Construction of a Composite Index to Measure Consumption Poverty and it's Comparison with the Conventional Indicator

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ABSTRACT. *Consumption poverty is continuing as an acute problem in less developed countries including Sri Lanka. The conventional approach of measuring consumption poverty using the total expenditure assigns equal weights to different consumption categories so that it is not capable of tackling the relative importance of these expenditure categories. Therefore, development of a realistic index to measure the consumption poverty to identify the genuinely poor households is vital in formulating policies to combat the poverty. Against this background, a Composite Index was constructed based on Weighed Principal Component Factor Analysis by using the data collected by the Sri Lanka Integrated Survey (SLIS). Values of the composite index were obtained for each of the 7479 households in the data set and the Forster-Greer-Thorbecke (FGT) poverty measures for different sectors, provinces and districts, to compare with the existing information were calculated. The information and implications generated by the new index will be useful in correctly identifying poor, and developing efficient policies and strategies to alleviate the poverty.*

INTRODUCTION

There is a general consensus that poverty is about deprivation or lack of well being due to low income or consumption. The approaches available in the literature to define the multidimensional nature of the poverty include monetary approach, capability approach, social exclusion approach and participatory approach (Gunewardena, 2004). Although there are a number of definitions on poverty found in the literature (Asian Development Bank, 2000; Atkinson, 1975; Sen, 1976; 1999; UNDP, 1997; World Bank, 1990; 2000; 2001), assessment of poverty using income or consumption indicators that fall within the monetary approach is the most widely used approach in policy formulation in Sri Lanka. Consumption poverty is defined as deprivation of income or consumption because it is believed either that this is the only impoverishment that matters or that any deprivation can be reduced to a common denominator. Difficulty of getting accurate information on household income has made consumption expenditure based indicators the most widely used measure in reporting and quantifying the poverty.

Identification of the poor or defining the poverty based on consumption expenditure in the monetary approach is also rather complex since consumption expenditure dimensions are multifaceted. Consumption poverty is not just an inability to spend to meet

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basic food necessities. This is because consumption expenditure includes; expenses on food, drink and tobacco, housing, fuel and light, clothing and textile, non-durable household goods, household services, personal care and health expenses, transport and communication, recreation, entertainment, education and cultural activities, and miscellaneous consumer durables and non- consumption expenditures. Not only direct cash consumption, but also non-cash or hidden consumption such as value of the home production, rental value of own/occupied house can also make a huge contribution to the total consumption. Furthermore, expenditure levels on each dimension are also different.

However, there is a lack of information to tell us how to add up these multiple dimensions of expenditure into a single indicator of consumption poverty. The prevailing estimation of consumption poverty is based on direct aggregation of various components using the following formula and all policies and strategies to alleviate the poverty are based on the poverty information given by this indicator.

$$TE = \Sigma x_i \quad ; \quad i = 1.....n \tag{1}$$

Where;

TE = Total expenditure as the poverty indicator.
n = Number of dimensions in consumption.
x_i = Expenditure on i^{th} dimension.

The Equation 1 implies that coefficient of each x_i is equal to unity, though all the dimensions of expenditure have been taken into account to obtain "Total" indication of consumption poverty. However, some variables (expenditure categories) have more influence on this total expenditure based poverty indicator than others. Further, such a holistic figure like this is not only confusing, but also difficult to analyze and compare. Such an approach may generate inaccurate information in poverty assessment and mislead important decisions in a country's development process. Therefore, development of a more meaningful composite indicator is necessary in order to absorb more effective policies and develop strategies in solving the continuing problem of poverty in Sri Lanka. Against this background, the purpose of this study is to construct a composite index to indicate consumption poverty taking into consideration, the relative importance of the variables and to compare the new information with the prevailing information.

In the following sections, the methodology together with the data and procedure of constructing the new index are discussed. The results obtained in the process of development using the Sri Lanka Integrated Survey (SLIS) data set is presented, which is followed by the comparison of new and old approaches. The conclusions and implications are also presented.

MATERIALS AND METHODS

Data

This study uses data of SLIS of 1999/2000 (ERD, 2000) commissioned by the World Bank. The data set related to the expenditure of 7479 households were processed as follows.

Household expenditure was converted to a monthly basis. Expenditure of cash and non-cash were summed together for each item, and expenditure on each item was added to the group (Food and drink (Fo), Clothing and textile (Cl), Housing (Ho), Health (Hea), Education (Ed), Fuel and light (Fu), Transport and communication (Tr), Recreation and entertainment (Re), Kitchen utensil and toys etc (Ki), Social Expenses and remittance (So), and expenditure on Non- consumption (No). These monthly household total expenditures of each group (variable) for each household were divided by corresponding household size separately to obtain monthly household per capita expenditure of 11 variables for 7479 households. Then, these 11 variables were divided into three groups.

Group 1: Expenditure on basic needs (Fo, Cl, and Ho).

Group 2: Expenditure on secondary needs (Hea, Ed, Fu, Tr, Re, Ki, So).

Group 3: Expenditure on non-consumptive items

Construction of the composite index

Weighted principal based component factor analysis was used to construct the composite index, following Garcia and Puetra (1997). De Silva *et al.* (2000) used a similar procedure to develop a human development index. The construction of the new index involves several steps.

Initially, the original expenditure variables were grouped into *p* groups. Principal Components Analysis (PCA) was employed for each group of variables separately to decide the weight for each group. The reciprocal of the square root of the eigen value of the first principal component, ($\sqrt{\lambda_{1k}}$) was used as the weight ω_k for the group k.

$$\omega_k = 1 \Big/ \sqrt{\lambda_{ik}} \tag{2}$$

Then the rescaled variables were;

For group 1: $X_{11}/(\sigma_{11*}\sqrt{\lambda_{11}})$ …….$X_{n1}/(\sigma_{n1*}\sqrt{\lambda_{11}})$
For group 2: $X_{12}/(\sigma_{12*}\sqrt{\lambda_{12}})$…….$X_{n2}/(\sigma_{n2*}\sqrt{\lambda_{12}})$
For group 3: $X_{13}/(\sigma_{13*}\sqrt{\lambda_{13}})$

Where; i =1,2,….,n number of variables within a group; k =1,2,….,p are number of groups.

At the second stage, these rescaled variables were used for factor analysis using covariance option to make the weights into factors. In this stage, PCA was employed for the rescaled variables and few principal components ($Z_1,Z_2,\ldots,Z_m$) whose eigen values that can account for most of the variability of the original variables were retained as unrotated factors. In other words, for the factor analysis, only *m* of the PCs of the covariance matrix of consumption was retained. The method of "varimax" of orthogonal rotation with Kaisan normalization was then carried out for factor rotation to put labels on the factors. The next stage of the analysis dealt with calculating the Factor Scores; $F_1, F_3,\ldots, F_m$.

$$F_1 = a_{11}X_1 + a_{12}X_2 +,.....,+a_{1n}X_n$$

$$F_2 = a_{21}X_1 + a_{22}X_2 +,.....,+a_{2n}X_n$$
$$F_m = a_{m1}X_1 + a_{m2}X_2 +,.....,+a_{mn}X_n \tag{3}$$

Where; F_i = Factor scores of i^{th} factor

a_{ij}= Factor score coefficient

Factor scores of each observation (*i.e.* household or individual) indicate their degree of poverty derived from the average composite poverty index. Clearly F_i is essentially just an average of the consumption expenditures and this average consumption expenditure can be considered as a simple index of poverty. By substituting rescaled values of variables to the above equation, factor scores for each household were obtained.

At the third stage, the mean value of factor scores were taken and multiplying these with their corresponding eigen value of the factor, the new Poverty Index for each household was obtained.

Once the model for consumption poverty indicator was derived, a new poverty line was obtained following Vidyaratne and Tilakaratne (2003) on sectoral and provincial poverty lines for Sri Lanka. In this process, at first, total and food poverty lines for 1995/96 and projected poverty line for 2000 was considered. This was updated for 1999/2000 using the Colombo Consumer Price Index (CCPI); then, the total poverty line, the food poverty line and the non-food poverty line was estimated. Poverty lines for other dimensions were estimated proportionately to the expenditure on other each dimension separately. After deciding poverty lines for each dimension, they were rescaled and used in the factor model $F_i = a_{i1}X_1 + a_{i2}X_2 +,.....,+a_{in}X_n$. The combined value of factor scores is the new poverty line derived under the constructed composite poverty indicator.

Forster-Greer-Thorbecke (FGT) poverty indices were then obtained for the new composite poverty indicator to capture head count index, depth and severity of poverty. The Forster-Greer-Thorbecke Index is defined as;

$$P_a = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z - y_i}{z}\right]^a \tag{4}$$

Where;

n = Total Population

z = Poverty line

y_i = Expenditure of the i^{th} individual

q = The number of persons with expenditure below the poverty line.

a = Measure of sensitivity of the index to poverty

If a = 0, the FGT Index reduces to the Head Count Index (HCI) which measures the Incidence of Poverty (IOP). If a = 1, the index is the Poverty Gap Index (PGI) which measures the Depth of Poverty (DOP) and if a = 2, the index reduces to the Squared Poverty Gap Index (SPGI) which measures the Severity of Poverty (SOP).

RESULTS AND DISCUSSION

Composite index

As described in the methodology section, the expenditure variables were divided into three groups and then PCA was employed for each group. The resultant first eigen values of the PCA are given in Table 1.

Table 1. First eigen values (λ_{1k}) of Principal Component Analysis in each set.

Group (k)	Eigen values (λ_{1k})	Square root of λ_{1k}
1	2.7111	1.6465
2	4.9258	2.2194
3	1.0000	1.0000

Table 2 gives the results of Principal Component Factor Analysis (PCFA) of weighted variables using the covariance option. As shown in the table 2, 52.4% and 28.4% of variability of original variables were accounted for by first and second factors respectively, thus 80.8% of the total variability was accounted for by first two factors together.

Table 2. Results of Principal Component Factor Analysis of weighted variables.

Factors	Eigen value	Percentages	Cumulative percentage
Factor1	1.8486	52.4	52.4
Factor2	1.0009	28.4	80.8
Factor3	0.3476	9.9	90.7
Factor4	0.2022	5.7	96.4
Factor5	0.0820	2.3	98.7
Factor6	0.0322	0.9	99.6
Factor7	0.0085	0.2	99.8
Factor8	0.0025	0.1	99.9
Factor9	0.0023	0.1	100.0
Factor10	0.0007	0.0	100.0
Factor11	0.0002	0.0	100.0
Total	3.5277	100.0	

The effective weights and the final communalities of 11 expenditure variables were obtained and these are depicted in Table 3. This information further verifies that the identified factors explain a substantial variability of the original variables.

Table 3. Effective weights and final communities.

Variable	Effective weight	Final communality
Food and drink (Fo)	0.369	0.78049
Clothing and textiles (Cl),	0.369	0.76423
Housing (Ho),	0.369	0.96206
Education (Ed)	0.203	0.88670
Health (Hea)	0.203	0.62562
Fuel and light (Fu),	0.203	0.91626
Transport and communication (Tr),	0.203	0.90640
Recreation and entertainment (Re)	0.203	0.59606
Kitchen utensil and toys etc (Ki),	0.203	0.00493
Social expenses and remittance (So)	0.203	0.62562
Expe. on non-consumption (No).	1.000	1.00000
Total (weighted)	3.528	

Following Equation 3, the equations for each of the factors F_1 and F_2 were expressed for each of the households in the data set as;

$$F_1 = 0.176Fo + 0.174Cl + 0.196Ho + 0.103Ed + 0.087He + 0.105Fu + 0.105Tr + 0.085Re + 0Ki + 0.087So + 0.07No$$

$$F_2 = -0.003Fo - 0.002Cl + 0.006Ho + 0.001Ed + 0.002He + 0.002Fu + 0.003Tr + 0.002Re - 0.015Ki + 0.003So + 0.999No$$

Substituting of rescaled values of variables to the above equation yielded the factor scores.

The required poverty index was obtained for all the households in the data set, by taking the mean value of factor scores and multiplying these with their corresponding eigen values of the factor as outlined in Table 4.

Table 4. Poverty index estimation for households.

Serial No.	Household No.	Poverty index
1	1	0.305
2	2	0.418
3	3	0.792
-	-	-
-	-	-
7479	7500	0.392

A new poverty line was calculated using the information of Vidyaratne and Tilakaratne (2003) as describe in the Materials and Methods section. The composite index analogous to the poverty line was 0.396.

Comparison of the results with the existing information

The FGT indices, (HCI, PGI and SPGI) were estimated by using the new poverty indicator values and the new poverty line. Then these were compared with the same indices that are based on the conventional approach, *i.e.* the total expenditure poverty indicator. The individual values of poverty indices of the 7479 households were grouped by sectors, provinces and districts for the comparison and depicted in Table 5.

Table 5. Comparison of the Head Count Index.

Category		A (New)		B (Old)	
		HCI	Rank	HCI	Rank
Sri Lanka		0.31		0.36	
Sector:					
	Urban	0.22	3	0.25	3
	Rural	0.33	2	0.37	2
	Estate	0.37	1	0.52	1
Province:					
	Western	0.25	8	0.25	9
	Central	0.43	1	0.42	3
	Southern	0.29	6	0.36	6
	Northern	0.24	9	0.38	5
	Eastern	0.25	7	0.28	8
	Northwest	0.30	5	0.34	7
	North Central	0.42	2	0.45	2
	Uva	0.37	3	0.54	1
	Sabaragamuwa	0.35	4	0.39	4
Districts:					
	Colombo	0.25	15	0.25	21
	Gampaha	0.17	21	0.19	23
	Kaluthara	0.35	11	0.33	14
	Kandy	0.29	14	0.40	10
	Matale	0.53	1	0.54	3
	Nuwara Eliya	0.47	3	0.37	12
	Galle	0.18	20	0.31	16
	Matara	0.22	18	0.34	13
	Hambantota	0.43	6	0.44	8
	Jaffna	0.14	22	0.27	18
	Mannar	0.30	12	0.60	1
	Vavuniya	0.39	9	0.39	11
	Mullaitivu	-	-	-	-
	Kilinochchi	-	-	-	-
	Batticaloa	0.12	23	0.32	15
	Ampara	0.44	4	0.27	20
	Trincomalee	0.23	17	0.27	19
	Kurunegala	0.21	19	0.44	7
	Puttalam	0.38	10	0.20	22
	Anuradhapura	0.42	7	0.41	9
	Polonnaruwa	0.41	8	0.50	6
	Badulla	0.30	13	0.51	5
	Monaragala	0.44	5	0.57	2
	Ratnapura	0.23	16	0.28	17
	Kegalle	0.49	2	0.52	4

Note: B (Old) values were calculated based on old poverty indicator (Siddhisena and Jayatilaka, 2003).

The ranking of the incidence of poverty in districts of Sri Lanka based on two approaches were not consistent as shown by a poor correlation (Spearman's rank correlation

= 0.509). The estimated HCI based on composite index for Sri Lanka is 0.31, which is the proportion of the population below the poverty line and indicates overall poverty situation in the country. The HCI for the country given by the old poverty indicator is 0.36 and it overestimates the poverty in Sri Lanka and a considerable proportion of the population (5%), identified as non-poor by the composite index has been identified as poor by the old indicator.

Table 5 further discloses that sectoral poverty given by the old indicator is higher than the poverty revealed by the composite index. Urban sector is the least impoverished group compared to the others and it does not show an enormous difference in the incidence of poverty between two indicators with reference to the urban sector. Further, it discloses that the estate sector is suffering the greatest poverty compared to the other two sectors based on both indicators. However, there is a huge gap of (0.15) between the two indicators in terms of HCI indicating that the conventional approach overestimates the situation. According to the provincial distribution of HCI under the new index, the highest poverty was recorded from Central province (0.43) due to high contribution of HCI from Nuwara Eliya and Matale districts, whereas the old poverty measure indicated that the highest poverty was in the Uva province (HCI is 0.54) and it is more vulnerable (by 0.11) than the highest poverty given by the new indicator. The Western province which is the most developed province of the island possesses the same HCI (0.25) under the two approaches.

When the distribution of HCI among districts is considered, Matale, Kegalle, Nuwara Eliya, Ampara, Moneragala, Hambantota, Anuradhapura and Polonnaruwa districts (HCI is larger than 0.40) emerge as relatively most deprived districts to have poor; Vavuniya, Puttalam, Kalutara, Mannar and Badulla (HCI is in between 0.30 and 0.40) can be identified as moderately poverty affected districts while Kandy, Colombo, Ratnapura, Trincomalee, Matara, Kurunegala, Galle, Gampaha, Jafna and Batticaloa (HCI less than 0.30) can be identified as relatively less poverty affected districts in terms of the new composite poverty indicator. However, according to the existing indicator, Mannar, Moneragala, Matale, Kegalle, Badulla, Polonnaruwa, Kurunegala, Hambantota and Anuradhapura districts (HCI is larger than 0.40) are considered as relatively the most deprived districts while Kandy, Vavuniya, Nuwara Eliya, Matara, Kalutara Batticaloa Galle (HCI is in between 0.30 and 0.40) are identified as moderately poverty affected districts; Ratnapura, Jaffna, Trincomalee, Ampara, Colombo Puttalam and, Gampaha, (HCI less than 0.30) are known as relatively less poor districts. This comparison discloses that the number of most deprived districts is equal under the both indicators, but the number of less poverty affected districts is less (07) under the prevailing poverty indicator than the composite indicator (09). It also provides insights to policy making process about how poverty reduction programs should be launched among districts with the new view of poverty distribution.

Similarly, the other important TGT measures, PGI and SPGI were also estimated using the composite index and then compared with the existing values. Tables 6 and 7 depict the results of these comparisons.

Table 6. Comparison of the Poverty Gap Index.

Category		A (New)		B (Old)	
		PGI	Rank	PGI	Rank
	Sri Lanka	0.10		0.15	
Sector:					
	Urban	0.07	3	0.10	3
	Rural	0.11	1	0.16	2
	Estate	0.10	2	0.22	1
Province:					
	Western	0.07	8	0.10	9
	Central	0.15	1	0.19	3
	Southern	0.12	4	0.14	7
	Northern	0.08	7	0.15	5
	Eastern	0.07	9	0.10	8
	Northwest	0.09	6	0.14	6
	North Central	0.14	3	0.21	2
	Uva	0.15	2	0.24	1
	Sabaragamuwa	0.11	5	0.17	4
Districts:					
	Colombo	0.07	14	0.10	18
	Gampaha	0.06	18	0.07	22
	Kaluthara	0.09	12	0.14	13
	Kandy	0.08	13	0.17	10
	Matale	0.21	2	0.25	3
	Nuwara Eliya	0.16	5	0.16	12
	Galle	0.03	22	0.12	15
	Matara	0.06	16	013	14
	Hambantota	0.22	1	0.17	9
	Jaffna	0.03	21	0.08	21
	Mannar	0.12	10	0.28	1
	Vavuniya	0.13	8	0.16	11
	Mullaitivu	-	-	-	-
	Kilinochchi	-	-	-	-
	Batticaloa	0.02	23	0.11	16
	Ampara	0.14	7	0.10	19
	Trincomalee	0.05	19	0.10	20
	Kurunegala	0.06	17	0.20	8
	Puttalam	0.12	11	0.06	23
	Anuradhapura	0.14	6	0.20	7
	Polonnaruwa	0.13	9	0.23	4
	Badulla	0.07	15	0.21	6
	Monaragala	0.21	3	0.27	2
	Ratnapura	0.05	20	0.11	17
	Kegalle	0.17	4	0.23	5

Note: B (Old) values were calculated based on old poverty indicator (Siddhisena and Jayatilaka, 2003).

Table 7. Comparison of Squared Poverty Gap Index.

Category		A (New)		B (Old)	
		SPGI	Rank	SPGI	Rank
	Sri Lanka	0.22		0.09	
Sector:					
	Urban	0.04	3	0.06	3
	Rural	0.28	1	0.09	2
	Estate	0.05	2	0.13	1
Province:					
	Western	0.03	8	0.06	8
	Central	0.08	3	0.11	3
	Southern	0.80	2	0.07	7
	Northern	0.07	5	0.09	5
	Eastern	0.03	9	0.06	9
	Northwest	0.04	7	0.09	6
	North Central	0.08	4	0.13	2
	Uva	0.81	1	0.14	1
	Sabaragamuwa	0.05	6	0.10	4
Districts:					
	Colombo	0.04	14	0.07	15
	Gampaha	0.03	17	0.04	22
	Kaluthara	0.04	13	0.08	13
	Kandy	0.03	16	0.10	10
	Matale	0.11	5	0.15	3
	Nuwara Eliya	0.09	6	0.09	12
	Galle	0.01	22	0.06	16
	Matara	0.06	10	0.07	14
	Hambantota	0.90	1	0.10	11
	Jaffna	0.02	21	0.04	21
	Mannar	0.12	3	0.18	1
	Vavuniya	0.12	4	0.10	9
	Mullaitivu	-	-	-	-
	Kilinochchi	-	-	-	-
	Batticaloa	0.01	23	0.06	19
	Ampara	0.06	11	0.06	18
	Trincomalee	0.02	19	0.06	20
	Kurunegala	0.03	18	0.12	7
	Puttalam	0.06	12	0.03	23
	Anuradhapura	0.08	9	0.13	6
	Polonnaruwa	0.08	8	0.14	4
	Badulla	0.03	15	0.12	8
	Monaragala	0.45	2	0.17	2
	Ratnapura	0.02	20	0.06	17
	Kegalle	0.09	7	0.13	5

Note: B (Old) values were calculated based on old poverty indicator (Siddhisena and Jayatilaka, 2003).

Overall, the values of PGI and SPGI obtained from the new approach do not appear to be consistent with the existing information as shown by Tables 6 and 7. The new

indicator identifies that the rural sector has the highest depth of poverty whereas according to the old indicator, the estate sector suffers from the highest depth of poverty. Rankings of districts based on depth of poverty (PGI) by two indicators showed a fairly low correlation (Spearman's rank correlation = 0.592). A similar pattern was observed with the information relevant to the severity of poverty among the sectors (SPGI). District rankings of SPGI based on two approaches again had a little consistency as indicated by Spearman's rank correlation 0.302.

CONCLUSIONS

Conventional indicator of consumption poverty is based on total expenditure where the relative importance on various consumption variables is completely ignored. As an alternative to this, weighted principal component factor analysis was employed for various dimensions of household expenditure to construct a composite index to measure the consumption poverty. The study revealed that the poverty information given by two approaches are not consistent and in some situations the old approach has overestimated the poverty. Given that the new approach stresses the weights for each expenditure variable to emphasize their different importance, it is worthwhile to consider exercising the new approach in measuring poverty and evaluating the effectiveness of anti-poverty programs.

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