expenditure Elasticity	Price elasticity	
Food, beverages and tobacco	0.56	-0.51	Necessities
Clothing and footwear	0.70	-0.76	Necessities
Gross rent, fuel and power	1.35	-0.40	Necessities
Household equipment and operation	1.08	-0.31	Necessities
Medical and health care	1.38	-0.78	Necessities
Transport and communication	1.09	-0.45	Necessities
Education, recreation and culture	1.20	-0.73	Necessities
Miscellaneous goods and services	0.96	-0.57	Necessities

(e) Elasticities of demand for total expenditure and prices in New Zealand (From Table 3 in Maki (2002))

	Total Expenditure Elasticity	Price elasticity	Törnqvist-Wold hypothesis	Alternative hypothesis
Food	0.74	-0.48	Necessities	Necessities
Housing	1.08	-0.45	Necessities	Necessities
Household operation	0.71	-1.96	(Necessities)	(Luxuries)
Apparel	1.14	-0.68	Necessities	Necessities
Transportation	1.12	-1.45	(Necessities)	(Luxuries)
Other goods	1.04	-0.45	Necessities	Necessities
Other services	1.27	-0.14	Necessities	Necessities

We evaluate the empirical observation based on the Törnqvist-Wold hypothesis. Looking at the table, we understand that almost all commodities and services are classified as necessities. However, two categories are luxuries based on the Törnqvist-Wold hypothesis such as cereals in Cote d'Ivoire (Table 10 (a)), and meat in Indonesia (Table 10 (c)). In Japan and in New Zealand, all the items are classified as necessities even though the price elasticity is elastic in New Zealand (Table 10 (e)).

Based on the Alternative hypothesis, the number of luxuries increases; Fresh fish and Other fish in Cote d'Ivoire (Table 10 (a)), Beef, Fish, Imported rice, Domestic rice, Maize, Yams, and Plantain in Cote d'Ivoire (Table 10 (b)), Vegetables in Indonesia (Table 10 (c)), and Household operation and Transportation (Table 10 (e)) are classified as luxuries. Particularly in Table 10 (b) one out of eight commodities are luxuries based on the Alternative hypothesis.

Our findings suggest that the Törnqvist-Wold hypothesis is better than the Alternative hypothesis in identifying necessities and luxuries.

7. Conclusion

In the present analysis we tested the validity of the downward sloping Engel curve using cross-sectional data in Tanzania. Since we verified the validity of the Engel's Law in various developed countries, we are interested in determining whether the downward sloping Engel curve is also evident in developing countries. This issue has important policy implications because the absolute poverty problem is serious in developing countries and it is thus important to have a detailed understanding of food consumption patterns among households in different total expenditure groups.

Our empirical findings are as follows. Contrary to Engel's Law, we find that the Engel curve is upward sloping in the very poor households whose caloric intake for the daily food expenditure evaluated by adult equivalence scale is less than 2,200 calories. When the total expenditure increases, the very poor households increase their food expenditure more than the increase in total expenditure. This behavior is well described by the specification of the QUAID system. In Table 4 the total expenditure elasticity has a value greater than unity in the lowest deciles based on the results of both the OLS and the quantile regressions.

Regarding micro-data analysis, nonparametric regression plays an important role before estimating econometric models based on economic theory. Using micro-data set, it is difficult to get the true relationship due to "noise" so we obtain much more information utilizing not only the OLS regression but also quantile regressions. By using first quartile, median and third quartile regressions, we clarify the data dispersion in much more detail.

Regarding economic and social policy, the upward sloping Engel curve suggests that poverty alleviation and economic development programs have not had an impact on the poorest households and more targeted assistance is crucial.

Based on the above findings regarding the inverse U-shaped Engel curve, we consider the characteristics of necessities and luxuries utilizing not only total expenditure elasticity but also own-price elasticity in the theory of consumer demand. This information is important for the government to target subsidies and other transfer payments to maintain the standard of living and support the most vulnerable population. During bad harvests, because of price increases in necessities, the standard of living in the nation decreases. When we have information regarding the price elasticity of demand, it is possible to fine tune subsidies and distribution of necessities in order to mitigate the negative impact of inflation and shortages.

In the consumer demand theory we have two possibilities to define necessities and luxuries; the one is the Törnqvist-Wold hypothesis, and the other is the Alternative hypothesis. After checking the existing empirical observations, we understand that the Törnqvist-Wold hypothesis is better to explain the real world observations. Regarding the empirical results by Deaton (1987, 1988, 1990) and by Maki (1998, 2002), we understand that almost all the food commodities and broader items are necessities.

This empirical analysis clarifies the utility of measuring household demand and price elasticities for basic necessities in order to improve programs targeting poor households. Such policy is very important to mitigate absolute poverty in developing countries and develop more effective anti-poverty programs.

Turning to the original problem that certain food items are classified as luxury goods in the very poor households while classified as necessities in the poor and non-poor households in Tanzania, we understand that food expenditure is classified as a necessity according to the Törnqvist-Wold hypothesis because own-price elasticity for the food category as a whole is inelastic as indicated in Tables 6 and 9. When economists evaluate a commodity or service as necessity or luxury only using cross-section data, they sometimes suffer misunderstanding due to overlooking the price effects.

Notes:

(1) We found a U-shaped Engel curve in Indonesia in 2001 SUSENAS.

(2) When we consider the estimating process for the food poverty line, the adult equivalence scale plays an important role for food expenditure related to caloric intake. However, it is difficult to make a direct link between the adult equivalence scale and non-food expenditures. There are relatively many categories in non-food expenditures that are strongly related to factors other than calories. For example, educational expenditures are strongly connected with the number of children and their ages within the household.

(3) Banks, Blundell and Lewbel (2002) reported in their analysis that the AID system is sufficient to explain expenditure share on food in the *Family Expenditure Survey* in the UK for the period between1980-1982. Food expenditure share in the UK data decreases monotonically as total expenditure increases in the observation period.

(4) We observed a small value for Engel's coefficient even in the very poor households. The above table indicates that the minimum value for the Engel's coefficient in the lowest total expenditure deciles (V1 in Table 2) among the very poor households is 0.20 percent, indicating that very poor households purchased almost nothing for food items during the survey period. There are some reasonable explanations for this finding: (1) members of the household stayed at their friends' house as guests and consumed food without any charge; (2) a household purchased no food commodities for the survey period and reported zero expenditure in the survey; (3) a household reported nothing due to misreporting on in-kind consumption for food; and (4) a household forgot to report food expenditure though it purchased food categories. However, the weight of very poor households in Tanzania is above 10 percent (1,000 households) and thus cannot be ignored.

(5) Due to the Törnqvist-Wold hypothesis, Sunflower oil (10) is classified as a necessity as indicated in Table 9.

(6) This means that Eq_1/Ep_2 is positive in the two-commodity case.

(7) This means that Eq_1/Ep_2 is negative in the two-commodity case.

References:

Banks, James, Richard Blundell and Arthur Lewbel (1977), “Quadratic Engel curves and consumer demand,” *Review of Economics and Statistics*, *79*, 527-539.

Cameron, A. Colin and Pravin K. Trivedi (2005), *Microeconometrics: Methods and Applications*, Cambridge University Press: Cambridge, UK.

Deaton, Angus and John Muellbauer (1980), “An almost ideal demand system,” *American Economic Review*, *70*, 312-336.

Deaton, Angus (1987), “Estimation of own- and cross-price elasticities from household survey data,” *Journal of Econometrics*, *36*, 7-30.

Deaton, Angus (1988), “Quality, quantity, and special variation of price,” *American Economic Review*, *78*, 418-430.

Deaton, Angus (1990), “Price elasticities from survey data – Extensions and Indonesian results, “ *Journal of Econometrics*, *44*, 281-309.

Greene, William H. (2008), *Econometric Analysis*, Pearson: New Jersey.

Howe, Howard, Robert A. Pollak and Terence J. Wales (1979), “Theory and time series estimation of the quadratic expenditure system,” *Econometrica*, *47*, 1231-1247.

Koenker, Roger and Gilbert Bassett, Jr (1978), “Regression quantiles,” *Econometrica*, *46*, 33-50.

Koenker, Roger (2005), *Quantile Regression*, Cambridge University Press: Cambridge, UK.

Maki, Atsushi (1998), “How high consumer prices are in Japan!” *Japan and the World Economy*, *10*, 173-186.

Maki, Atsushi (2002), “Changes in New Zealand consumer living standards during the period of deregulation 1984-1996,” *Economic Record*, *78*, 443-450.

Stone, J.R.N. (1954), “Linear expenditure systems and demand analysis: An application to the pattern of British demand,” *Economic Journal*, *64*, 511-27.

Wold, Herman and Lars Juréen (1953), *Demand Analysis: A Study in Econometrics*, John Wiley and Sons: New York.