COMPOSITE POVERTY MEASURES AND ANALYSIS USING FUZZY SETS AND TECHNIQUES IN GHANA

Daniel Agbeko[1]

Senior Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana, E-mail: dagbeko@htu.edu.gh

Donatus Ayitey[2]

Senior Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

Augustine Kwadwo Yeboah[3]

Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

Charlotte Kpogli[4]

Assistant Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

Abstract

This paper sought to contribute to the understanding of the progress that was made in achieving the first Millennium Development Goal (reduce by one-half those faced with extreme poverty in Ghana). It therefore addresses three main issues namely: 1) the incidence of poverty among the apparel manufacturers in Ghana, 2) the sources of this deprivation, and 3) the dynamics of the deprivation between 2002 and 2007. Based on Fuzzy Methodology and primary data collect over 2002 and 2007 period, a key finding was that, deprivation among apparel manufacturing households was 41.8 percent in 2002 but dropped to 34.2 percent in 2007. Food deprivation and income inadequacy were established to be among the highest sources of poverty among apparel manufacturing households in Ghana.

Key Words: Poverty, Households , Fuzzy Methodology and Ghana

1   Introduction

Of grave concern since the beginning of the new millennium is how to find a lasting solution to extreme poverty and hunger facing a significant proportion of the world's population? Over 1 billion people in the world live on less than US $1 a day two-third of whom are from Sub-Saharan Africa (UN HDR, 2003)[5]. Among measures agreed upon to deal with poverty at the 2005 G8 Summit in Gleneagles, Scotland, were to cancel the debts of the world's poorest nations, increase development aid to the poorest countries and the opening up of the developed nations' markets through the removal of agricultural subsidies and export tariffs. By and large, questions over where to start and how to reduce the level and rate of poverty and deprivation among people in a more sustainable way still remain basically unanswered. What was clear was that poverty measures should go beyond income poverty.

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[1] Senior Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana, E-mail: dagbeko@htu.edu.gh

[2] Senior Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

[3] Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

[4] Assistant Lecturer, Department of Multidisciplinary Studies Ho Technical University, Ho Volta Region, Ghana

[5] Matthew Kahane - Coordinator, Józefina Hrynkiewicz, Jolanta Supinska, Irena Herbst, Andrzej Bratkowski, Malgorzata Pawlisz. 2003. Human Development Report 2003: Millennium Development Goals: A Compact Among Nations to End Human Poverty. New York.

2 Conceptualization of Poverty and Well-being

Poverty can be conceptualize narrowly or broadly. Sen (1976) was critical of the poverty measures namely 'head-count ratio' and 'poverty-gap' which were widely used at the time describing the former as violating both the basic monotonicity[6] and transfer[7] axioms. Whilst the head-count approach is based on real income and classified as poor all those below some pre-determined income level, the poverty–gap approach accounts for the aggregate difference between the income of all the poor and that of the poverty line. However, both measures are insensitive to income redistribution among the people. Sen (1976) therefore, constructed an index[8] comprising of the two measures and including the Gini coefficient to account for the income redistribution effects lacking in the previous methods. Even Sen's (1976) index hinges on income and therefore a uni-dimensional technique of capturing poverty. It should however, be noted that Sen's approach was reducing what was essentially multi-dimensional to single dimensional by aggregating various goods for a single person using the market prices thus getting real income for that individual which is comparable to that of others. Questions over differences in individual indirect utility functions which might render this aggregation based on prices misleading have been raised.

Foster, Greer and Thorbecke (1984) employ a parametric measure of poverty that satisfies Sen's axioms of monotonicity and transferability with the formulae specification as

$$P_b = 1/n \sum_{h=1}^{q} [(z - y_h)/z]^b$$ where z represents some predetermined poverty line greater than zero, y_h

is the hth household income, n captures total number of households and q represents households with income levels higher than z. P is the poverty measure, b is the non-negative parameter and P_b indicates some class of poverty measure in general where b can assume values such as 0, 1 or 2. The equation defines some weighted sum of the income shortfalls of poor households. Setting b to 0 provides headcount poverty index measuring the incidence of poverty thus the proportion of those below the predetermined poverty line. P_1 is interpreted as the poverty gap index measuring the depth of poverty which makes it easier for policy makers and implementers to know exactly the amount of income needed to reduce poverty. P_2 measures that squared poverty gap accounting for the degree of inequality among the poor people. The approach still suffers from the fact that it is based on either income or expenditure only.

Some authors have proposed measures which are multi-dimensional and can help capture poverty more accurately than the single indicator approaches. Atkinson and Bourguignon (1982) writing on the comparison of multi-dimensioned distributions of economic status noted that the single measure approach in gauging even inequality needs to incorporate many more factors made up of monetary and non-monetary variables such as health status and housing in addition to income. In the written works of Halper (1973), phrases such as 'deserving poor', 'undeserving poor' and 'undeserving rich' were employed to highlight the differences that exist among the poor themselves referring basically to some who are hardworking enough but their circumstances are such that they are still poor through no fault of theirs and such people deserved to be assisted out of poverty. The undeserving poor though constitute the bulk of the poor who are widely perceived as being poor out of their own laziness or luck of good judgment among others and so do not need any assistance as they themselves do not put in any efforts to escape their current circumstances.

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[6] Monotonicity here implies that a reduction in income of persons below the poverty line leads to increase in poverty measure assuming other factors remain unchanged.
[7] Violating transfer axiom means that reassignment of income from one person below the poverty line to another person above the poverty line must increase the poverty measure, all factors remaining the same.
[8] Sen (1976) poverty index where P symbolizes poverty index, H denotes headcount, I denotes income poverty-gap and G denotes Gini coefficient.

3 Theoretical Framework and Multidimensional Measure of Poverty

Unlike the classical set theory and logic which deals with precise measures, for example, one either belongs to a set of poor people or rich people or not, Fuzzy set theory and logic (Zadeh, 1965) is based on the idea that it is better to be vaguely right than to be precisely wrong and admits membership values in their imprecise form. For example, with respect to poverty/deprivation, the measurements will accommodate the degree of deprivation from completely deprived through partially deprived to completely non-deprived. Thus, this is quite different from the likelihood of belonging to a specific set of poor people which must be obeyed without which no flexibility is possible. Betti, Chelli, Lemi and Verma (2006) wrote that most approaches employed in the analysis of poverty have two weaknesses in that not only are they based on single proxy of poverty such as income or consumption expenditure but also categorize the people into poor and non-poor based on some arbitrary poverty line. Betti et al. (2006), realized in part that the classification into poor and non-poor leaves out vital information.

4   The Methodology

The study follows Dagum (2002) and Dagum and Costa (2004) approach which is grounded on Cerioli and Zani (1990) with the modifications required to help address these sets of issues specifically:

- Poverty/deprivation index for each household (both static and dynamic measures)
- Poverty index for j-th attribute
- Composite poverty index for all the 140 households (both static and dynamic measures)
- Sources of poverty/deprivation

We start by:

Firs*t*, let $X = (X_1,....,X_j,....X_m)$ denote j (j=1, 2,…, m) number of attributes in m-dimension (m=2,3,….) vector of attributes. Costa (2002) defined m-dimension vector of attributes to be made of economic, social and cultural among others. Second,   let $H = (h_1,h_2,.......h_n)$ denotes a vector of n households and third, let D denotes a subset of deprived households such that $h_i \in D$ (i=1,2,….,n) indicates deprivation of some j attributes in m-dimension of attributes.

Let us define members of deprived set of households as $\mu_D(X_j(h_i)) = x_{ij}$, where $0 \leq x_{ij} \leq 1$. This implies that:

$$
\begin{cases}
- & x_{ij} = 0 \quad \textit{iff the } i-th \textit{ houshold} \\
& \quad\quad \textit{possess the } j-th \textit{ attribute} \\
\\
- & x_{ij} = 1 \quad \textit{iff the } i-th \textit{ household   does not} \\
& \quad\quad \textit{possesses the } j-th \textit{ attribute} \\
\\
- & 0 \prec x_{ij} \prec 1 \quad \textit{iff the } i-th \textit{ household partially} \\
& \quad\quad \textit{possesses the } j-th \textit{   attribute} \\
& \quad \textit{with } \text{int}\textit{ensity belonging   to} \\
& \quad \textit{the open   int}\textit{erval } [0,1]
\end{cases}
$$

As there are m attributes that may collectively define the level of deprivation of each household in which case we have m-dimension of attributes, our **poverty index of the i-th household** becomes:

1. $$\mu_D(h_i) = \frac{\sum_{j=1}^{m} x_{ij} w_j}{\sum_{j=1}^{m} w_j}$$ where w_j captures the weight assigned to the j-th attribute defined as the

intensity of deprivation of X_j. The are various weighting systems that have been proposed by various authors including Cerioli and Zani 1990, Cheli and Lemmi (1995), and Filippone et al (2001) who attempted to compare different weighting system with the aim of establishing differences in outcomes with respect to these system. However, not veering into other weighting systems, we consider Cerioli and Zani's (1990) which have been readily employed by several writers including Dagum and Costa (2002). They modelled their **weights** w_j as the inverse function of average degree of deprivation formally defined as:

2. $$w_j = \log\left[\frac{n}{\sum_{i=1}^{n} x_{ij} n_i}\right] \geq 0$$

For equation 2 to be positive or equal to zero implies $\sum_{i=1}^{n} x_{ij} n_i > 0$ condition must hold. The weighting

is so defined such that any attribute X_j with degree of membership $x_{ij} = 0$ and $x_{ij} = 1$ for all i, i=1…..n, show extreme situations with the former indicating no deprivation in the said attribute and therefore makes inconsequential the intention to capture levels of deprivation with respect to the attribute and can be excluded. The latter indicates the opposite where the j-th attribute is not possessed by any of the i-th household hence situation of complete deprivation shown by $w_j = \log[n/n] = \log[1] = 0$. Equation 2 satisfies an important property by attaches more importance to attributes that are common with few households deprived of them meaning that all factors held constant, the intensity of deprivation is much more pronounced where people find it difficult to conform to the norm. For example, if having access to at least basic education is a norm in a society, the signs of derivation become obvious where some people are without this basic education. Miceli (1998) gave more insight into the appropriateness of the weighting system in equation 2 when he cited Theil (1967) common information function defined over $(0, \infty)$ which decreases with the probability of the occurrence of an event meaning that the more unlikely the occurrence of an event, the more shocked people become with the cite of the event.

Having specified the poverty estimate for the i-th household in the sample population along the lines of Dagum and Costa (2004) using the weights of Cerioli and Zani (1990), the study proceeds to the specification of **poverty index for the population** follows:

3. $$\mu_D = \frac{\sum_{i=1}^{n} \mu_D(h_i)g(h_i)}{\sum_{i=1}^{n} g(h_i)} = \frac{1}{n}\sum_{i=1}^{n} \mu_D(h_i)g(h_i)$$

where equation 3 is simply a weighted average of equation 1 (the weighted average of the i-th household). The function $g(h_i)$ symbolizes the number of households. For each of m attributes under consideration, the theory of fuzzy sub-set provides an opportunity to capture one-dimension of j-th attribute possessed by the i-th household where we recall the degree of membership x_{ij} and define **poverty index for the j-th** attribute as:

4. $$\mu_D(X_j) = \frac{\sum_{i=1}^{n} x_{ij}g(h_i)}{\sum_{i=1}^{n} g(h_i)} = \frac{\sum_{i=1}^{n} x_{ij}n_i}{\sum_{i=1}^{n} n_i}$$

where equation 4 measures the degree of deprivation of population n in j-th attribute with the difference in using n_i instead of w_j as weights underlies the fact that the former has to do with the weight or importance attached to the i-th sample observation whilst the latter with the degree of deprivation of X_j.

5   The Choice of Membership Functions

In our methodology, the following steps were followed. Poverty indicators based on Ghana Living Standard Surveys were first selected. We classify these poverty indicators according to the membership function that defined them (see examples in Table 1). The binary functions define YES/NO, HAVE/HAVE NOT and DEPRIVED/NOT DEPRIVED questions among others. These attributes comprised of possessing of telephone/mobile phone, refrigerator, air conditioner, computer, electrical iron/other iron, water boiler, bed, video recorder/TV, car, wrist watch/clock and others or not.

Table 1: Examples of Membership Functions

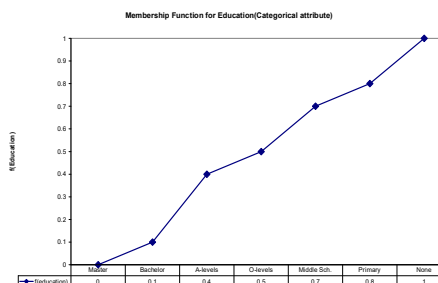| Binary Function	Applying binary function to dichotomous Variable(Car)
$$f(x) = \begin{cases} 1 & deprived \ of \\ & attribute \ x \\ 0 & not \ deprived \\ & of \ attribute \ x \end{cases}$$ Questions here apply to possession of an item e.g. car. The answer is either yes or no.	 Membership Function for Car(dichotomous attribute)
Categorical Function(Positive slope)	Applying categorical function to categorical Variable(e.g. levels of education)
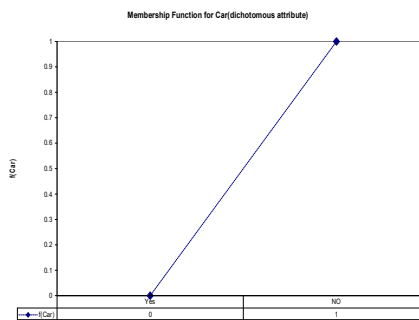
$$f(x) = \begin{cases} 1 & if \ x \prec x_{min} \\ \dfrac{x_{max} - x}{x_{max} - x_{min}} & if \ x_{min} \leq x \prec x_{max} \\ 0 & if \ x \geq x_{max} \end{cases}$$

Questions here apply to categories of say education. The higher the level of education, the better and hence a positive slope
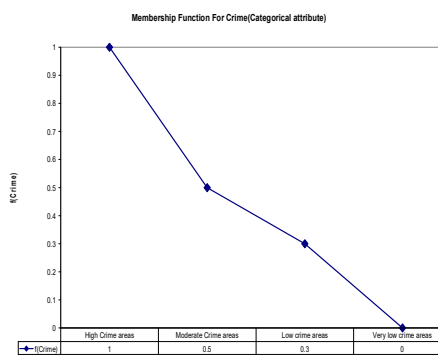

Membership Function for Education(Categorical attribute)

	Master	Bachelor	A-levels	O-levels	Middle Sch.	Primary	None
f(education)	0	0.1	0.4	0.5	0.7	0.8	1

Categorical Function(Negative slope)

$$f(x) = \begin{cases} 1 & if \ x < x_{min} \\ \dfrac{x - x_{min}}{x_{max} - x_{min}} & if \ x_{min} \leq x < x_{max} \\ 0 & if \ x \geq x_{max} \end{cases}$$

Questions here apply to levels of say crime. The higher the level of crime, the worse and hence a negative slope

Applying categorical function to categorical Variable (e.g. levels of crime in one's area)

Membership Function For Crime(Categorical attribute)

	High Crime areas	Moderate Crime areas	Low crime areas	Very low crime areas
f(Crime)	1	0.5	0.3	0

Categorical functions define attributes such as levels of education which comprise of tertiary, secondary, primary and basic/adult education. For these attributes, the higher the level of education, the less deprived one is with respect to those attributes and hence the positive slopes for the membership function. Other attributes such as levels of crime in the neighborhoods range from low on the average, relatively high to very high. Cost of living varies from low on the average, relatively high to very high. These are defined by categorical functions with negative slopes as in Table 1. Thus, the multidimensional computation of poverty indices is illustrated in Table 2 which presents:

- poverty index of the i-th household($\mu_D(h_i)$)

- weight assigned to the j-th attribute (w_j)

- poverty index for the population (μ_D)

- poverty index for the j-th attribute ($\mu_D(X_j)$)

Table 2: Example of multidimensional measure of poverty at a point in time

Dimensions (Di)	Car	Income	Education	Food	Crime	$\mu_D(h_i)$
Households	(D1)	(D2)	(D3)	(D4)	(D5)	(Poverty index for i-th household)
1	1	1	1	1	1	0.978
2	1	0.7	0	0.6	1	0.535
3	1	0.3	0.1	0	0.5	0.167
4	1	0.7	0.4	0	0.5	0.325
5	1	0	1	0	0.5	0.302
6	1	0	0	0	0	0
$\sum_{i=1}^{n} x_{ij}$	6	2.7	2.5	1.6	3.5	$\mu_D =$

w_j	0	0.347	0.38	0.574	0.234	0.394 (poverty index for the population)
$\mu_D(X_j)$	1	0.45	0.417	0.267	0.583	
$\mu_D(X_j)*w_j$	0	0.156	0.158	0.153	0.137	

Note: These poverty indices are computed based on some membership functions in Table 1 using equations 1, 2, 3 and 4.

The D1, D2, D3, D4 and D5 capture five dimensions of attributes over six households in the first column (Table 2). From equations 1, 2, 3 and 4 we compute the example in Table 2. The membership values of each dimension (Di) of attributes were first defined by the respective membership functions in Table 1 and the results for each of these dimension then used for multidimensional computation in Table 2.

5.1 Capturing Poverty/Deprivation Changes Overtime: Longitudinal Measure

In the previous sections, we specified the static measures of deprivation and now we have to establish changes in this deprivation overtime. This section is based on the works of Betti and Verma (1998), Betti and Cheli (2000), Verma and Betti (2002), Dubois and Parade (1980) and Zadeh (1965). Poverty is measured over t (current time period) and t-5 (previous time period defining 5 years back). This implies that our degree of membership takes the forms: $\mu_D\left[X_j(h_i)\right]^t$ and $\mu_D\left[X_j(h_i)\right]^{t-5}$, our poverty index of the i-th household becomes: $\mu_D(h_i)^t$ and $\mu_D(h_i)^{t-5}$, our poverty index for the population becomes: $\mu_D^{\ t}$ and $\mu_D^{\ t-5}$, our poverty index for the j-th attribute becomes: $\mu_D(X_j)^t$ and $\mu_D(X_j)^{t-5}$.

Occurrence of poverty/deprivation in **both** time periods as proposed by Betti and Verma (2002) is captured as fuzzy intersection of situations in both sets as:

$$a_1. \quad \left[\mu_D(h_i)^{t-5} \cap \mu_D(h_i)^t\right] = \min\left[\mu_D(h_i)^{t-5},\ \mu_D(h_i)^t\right]$$

6.
$$b_1. \quad \left[\mu_D^{t-5} \cap \mu_D^t\right] = \min\left[\mu_D^{t-5},\mu_D^t\right]$$

$$c_1. \quad \left[\mu_D(X_j)^{t-5} \cap \mu_D(X_j)^t\right] = \min\left[\mu_D(X_j)^{t-5},\ \mu_D(X_j)^t\right]$$

Occurrence of poverty/deprivation in **either** time period is captured as fuzzy union of both sets:

$$a_2. \quad \left[\mu_D(h_i)^{t-5} \cup \mu_D(h_i)^t\right] = \max\left[\mu_D(h_i)^{t-5},\ \mu_D(h_i)^t\right]$$

7.
$$b_2. \quad \left[\mu_D^{t-5} \cup \mu_D^t\right] = \max\left[\mu_D^{t-5},\mu_D^t\right]$$

$$c_2. \quad \left[\mu_D(X_j)^{t-5} \cup \mu_D(X_j)^t\right] = \max\left[\mu_D(X_j)^{t-5},\ \mu_D(X_j)^t\right]$$

Equations 6 and 7 allow us to measure on all fronts whether poverty has gradually reduced or increased among the apparel manufacturers since early 2000s. More formally, Betti et al. (2006) framework enables studies like this one to establish whether i-th individual or household is exiting,

entering or never in poverty using fuzzy operators. Never deprived households within the two periods are represented by the fuzzy intersection where the $\overline{\mu}$ connotes '**never in poverty**' as:

$$a_3. \qquad \left[\overline{\mu}_D(h_i)^{t-5} \cap \overline{\mu}_D(h_i)^t\right] = 1 - \max\left[\mu_D(h_i)^{t-5}, \ \mu_D(h_i)^t\right]$$

7.8.

$$b_3. \qquad \left[\overline{\mu}_D^{t-5} \cap, \overline{\mu}_D^t\right] = 1 - \max\left[\mu_D^{t-5}, \mu_D^t\right]$$

Exiting from poverty is captured by fuzzy intersection:

$$a_4. \quad \left[\mu_D(h_i)^{t-5} \cap \overline{\mu}_D(h_i)^t\right] = \max\left[0, \ \mu_D(h_i)^{t-5} - \mu_D(h_i)^t\right]$$

9.

$$b_4. \quad \left[\mu_D^{t-5} \cap \overline{\mu}_D^t\right] = \max\left[0, \ \mu_D^{t-5} - \mu_D^t\right]$$

Entering into poverty is defined by the fuzzy intersection:

$$a_5. \quad \left[\mu_D(h_i)^{t-5} \cap \overline{\mu}_D(h_i)^t\right] = \max\left[0, \ \mu_D(h_i)^t - \mu_D(h_i)^{t-5}\right]$$

10.

$$b_5. \qquad \left[\mu_D^{t-5} \cap \overline{\mu}_D^t\right] = \max\left[0, \ \mu_D^t - \mu_D^{t-5}\right]$$

6 Data Sources, Variables, Missing Data and Outliers
The data were collected from a sample of 140 households connected directly to apparel manufacturing. Household heads, most of whom are the owners of these micro, small and medium sized apparel businesses were interviewed and information on household attributes was obtained for 2002 and 2007. These households were expected to have depended on apparel manufacturing for a couple of years which could be at least five years. Comparison of some selected household indicators in 2007 against 2002 enabled multidimensional assessment to be made overtime.

The first dimension referred to as D1 in Table 3 captures attributes on shelter. Data on the nature of the flooring materials, roofing, walling, and the number of rooms were obtained. The second dimension (D2) detailed the source of water supply to the household. Whilst dimension three (D3) subdivided into three categories namely durable assets, food, and other assets are listed. D4 and D5 provided daily expenditure on food and monthly expenditure on clothing respectively. D6 dwelled on sanitation attributes. Other dimensions such as D7 raised multiple choice questions on source of household energy supply classified into lighting and cooking. D8 on health categorized into orthodox medication and self medication. D9 on capabilities grouped into education at home, education at school and education at workplace.

D10 captures security and safety of location attributes partitioned into financial and social measures as well as violence and cost of living. The final dimension D11 posted issues on category of income that best describes the respondent's situation. Care is taken in the designing of the questionnaire to ensure that only relevant questions are raised and any other issue that might be of less interest is given second treatment.

The problem of missing data or doubtful information was addressed on the field by follow-up calls or visit to households to ascertain the right information and data. This was possible because the survey team had the contact information of the household heads visited and or interviewed.

The nature of the fuzzy methodology employed ensured that outliers were admitted based on membership functions without any problem. In fact, an outlier or extreme value here simply means one is either *completely* deprived or *completely* non-deprived in an attribute.

For example, with respect to income (which is a positive attribute), the measurements accommodates the degree of deprivation in income from completely deprived and taking the value of 1, where say one earns nothing over a period, through partially deprived, taking the value between 1 and 0, where one earns some amount of money, to completely non-deprived, taking the value of 0. If one earns a lot, it simply means he/she is completely non-deprived and if one earns nothing, it simply means, he/she is completely deprived.

For negative attributes such as crime, the higher the level of crime, the worse and hence one's membership function takes on the value of 1, where the level of crime is worst, between 1 and 0 where it is worse or bad, and 0 where crime is not a problem.

6.1 Aggregation of attributes and their dimensions

Relying on the membership functions specified in Table 1, applying and matching them to each attribute according to their nature and using the aggregation and weighting functions in section 5, we compute the static measures of deprivation for all the 140 households together (composite index) and for each household individually. The dynamic measures are calculated from the application of the functions specified in section 5.3. Aggregation of (a) different dimensions of deprivation with respect to the j-th attributes ,(b) single dimension of deprivation with respect to j-th attributes and (c) assignment of weights to these attributes (w_j) was carried out with the aim of capturing the degree of the importance of these attributes to the deprived households.

7 Presentation and analysis of results: Static measures
7.1 Poverty index for the population

The results are presented in Table 4. In 2002, poverty index for the population stood at 0.418 comprising 41.8 per cent of the households judged to be deprived compared to 0.342 in 2007 constituting 34.2 per cent in that year. The trend seems a little favorable with a reduction of deprivation by 6 percentage points over the years. However, the rate of occurrence of deprivation among households in 2007 is even very high and it would be good to know the share of contribution by each dimension of attributes to the deprivation index. Columns (a) and (c) of Table 3 present values for weights attached to the household attributes in the sample computed from equation 2.

Table 4: Poverty index for the j-th attribute and Population

These apparel manufacturing households appear to attach the highest importance to housing attributes with the weight of 0.524 in 2002 and 0.644 in 2007, health attributes with the values of 0.469 and 0.505 compared to Food 0.081 and 0.300, income 0.148 and 0.358 and clothing with values of 0.254 and 0.476 in that order in both years respectively. This is understandable in that people residing in their own homes do not need to spend a large proportion of their incomes on rent.

High importance is also attached to security and energy attributes with the index of 0.459, 0.341 and 0.403, 0.550 in 2002 and 2007 respectively. The importance attached to these attributes have not been stable because apart from security attributes, all other 10 dimensions of attributes appear to have greater weights attached to them in 2007 compared to 2002 that increased the cumulative weight from 3.759 to 5.020 over the years.

7.2 Sources of Poverty

Even though much importance has been attached to housing attributes, the greatest influence on poverty has been from expenditure on food recording the highest poverty ratio of 0.830 and 0.501 in 2002 and 2007 respectively in Table 4. This constitutes 15.8 and 12.7 per cent of contribution to deprivation among all categories as shown in Figure 1. Despite the fact that some families have subsistence farms to supplement their food needs, the bulk of their earnings is still spent on food. The share of expenditure on food however dropped by more than 3 percentage points between 2002 and 2007 for the households. As the share of expenditure on food is directly linked to the level of income, the prevailing situation of high expenditure on food is therefore an indication of underdevelopment.

 The second highest cause and contributor to poverty is the inadequate income that these households have to contend with. The poverty ratio of 0.712 in 2002 and 0.438 in 2007 constituting 13.5 and 11.1 per cent respectively made this source very important. Many families of sizes between two and four persons made net monthly income of between 50 and 100 Ghana cedis in both 2002 and 2007. Fewer families earned monthly income between 100 and 500 Ghana cedis over the period. Rarely did a family of any size exceed 500 Ghana cedis per month.

Security and safety of location attributes are captured broadly as they include source of families' support in difficult times. Such support comprised of own resources, government support, family support, friends support and others. Security and safety of location emerged as a very large source of deprivation in 2007 contributing 11.6 percent compared to 2002 rate of 6.6 percent. Many household heads during the interviews acknowledged that the cost of living has really been increasing and this might be accounting for that relatively high influence on poverty. The contribution of expenditure on clothing to the deprivation of these households was higher in 2002 reaching the poverty ratio of 0.557 constituting 10.6 per cent, but reduced in 2007 to 0.334 comprising 8.5 percent.

One more important factor that contributed significantly to poverty is lack of sanitation facilities. Sanitation attributes include toilet facilities indicating whether families have access to private flush toilets or water closets, private squat toilets, public toilets, boreholes or pit latrines. Access to bathing facilities such as indoor bathtubs, indoor showers, total or semi-detached outdoor bathing rooms and others were captured as well. Waste disposal systems very important especially for urban folks involving access to private waste disposal options, public waste disposal options or informal disposal options and others are incorporated. Many households are deprived of some of these facilities. Thus, the poverty index for this attribute was 0.520 in 2002 and 0.360 in 2007 evolving as the fourth major contributor to overall poverty. In fact, it formed 9.9 percent of the index in 2002 and 9.2 percent in 2007.

We tried to also look into how central a problem for apparel manufacturing families' ability to own homes by investigating whether the houses in which they live are self-owned, rented, family homes, public apartments and others. Poverty ratio for home ownership was 0.401 in 2002 and 0.349 in 2007

which actually translated to 7.6 per cent and 8.9 per cent respectively. The higher share of percentage contribution to poverty in 2007 seems to indicate that, it is getting more difficult for these people to own homes. Majority of them duel in rented homes, a rather costly option as more expenditure on rental payments weighs heavily on their already meager incomes.

On the other hand, considering access to housing in general, apparel manufacturing families do not seem to have much of a problem. The least contributing variable to deprivation in 2002 and 2007 has been access to housing with poverty index of 0.229 and 0.227 correspondingly. These ratios amount to 5.7 percent in 2002 and 5.8 in 2007 in terms of their contribution to population poverty index. Another important source of deprivation is from capability related attributes. We classified them into three categories namely education at home, education at school and education at workplace. The estimated poverty ratio for capability attributes as in Table 4 is 0.442 in 2002 and 0.346 in 2007. This ratio translates into 8.4 percent contribution to the population poverty ratio in 2002 and a little bit higher in 2007 reaching 8.2 percent (see Figure 1).

Health of apparel manufacturers is vital to the sustenance of their businesses and access to quality health care is a major decision for these households to make. The level of deprivation with respect to access to healthcare was estimated to be 0.340 in 2002 and 0.313 in 2007. This translates into 6.5 percent of total deprivation in 2002 and went up to 8 per cent in 2007. Access to healthcare measures include ones ability to have the services of a private doctor, access to hospitals, access to the services of pharmacist and nurses including midwifery services among others.

Figure 1

Attributes and their Contribtuion to Deprivation in 2002 and 2007
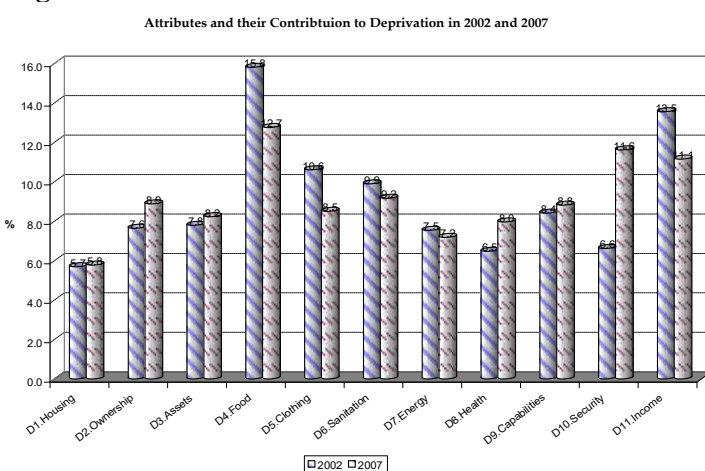
Another important source of deprivation is lack of durable and non-durable assets. Durable assets comprise of day-to-day basic stuffs from beds, electric irons, clocks and wristwatches, mobile phones and telephones to more expensive items like television sets, computers, refrigerators, air conditioners and automobiles. Non-durable items include food items for breakfast, lunch and dinner. Poverty index for assets stood at 0.409 in 2002 and 0.324 in 2007. This converts to 7.8 percent contribution to deprivation in 2002 and 8.2 per cent in 2007. Worst of all, the little rise in their contribution to poverty by even 0.4 of a percentage point is no good news.

One last source of deprivation is energy supply to households for lighting, heating and cooking. The deprivation index for energy attributes even though large is among the least contributors to the overall deprivation in both years. It was 0.396 in 2002 but reduces to 0.282 in 2007. The relative contribution to overall deprivation was 7.5 per cent in 2002 and 7.2 per cent in 2007. A reduction of 0.3 of a percentage point highlights the efforts being made by government over the years for most households in Ghana to have access to electricity and in line with the general trend in the country that more and more households across regions and business groups are being connected to the national grid over the years.

In Table 5 in appendix , poverty index for each of 140 households is presented for 2002 and 2007. The general understanding for the entire 140 households is that, deprivation index, appears to be relatively lower in 2007 compared to 2002. Again in Table 5 in appendix , we see a disturbing trend where some households are experiencing rising deprivation. The number even though low is noteworthy. There are 13 out of 140 households sampled that are falling deeper and deeper into poverty. The number translates to 9.3 percent of the households in the sample.

7.7.3 Dynamic Assessment of Poverty

In this section, we tried to assess the situation of poverty in both time periods by estimating the extent to which poverty is persisting and the level of deprivation likely to be affecting these households at any-time period. Table 6 in appendix shows that persistent deprivation index for all 140 households which capture poverty in both 2002 and 2007 stood at 0.34 and any-time poverty index which measures poverty in either 2002 or 2007 stood at 0.42. These deprivation indices are quite high for households linked to apparel related jobs. Table 6 in appendix also presents the index of each of the 140 households.

A look at Figure 2 and Table 7 depicts what the dynamics are with respect to the rate of persistence poverty, any-time poverty, those households never in poverty, those households exiting and those entering poverty. Out of the 140 households, poverty continues to persist among 34 percent of them and at any-time, about 42 per cent of the households are likely to be deprived. About 58 per cent of household were never in poverty over the period and 8 per cent of those likely to be in poverty are exiting.

Starting with the rate of persistent of poverty, 36 per cent of households linked to micro firms are likely to have their poverty persisting compare to 32 per cent of households linked to small and medium sized enterprises. With any-time poverty, 43 per cent of households linked to micro firms are likely to be affected compared to 40 per cent for those linked to small and medium sized enterprises. Correspondingly, the proportion of households never in poverty stood at 57 per cent for households linked to micro firms compared to 60 per cent for those linked to small and medium sized firms. More households linked to small and medium sized firms appear to be exiting poverty at a faster rate of 8 per cent compared to households linked to micro firms that are exiting at 7 per cent over the period.

Figure 2:
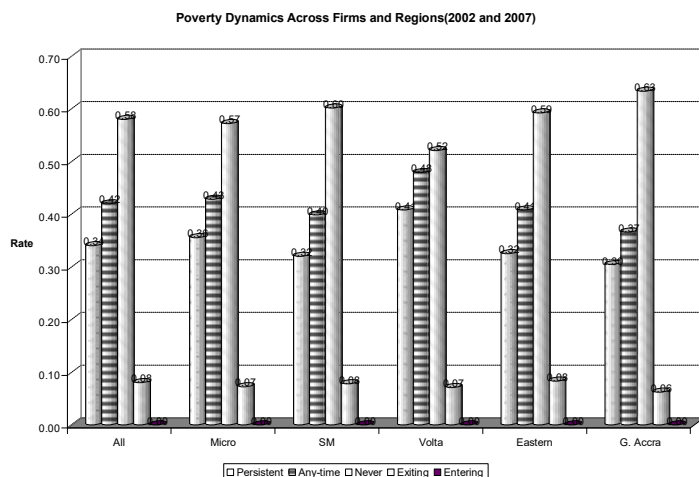
Also, we look closely at Figure 2 for the distribution of poverty among apparel manufacturing related households across the three regions. Among the three regions, poverty is more persistent in the Volta region measuring up to 41 per cent compared to 32 per cent for Eastern region and 30 per cent for Greater Accra region. The proportion of households never in poverty was 63 per cent for Greater Accra region, 59 percent for the Eastern region and 52 percent for the Volta region. Considering the rates at which households are lifting themselves out of poverty, the best performing region is Eastern with the rate of 8 percent followed by Volta region with 7 per cent and Greater Accra with 6 per cent. Across the three regions, there are not many households that appear to be entering poverty which is an encouraging sign that people are becoming less and less deprived in most of the attributes presented in Figure 1.

7.8 Summary and Conclusion

In this paper, we sought to estimate and analyze the incidence of poverty among households linked to apparel manufacturing jobs. We also focused on the sources of this deprivation. Dynamic assessment was also made across households. Deprivation among these households is quite high with poverty index for 140 households estimated to be 41.8 percent in 2002 but dropped to 34.2 percent in 2007. Food deprivation and income inadequacy have been established to be among the highest sources of poverty for these households in the apparel related jobs.

Other important sources of deprivation are inadequate personal capabilities including lack of formal education due to the fact that the apparel sub-sector is known to attract huge numbers of school drop-outs mostly female. Security attributes also ranked high among the crucial sources of poverty. These security attributes include insurance against any unforeseen health and business conditions as well high cost of living. Most of these households are also unable to own their own homes due to low incomes and high expenditure on food. However, they are able to rent houses and have made progress with respect to access to energy.

Between 2002 and 2007, we estimated that, on the average, poverty persisted among 34 per cent of the households in the sample and any-time poverty affects 42 per cent of the households. Households linked to small and medium sized firms were relatively less deprived than those connected to micro

firms. And among the three regions, the highest rate of deprivation occurred among households linked to firms in the Volta region. Those households connected to firms located in the Greater Accra region have been established to be relatively least deprived compared to those in the Eastern region.

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Appendix

Table 5: poverty index of the i-th household and population

Household h_i	2002 $\mu_D(h_i)$	2007 $\mu_D(h_i)$	Household h_i	2002 $\mu_D(h_i)$	2007 $\mu_D(h_i)$	Household h_i	2002 $\mu_D(h_i)$	2007 $\mu_D(h_i)$
1	0.45	0.31	48	0.62	0.48	95	0.35	0.39##
2	0.53	0.44	49	0.34	0.32	96	0.42	0.33
3	0.56	0.39	50	0.36	0.26	97	0.37	0.31
4	0.37	0.47##	51	0.21	0.22##	98	0.30	0.25
5	0.30	0.25	52	0.37	0.32	99	0.34	0.27
6	0.42	0.35	53	0.29	0.23	100	0.41	0.31
7	0.48	0.40	54	0.34	0.32	101	0.34	0.35##
8	0.39	0.43##	55	0.41	0.30	102	0.29	0.24
9	0.64	0.54	56	0.44	0.37	103	0.70	0.63
10	0.67	0.44	57	0.36	0.33	104	0.39	0.32
11	0.65	0.41	58	0.35	0.29	105	0.36	0.29
12	0.56	0.42	59	0.40	0.40	106	0.45	0.30
13	0.56	0.41	60	0.40	0.32	107	0.34	0.31
14	0.45	0.35	61	0.34	0.26	108	0.33	0.31
15	0.62	0.38	62	0.45	0.36	109	0.40	0.35
16	0.51	0.38	63	0.48	0.33	110	0.14	0.18##
17	0.48	0.36	64	0.52	0.37	111	0.46	0.34
18	0.53	0.38	65	0.44	0.34	112	0.37	0.31
19	0.47	0.29	66	0.46	0.29	113	0.36	0.30
20	0.39	0.29	67	0.45	0.38	114	0.27	0.25
21	0.44	0.30	68	0.35	0.27	115	0.28	0.23
22	0.77	0.51	69	0.41	0.32	116	0.32	0.29
23	0.62	0.43	70	0.47	0.35	117	0.32	0.21
24	0.61	0.33	71	0.49	0.30	118	0.33	0.31
25	0.43	0.33	72	0.54	0.42	119	0.20	0.25##
26	0.39	0.32	73	0.41	0.27	120	0.32	0.32
27	0.60	0.49	74	0.30	0.26	121	0.24	0.26
28	0.52	0.64##	75	0.39	0.31	122	0.40	0.35
29	0.65	0.56	76	0.35	0.29	123	0.38	0.32
30	0.60	0.44	77	0.34	0.32	124	0.35	0.28
31	0.40	0.42##	78	0.40	0.27	125	0.27	0.24
32	0.51	0.44	79	0.41	0.46##	126	0.41	0.43##
33	0.51	0.43	80	0.37	0.39##	127	0.26	0.21
34	0.44	0.38	81	0.42	0.36	128	0.32	0.13
35	0.48	0.39	82	0.40	0.39	129	0.34	0.25
36	0.48	0.44	83	0.34	0.21	130	0.33	0.28
37	0.48	0.39	84	0.35	0.36##	131	0.30	0.19
38	0.52	0.46	85	0.49	0.40	132	0.25	0.24
39	0.53	0.45	86	0.34	0.34	133	0.37	0.30
40	0.51	0.44	87	0.39	0.29	134	0.40	0.38
41	0.46	0.43	88	0.43	0.37	135	0.41	0.25
42	0.50	0.44	89	0.31	0.25	136	0.39	0.29
43	0.44	0.38	90	0.32	0.40##	137	0.41	0.35
44	0.58	0.47	91	0.39	0.33	138	0.40	0.32
45	0.43	0.40	92	0.35	0.35	139	0.35	0.28
46	0.45	0.34	93	0.37	0.32	140	0.39	0.32
47	0.46	0.31	94	0.42	0.24	Total (μ_D)	0.42	0.34

indicates households with increased deprivation

Table 6: Persistent of Poverty and Any-time Poverty across Households and Population

Household h_i	Persistent $\mu_D(h_i)$	Any-time $\mu_D(h_i)$	Household h_i	Persistent $\mu_D(h_i)$	Any-time $\mu_D(h_i)$	Household h_i	Persistent $\mu_D(h_i)$	Any-time $\mu_D(h_i)$
1	0.31	0.45	48	0.48	0.62	95	0.35	0.39
2	0.44	0.53	49	0.32	0.34	96	0.33	0.42
3	0.39	0.56	50	0.26	0.36	97	0.31	0.37
4	0.37	0.37	51	0.21	0.22	98	0.25	0.30
5	0.25	0.30	52	0.32	0.37	99	0.27	0.34
6	0.35	0.42	53	0.23	0.29	100	0.31	0.41
7	0.40	0.48	54	0.32	0.34	101	0.34	0.35
8	0.39	0.39	55	0.30	0.41	102	0.24	0.29
9	0.54	0.64	56	0.37	0.44	103	0.63	0.70
10	0.44	0.67	57	0.33	0.36	104	0.32	0.39
11	0.41	0.65	58	0.29	0.35	105	0.29	0.36
12	0.42	0.56	59	0.40	0.40	106	0.30	0.45
13	0.41	0.56	60	0.32	0.40	107	0.31	0.34
14	0.35	0.45	61	0.26	0.34	108	0.31	0.33
15	0.38	0.62	62	0.36	0.45	109	0.35	0.40
16	0.38	0.51	63	0.33	0.48	110	0.14	0.18
17	0.36	0.48	64	0.37	0.52	111	0.34	0.46
18	0.38	0.53	65	0.34	0.44	112	0.31	0.37
19	0.29	0.47	66	0.29	0.46	113	0.30	0.36
20	0.29	0.39	67	0.38	0.45	114	0.25	0.27
21	0.30	0.44	68	0.27	0.35	115	0.23	0.28
22	0.51	0.77	69	0.32	0.41	116	0.29	0.32
23	0.43	0.62	70	0.35	0.47	117	0.21	0.32
24	0.33	0.61	71	0.30	0.49	118	0.31	0.33
25	0.33	0.43	72	0.42	0.54	119	0.20	0.25
26	0.32	0.39	73	0.27	0.41	120	0.32	0.32
27	0.49	0.60	74	0.26	0.30	121	0.24	0.26
28	0.52	0.52	75	0.31	0.39	122	0.35	0.40
29	0.56	0.65	76	0.29	0.35	123	0.32	0.38
30	0.44	0.60	77	0.32	0.34	124	0.28	0.35
31	0.40	0.40	78	0.27	0.40	125	0.24	0.27
32	0.44	0.51	79	0.41	0.46	126	0.41	0.43
33	0.43	0.51	80	0.37	0.39	127	0.21	0.26
34	0.38	0.44	81	0.36	0.42	128	0.13	0.32
35	0.39	0.48	82	0.39	0.40	129	0.25	0.34
36	0.44	0.48	83	0.21	0.34	130	0.28	0.33
37	0.39	0.48	84	0.35	0.36	131	0.19	0.30
38	0.46	0.52	85	0.40	0.49	132	0.24	0.25
39	0.45	0.53	86	0.34	0.34	133	0.30	0.37
40	0.44	0.51	87	0.29	0.39	134	0.38	0.40
41	0.43	0.46	88	0.37	0.43	135	0.25	0.41
42	0.44	0.50	89	0.25	0.31	136	0.29	0.39
43	0.38	0.44	90	0.32	0.40	137	0.35	0.41
44	0.47	0.58	91	0.33	0.39	138	0.32	0.40
45	0.40	0.43	92	0.35	0.35	139	0.28	0.35
46	0.34	0.45	93	0.32	0.37	140	0.32	0.39
47	0.31	0.46	94	0.24	0.42	Total $\mu_D)$	0.34	0.42

Table 7: Household and the extent to which they were Never in Poverty, Exiting' Poverty and Entering Poverty (2002 and 2007)

Household	Never	Exiting	Entering	Household	Never	Exiting	Entering	Household	Never	Exiting	Entering
1	0.55	0.15	0.00	48	0.38	0.15	0.00	95	0.61	0.00	0.04
2	0.47	0.09	0.00	49	0.66	0.01	0.00	96	0.58	0.09	0.00
3	0.44	0.17	0.00	50	0.64	0.10	0.00	97	0.63	0.06	0.00
4	0.53	0.00	0.10	51	0.78	0.00	0.01	98	0.70	0.06	0.00
5	0.70	0.05	0.00	52	0.63	0.05	0.00	99	0.66	0.07	0.00
6	0.58	0.07	0.00	53	0.71	0.05	0.00	100	0.59	0.10	0.00
7	0.52	0.08	0.00	54	0.66	0.03	0.00	101	0.65	0.00	0.01
8	0.57	0.00	0.05	55	0.59	0.11	0.00	102	0.71	0.04	0.00
9	0.36	0.10	0.00	56	0.56	0.08	0.00	103	0.30	0.08	0.00
10	0.33	0.23	0.00	57	0.64	0.03	0.00	104	0.61	0.07	0.00
11	0.35	0.24	0.00	58	0.65	0.06	0.00	105	0.64	0.07	0.00
12	0.44	0.14	0.00	59	0.60	0.00	0.00	106	0.55	0.15	0.00
13	0.44	0.15	0.00	60	0.60	0.08	0.00	107	0.66	0.04	0.00
14	0.55	0.10	0.00	61	0.66	0.09	0.00	108	0.67	0.01	0.00
15	0.38	0.24	0.00	62	0.55	0.09	0.00	109	0.60	0.06	0.00
16	0.49	0.13	0.00	63	0.52	0.16	0.00	110	0.82	0.00	0.04
17	0.52	0.13	0.00	64	0.48	0.14	0.00	111	0.54	0.11	0.00
18	0.47	0.15	0.00	65	0.56	0.10	0.00	112	0.63	0.06	0.00
19	0.53	0.18	0.00	66	0.54	0.17	0.00	113	0.64	0.06	0.00
20	0.61	0.11	0.00	67	0.55	0.07	0.00	114	0.73	0.02	0.00
21	0.56	0.14	0.00	68	0.65	0.08	0.00	115	0.72	0.05	0.00
22	0.23	0.26	0.00	69	0.59	0.09	0.00	116	0.68	0.03	0.00
23	0.38	0.19	0.00	70	0.53	0.12	0.00	117	0.68	0.10	0.00
24	0.39	0.27	0.00	71	0.51	0.19	0.00	118	0.67	0.02	0.00
25	0.57	0.10	0.00	72	0.46	0.12	0.00	119	0.75	0.00	0.05
26	0.61	0.06	0.00	73	0.59	0.13	0.00	120	0.68	0.00	0.00
27	0.40	0.10	0.00	74	0.70	0.05	0.00	121	0.74	0.00	0.02
28	0.36	0.00	0.12	75	0.61	0.08	0.00	122	0.60	0.05	0.00
29	0.35	0.09	0.00	76	0.65	0.06	0.00	123	0.62	0.05	0.00
30	0.40	0.16	0.00	77	0.66	0.02	0.00	124	0.65	0.07	0.00
31	0.58	0.00	0.02	78	0.60	0.13	0.00	125	0.73	0.03	0.00
32	0.49	0.07	0.00	79	0.54	0.00	0.05	126	0.57	0.00	0.03
33	0.49	0.07	0.00	80	0.61	0.00	0.02	127	0.74	0.05	0.00
34	0.56	0.05	0.00	81	0.58	0.06	0.00	128	0.68	0.19	0.00
35	0.52	0.10	0.00	82	0.60	0.01	0.00	129	0.66	0.09	0.00
36	0.52	0.04	0.00	83	0.66	0.13	0.00	130	0.67	0.06	0.00
37	0.52	0.09	0.00	84	0.64	0.00	0.02	131	0.70	0.11	0.00
38	0.48	0.06	0.00	85	0.51	0.09	0.00	132	0.75	0.02	0.00
39	0.47	0.09	0.00	86	0.66	0.00	0.00	133	0.63	0.07	0.00
40	0.49	0.07	0.00	87	0.61	0.10	0.00	134	0.60	0.02	0.00
41	0.54	0.03	0.00	88	0.57	0.06	0.00	135	0.59	0.15	0.00
42	0.50	0.07	0.00	89	0.69	0.06	0.00	136	0.61	0.10	0.00
43	0.56	0.07	0.00	90	0.60	0.00	0.08	137	0.59	0.06	0.00
44	0.42	0.12	0.00	91	0.61	0.05	0.00	138	0.60	0.08	0.00
45	0.57	0.02	0.00	92	0.65	0.00	0.00	139	0.65	0.08	0.00
46	0.55	0.10	0.00	93	0.63	0.05	0.00	140	0.61	0.07	0.00
47	0.54	0.15	0.00	94	0.58	0.17	0.00	**All**	**0.58**	**0.08**	**0.00**