

## Measurement of Poverty Intensity in Khuzestan Province During 1997-2006

Seyyed Mortaza Afghah (Ph.D.) and Talea Ghanavatifat (M.Sc.)\*

Received: 2009/5/30

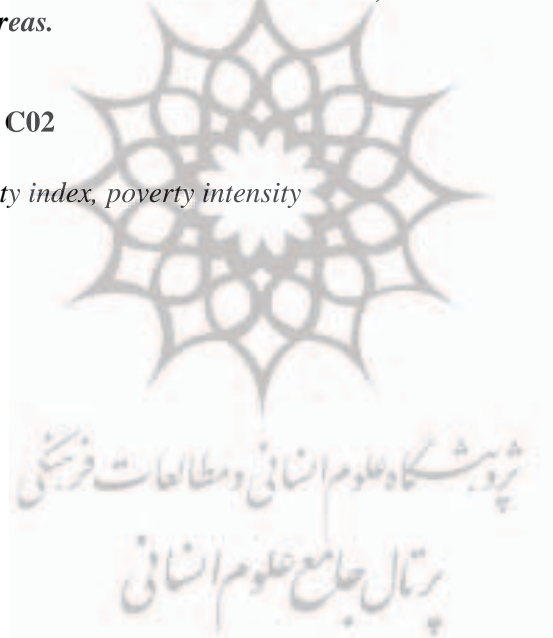
Accepted: 2009/9/15

### **Abstract:**

*Considering the importance of poverty in economic development issues, it is tried to estimate poverty intensity and examine its trend via using an applied index called SST. This index belongs to the family of decomposable indices and shows the poverty intensity in terms of the product of its components: poverty rate, average poverty gap ratio of the poor and Gini index of poverty gap ratio of the population. This decomposition makes possible for the researcher to follow the source of changes in poverty intensity via changes in its components. The results reveal that the SST index has increased during 1997–2006 both in urban and rural areas of the province. Also, the increase in the urban areas, is much more than the increase in rural areas.*

**JEL classification:** C02

**Keywords:** Poverty index, poverty intensity



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\* Assistant professor and graduate student of economics at Shahid Chamran University, respectively, Ahvaz, Iran. Email: ([smafghah1@yahoo.com](mailto:smafghah1@yahoo.com))

## 1. Introduction

Poverty has been the main issue for many social scientists and international organization over last decades. Many developed and developing countries have introduced anti-poverty strategies followed by comprehensive research and studies. Supported by World Bank, United Nations and International Monetary Fund, these countries have implemented variety of activities to tackle poverty.

Gathered in 2000, 189 world leaders concentrated on poverty elimination and supporting human rights for world countries in new millennium that led to publishing Millennium Development Goals (MDG). They introduced an eight goal program for world societies to be performed in following years. The first goal of the program is “Eradication of extreme poverty and hunger” that advised countries to perform measures to half number of people with less than \$ 1 per day and those suffering from starvation by 2015.

Concentrating on poverty eradication and increasingly welfare level, policy makers in Iran promoted several socio-economic plans. Furthermore, various academic and official studies have been performed. Some of these studies tackled poverty line and poverty indices as a whole while others concentrated on some particular provinces. Calculating poverty line in all provinces helps policy makers to allocate resources in more efficient conditions specially concern with the regions that are socio-economically in critical conditions.

In this paper, thus, it is tried to calculate poverty line and poverty intensity in Khuzestan province. Similar to many related studies, to estimate poverty intensity, it was necessary to calculate poverty line. The next step was measuring poverty index based on two main features: 1) being justifiable in theory; and 2) being understandable by policy makers. To meet these two features, therefore, SST approach was employed to estimate poverty intensity.

## 2. Research Hypotheses:

- It seems that poverty intensity in Khuzestan province (both urban and rural areas) has increased during 1997 to 2006.
- It seems that poverty intensity in urban areas of Khuzestan province has vastly increased compared with rural areas in the research period.

## 3. Ideal characteristics for a poverty intensity Index

An ideal poverty index should be symmetrically replication. That is, the value of the poverty index for the combination of two identical populations is the same as the value of the poverty index for each of the two populations. An ideal poverty index should also be a continuous function of individual incomes. Furthermore, it takes a higher value when a transfer happens from a poor individual to a rich one. Regarding these characteristics, Shorrocks (1995) suggested a modified Sen Index to estimate the poverty intensity. Zheng (1997) argued that this modification is identical to the limit of Thon's modified Sen Index. Thus, this index is called Sen-Shorrocks-Thon or SST index (Xu, 1998).

The SST index is symmetrically replication, continuous in individual incomes, homogeneous of degree zero in individual incomes and relative poverty line. It is consistent with the transfer axiom (that an acceptable measure of poverty should always increase if resources are taken from poor people and given to richer ones). It is conventional for the values of an index ranging between zero and one to have a logical geometric interpretation (Xu, 1998).

## 4. SST Index and It's Decomposition

The SST index and its components are very useful in economic studies but the relation between this index and its components should be explained in more details. If the average poverty gap ratios and the Gini index of poverty gap ratios are not estimated properly, the results cannot be reliable and most probably are not efficient (Xu and Osberg, 2001).

In most studies, it is argued that the poverty rate (Head-Count ratio) and the average poverty gap ratio of the poor (the income gap ratio) violate some important axioms (transfer axiom in particular) of an ideal poverty index. Clearly, these axioms play essential roles in poverty measurements.

Although neither poverty rate and poverty gap is separately a suitable measurement for poverty evaluation, both together, are capable of explaining poverty level.

Based on SST decomposition performed by Osberg-Xu and empirical and regional evidence during 1997, 1998 and 2000, cumulative percentage of changes in poverty gap and average poverty gap ratios reflect almost all of the percentage changes in poverty intensity over time (Osberg and Xu, 2001).

Due to the importance of SST index and its decomposition, it is necessary to explain them in more details.

Suppose incomes ( $y_i$ 's) for a population of size  $n$  sorted ascending so that  $y_1 \leq y_2 \leq \dots \leq y_n$ . If the poverty line of the population is considered as  $z$  and the number of people whose income are lower than poverty line as  $q$ , so for the  $i$ 'th person ( $i = 1, \dots, n$ ) the poverty gap ratio ( $x_i$ ) is defined as:

$$x_i = \frac{z - y_i}{z} \quad \text{if} \quad \frac{z - y_i}{z} \geq 0 \quad (1)$$

$$x_i = 0 \quad \text{if} \quad \frac{z - y_i}{z} \leq 0 \quad (2)$$

As is seen, the poverty gap ratio is zero for those who are not poor. Shorrocks (1995), then, suggested SST index of poverty intensity as:

$$P(y; z) = \frac{1}{n^2} \sum_{i=1}^n (2n - 2i + 1) \frac{z - y_i}{z} \quad (3)$$

or

$$P(y; z) = \frac{1}{n^2} \sum_{i=1}^n (2n - 2i + 1) x_i. \quad (4)$$

Here  $p(y; z)$  is the SST index.

Also, Shorrocks (1995) indicates the following:

$$P(y; z) = \mu(x)(1 + G(x)) \quad (5)$$

where  $\mu(x)$  and  $G(x)$  are the average of poverty gap ratio and the Gini index, respectively, for the distribution of poverty gap ratios.

The average of poverty gap ratios is defined by:

$$\mu(x) = \frac{1}{n} \sum_{i=1}^n x_i \quad (6)$$

Equation (6) can be broken down into poverty rate

$$H = \frac{q}{n} \quad (7)$$

and average poverty gap ratio of the poor (income gap ratio):

$$I = \frac{1}{q} \sum_{i=1}^n x_i \quad (8)$$

Furthermore, Shorrocks has employed equality of poverty gap ratios of population  $(1 + G(x))$  to estimate SST index. Here  $G(x)$  is defined as:

$$G(x) = 1 - \sum_{i=1}^n \left( \frac{1}{n} \right) \left( \frac{\sum_{j=1}^i x_j + \sum_{\substack{i \geq 2 \\ j=2}}^i x_{j-1}}{n\mu(x)} \right) \quad (9)$$

or

$$G(x) = 1 - \frac{1}{n^2 \mu(x)} \sum_{i=1}^n (2n - 2i + 1)x_i \quad (10)$$

that  $x_i$ 's are sorted ascending like  $x_1 \leq x_2 \leq \dots \leq x_n$ .

Consequently, the equation (5) can be developed as:

$$P(y; z) = HI(1 + G(x)) \quad (11)$$

Thus, the poverty intensity contains the poverty rate ( $H$ ), the average poverty gap ratio of the poor ( $I$ ), and the measure of the inequality of the poverty gap ratios of the population ( $1 + G(x)$ ). This decomposition enables economists to analyze the right sources of a change in the value of poverty intensity based on changes in each of these components over time. Thus, taking the natural logarithm of both sides of equation (11) results:

$$\ln P(y; z) = \ln H + \ln I + \ln(1 + G(x)) \quad (12)$$

where  $\Delta \ln(1+G(x))$  is an approximation of  $\Delta G(x)$  based on the first-order Taylor series expansion. Let  $\Delta A = A - A_{-1}$ , where  $A_{-1}$  is the amount of  $A$  at the previous period. Rewriting the equation (12), we have:

$$\Delta \ln P(y; z) = \Delta \ln H + \Delta \ln I + \Delta \ln(1+G(x)) \quad (13)$$

where  $\Delta \ln(1+G(x))$  is an approximation of  $\Delta G(x)$ . Equation (13) shows that the changes percentage in  $p(y; z)$  is the sum of the changes percentage in  $H$ ,  $I$  and  $G(x)$  (Xu and Osberg, 2001).

## 5. Literature review

A review on internal issues shows a wide range of academic studies on topic. Bagheri and Kavand (2006), for instance, have used SST index to estimate poverty line in Iran for years 2003 and 2004. Given a daily consumption of at least 2300 calories, they have calculated a poverty line for both urban and rural areas. Using data from Statistics Center of Iran and based on minimum necessary calories for a person (2300), they first estimated poverty line for urban and rural areas, then, measured SST index and estimated its three components, i.e. poverty rate, average poverty gap ratio of the poor and Gini index of poverty gap ratio of the population. The results revealed that poverty intensity increased from 5.9% in 2003 to 7% in 2004 that is 17% growth in poverty intensity in two years. SST components reveal that poverty rate had the main effect on the calculated poverty intensity.

In rural areas, however, poverty intensity decreased from 4.9% in 2003 to 4% in 2004. The reduction of poverty intensity in rural areas was due to the decrease in both poverty rate and poverty gap ratio of the poor.

There are also plenty of studies on topic at international level. Xu (1998), for instance, has examined poverty intensity using SST index for years 1969, 1979 and 1988 in the United States. First, he reviewed theoretical context of SST index, and concluded that this index had been developed during previous decades especially due to the features that an ideal poverty index has to have. He also suggested a useful geometric interpretation.

Furthermore, he accepted that this index was symmetric, monotonic, continuous, homogeneous of zero degree in incomes and poverty line and consistent with the transfer axiom.

In his research, Xu, employed per capita income (before tax-paying) and Panel Study of Income Dynamics (PSID) of the United States of America data to calculate SST index. Xu's research is also based on poverty line that was calculated by Smeeding (1991), though he devoted parts of his research to estimate poverty line. Based on Smeeding approach, the poverty line is the same as 50% of income median. Thus, Xu computed SST index for years 1996, 1979 and 1988 that were 12.01%, 13.35% and 15.57% respectively. As is shown, the poverty intensity in the United State has been increased during the research period.

Osberg and Xu (1999) used half the median of an income as relative poverty line and estimated the Sen-Shorrocks-Thon measure of poverty intensity in Canadian provinces for 1984, 1989 and 1991-1996. The outcomes show that poverty intensity decreased in Ontario in late 1980 to the level that is in North Europe, while increased significantly in 1994. This change was due to a development in government social security supports in 1980 and a cut in 1994 respectively. However, Prince Edward Island had a better performance in poverty intensity reduction.

At the national level, though, the poverty intensity decreased during 1980 decade but increased again from 1994 onwards.

In their case study about China, Osberg and Xu (2008), preferred to use relative poverty tool like 50% of income median compared with absolute poverty criteria, i.e. \$ 1 per day per person. They, then, employed Chinese Household Income Projected (CHIP) data to calculate SST index in 1995. They focused on rural areas of some provinces. They disregarded Beijing due to lack of enough rural population. The results showed vast changes in SST index and its three components. The poverty rate in rural areas changed between 61.9% and 9.7%. The scope of average changes in poverty gap was between 38.9 and 7 percent. This large variation is comparable with the

variation in poverty gap that is between 1.567 and 1.962. However, based on Gini index plus one across the rural areas of Chinese provinces the variation was relatively large compared with similar data observed in developed countries, while was small if poverty rate or poverty gap is based for comparison.

## **6. Interpretation of SST Index and its components**

The scope of SST index is ranging between zero and one. Larger values indicate more poverty intensity and vice versa.

### **6.1. Poverty Rate:**

This index is also between zero and one. Zero indicates a condition in which there are no people in society and on the opposite side one means that all people in the society are poor. Therefore, more poverty rate means there should be more poor people in the society.

### **6.2. Average poverty gap ratio of the poor:**

Average poverty gap ratio of the poor reflects the depth of poverty in society. The larger value of this index indicates more poverty in the society.

### **6.3. Gini Index for the poverty gap ratio:**

This Gini index measures inequality among poor and, like other indices in this research, is between zero and one. Zero reflects a condition of full equality among poor while one shows maximum inequality among poor.

## **7. Method of estimating SST Index**

The necessary data -income and expenditure of rural and urban households- were collected from Statistics Center of Iran. To estimate poverty intensity, the absolute poverty line is employed that is defined as the minimum level of calorie per day per person in Iran (2300). Furthermore, to calculate SST components, total household expenditures are employed. The area of this research is rural and urban households in Khuzestan Province for the period of 1997 to 2006.



To start estimating poverty intensity index, the total annual expenditures of the sample were divided by the dimension of household to calculate per capita expenditure. The outcomes, then, were divided by 12 (months) to reach total monthly per capita expenditure.

Now the computed poverty line could be compared with the household expenditures and thus poverty rate can be estimated. Applying the formula explained in section four, the average poverty gap ratio of the poor and Gini index for population are then estimated. Having computed all related components, i.e. average poverty gap ratio, poverty rate and the Gini plus one index of poverty gap ratio of population, the poverty intensity was estimated. The outcomes are revealed in tables 1 and 2.

### **8. Results and interpretation of urban areas of Khuzestan province**

As is shown in table 1, poverty intensity in urban areas has increased from 3.35% in 1997 to 7.2% in 1998. A review on SST components reveals that the increase in poverty intensity is due mostly to an increase in poverty line; from 6.95% to 13.48% and to poverty gap, from 24.6% to 27.94%. In other words, the 66.24% increase in poverty rate and 12.73% increase in poverty gap are accountable for the increase in poverty intensity. However, the Gini plus one index has a small decrease from 1.95 to 1.91 showing that this index



**Table 1: SST index and its components, percentage changes in SST index**  
Based on: Researcher's Calculations

Urban	SST	SST's Components			Changes in SST index and it's components			
		H	I	1+G(x)	$\Delta\ln(\text{SST})$	$\Delta\ln(\text{H})$	$\Delta\ln(\text{I})$	$\Delta\ln(1+\text{G}(x))$
1997	0.0335	0.0695	0.246	1.9566				
1998	0.072	0.1348	0.2794	1.9128	0.765121	0.662465	0.1273129	-0.0226401
1999	0.0691	0.1485	0.2433	1.9119	-0.04111	0.096793	-0.138349	-0.0004706
2000	0.1516	0.2478	0.3334	1.8353	0.785691	0.512037	0.3150477	-0.0408896
2001	0.1566	0.2776	0.3113	1.8117	0.032449	0.113559	-0.068586	-0.0129423
2002	0.1719	0.3653	0.2676	1.758	0.093218	0.274538	-0.151264	-0.0300888
2003	0.2698	0.5269	0.3095	1.6544	0.450768	0.366292	0.1454648	-0.0607384
2004	0.2286	0.4077	0.3218	1.7424	-0.16571	-0.25648	0.0389721	0.05182507
2005	0.1795	0.3778	0.2694	1.7632	-0.2418	-0.07617	-0.177733	0.01186687
2006	0.3246	0.525	0.3771	1.6398	0.592418	0.329033	0.3363131	-0.0725561

has had no significant effect on SST index during 1997 and 1998.

A comparison between years 1999 and 1998 shows a minor reduction in poverty intensity from 7.2% to 6.91% that seems to be mostly due to a decrease in poverty gap from 27.94% to 24.33% and the minor decrease in one plus Gini index means that its impact on poverty intensity can be ignored. However, the small increase in poverty rate from 13.48% to 14.85% reveals that it has no effect on poverty intensity during the two years.

The data for years 2000 to 2003 reveals an increasing trend in poverty intensity. The most responsible factor for this trend is poverty rate as is shown in table 1. However, the reduction in the one plus Gini index has no significant effect on the increase of poverty intensity.

Decrease in SST index from 22.86% in 2004 to 17.95% in 2005 is seemingly a reflection of the reduction in both poverty rate and average poverty gap; i.e. from 40.77% to 37.78% and from 32.18% to 26.94% respectively. The equality index, again, has no significant effect on poverty intensity reduction.

Finally, the SST index in 2006 reveals a relatively sharp increase compared with SST index in 2005 from 17.95% to 32.46%. Increase in both poverty rate (from 37.78% to 52.5%)

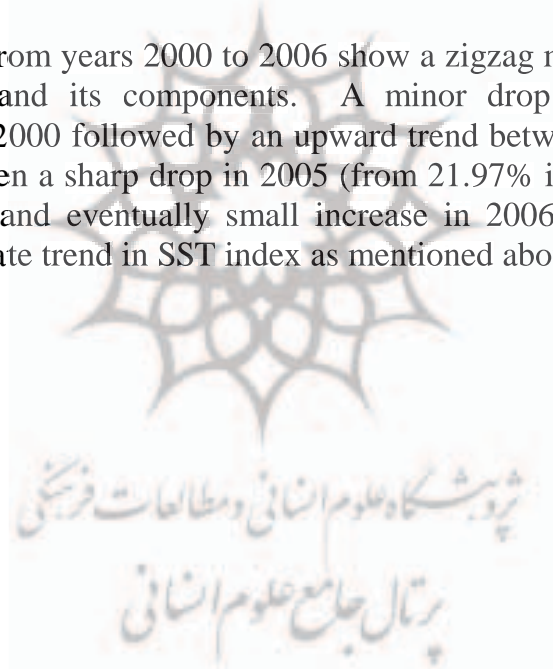
and poverty gap ratio of the poor (from 26.94% to 37.71%) are the main reason for the SST increase. There is also a 7.25% reduction in the one plus Gini index of poverty gap of population that shows no impact on SST increase.

### **9. Results and interpretation of rural areas of Khuzestan province**

As is shown in table 2, the increase in poverty intensity from 14.35% in 1997 to 30.24% in 1998 is mostly due to increase in both poverty rate and average poverty gap ratio of the poor. However, Gini index plus one has no effect on poverty intensity increase.

A comparison between years 1999 and 1998 reveals a sharp decrease in poverty intensity that seems to be a reflection of a distinct drop in both poverty rate and average poverty gap ratio (from 52.13% to 09.91% and from 35.52% to 17.6% respectively). Again, the one plus Gini index has no impact on SST reduction.

The results from years 2000 to 2006 show a zigzag movement in SST index and its components. A minor drop in 2001 compared with 2000 followed by an upward trend between years 2000 to 2004 then a sharp drop in 2005 (from 21.97% in 2004 to 8.4% in 2005) and eventually small increase in 2006 shows a relatively fluctuate trend in SST index as mentioned above.



**Table 2:** SST index and its components, Percentage changes in SST index Based on: Researcher's Calculations

Rural	SST	SST's components			Changes in SST index and it's components			
		H	I	1+G(x)	$\Delta\ln(\text{SST})$	$\Delta\ln(\text{H})$	$\Delta\ln(\text{I})$	$\Delta\ln(1+G(x))$
1997	0.1435	0.3093	0.2576	1.801				
1998	0.3024	0.5213	0.3552	1.6333	0.745416	0.522014	0.321273	-0.0977396
1999	0.0338	0.0991	0.176	1.9392	-2.19129	-1.6602	-0.702197	0.17167301
2000	0.1472	0.3207	0.2556	1.7958	1.471331	1.174377	0.3731297	-0.0768249
2001	0.1371	0.3136	0.2205	1.9828	-0.07108	-0.02239	-0.147716	0.09905938
2002	0.1534	0.3517	0.245	1.7802	0.112338	0.11466	0.1053605	-0.1077843
2003	0.2178	0.4636	0.2758	1.7036	0.350528	0.276244	0.1184178	-0.0439821
2004	0.2197	0.441	0.2917	1.7076	0.008686	-0.04998	0.0560499	0.00234522
2005	0.084	0.1795	0.2487	1.8817	-0.96145	-0.89887	-0.159479	0.09708675
2006	0.1711	0.3614	0.2676	1.769	0.711431	0.69981	0.073246	-0.0617612

### 10. Geometric Interpretation of SST Index

In this section, an example is applied to explain how to decompose SST index and how it can be presented via geometric interpretation. Suppose we have the following data sorted in ascending order, i.e.  $y_1=3$ ,  $y_2=9$ ,  $y_3=11$  and  $y_4=15$  and poverty line  $z$  is supposed to be 10 in this example. The computed poverty gap using equations (1) and (2) are  $x_1=0.7$ ,  $x_2=0.1$ ,  $x_3=0$  and  $x_4=0$ . Thus, the SST index is computed as follows:

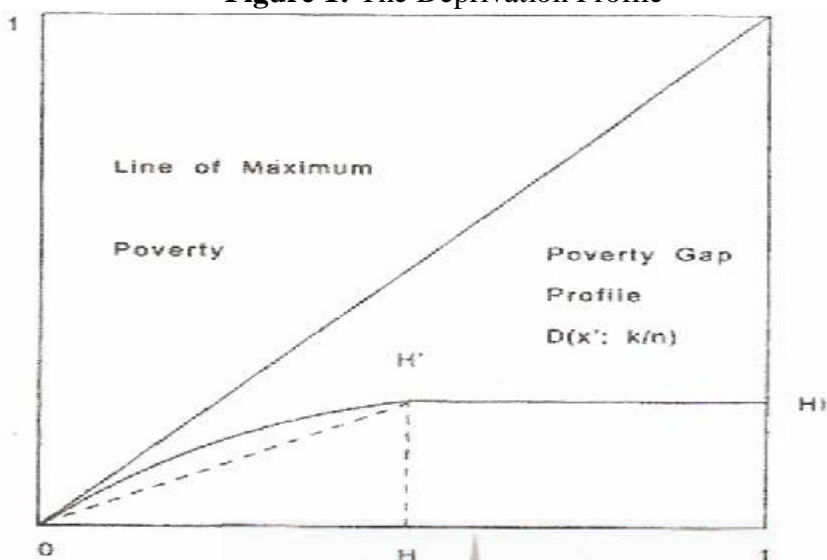
$$\begin{aligned}
 P(y; z) &= \frac{1}{n^2} \sum_{i=1}^n (2n - 2i + 1)x_i \\
 &= \frac{1}{16} (7(0.7) + 5(0.1)) \\
 &= 0.3375
 \end{aligned}$$

Like the Gini index, the SST index also has a simple geometric interpretation. The deprivation profile is a function of  $k/n$  for a given data series of  $x'$ :

$$D(x'; \frac{k}{n}) = \frac{1}{n} \sum_{i=1}^k x_i$$

Where  $x'$  refers to the sequence of  $x_i$ 's arranged in descending order.

**Figure 1: The Deprivation Profile**



Based on: Xu and Osberg (2001)

As is shown in Figure 1, the deprivation profile curve starts from the origin and reaches  $H'$ , then it becomes horizontal. The point  $H$  indicates the poverty rate and the point  $HI$  shows the average poverty gap ratio of the population. The average poverty gap ratio of the poor,  $I$ , is represented by the slope of dotted line  $OH'$  because  $HI/H = I$ .

The arc  $OH'$  is similar to the Lorenz curve. The degree that the arc  $OH'$  deviates from the dotted  $OH'$  implies the degree of inequality of deprivation values. Therefore, the SST index can be shown as the ratio of the area under poverty gap profile to the area under the line of maximum poverty (the 45 degree line) as is shown in Figure 1.

For the same data set, the poverty rate is  $H = 0.5$ , the average poverty gap ratio of the poor is  $I = 0.4$ , and the average poverty gap ratio of the population is  $\mu(x) = 0.2$ . Based on the equation (9), the Gini index is given by:

$$G(x) = 1 - \sum_{i=1}^n \left( \frac{1}{n} \right) \left( \frac{\sum_{j=1}^i x_j + \sum_{\substack{i \geq 2 \\ j=2}}^i x_{j-1}}{n\mu(x)} \right)$$

$$= 1 - \frac{1}{4} \left( \frac{0.1 + 0.9}{0.8} \right)$$

$$= 0.6875$$

So

$$P(y; z) = HI(1 + G(x))$$

$$= (0.2)(1 + 0.6875)$$

$$= 0.3375$$

As equations (4) and (11) reveal, the results are identical. Thus, the SST index computed directly from equation (4) is equivalent to that computed indirectly by the product of its three decomposed components (Xu and Osberg, 2001).

## 11. Conclusion

As the main socio-economic issue in Iran during last decades, poverty and related issues have been at the core of many academic studies. Not only poverty at the national level is an important issue but also differences between the scope and depth of poverty in various provinces are of concern in many academic studies. In this paper, we tried to compute poverty intensity using SST approach that seems to be the most reliable approach by now.

The results from the data analyzing in this paper reveal that the poverty intensity in urban areas of Khuzestan province has had a sharp increase from 3.35% in 1997 to 32.46% in 2006. Thus, the first hypothesis of the present research is not rejected.

To examine the reason for such drastic increase, the components of poverty intensity index are also calculated. The outcomes show that the increase of poverty rate from 6.95% in 1997 to 52.5% in 2006 in the one hand and the growth of poverty gap ratio of the poor from 24.6% in 1997 to 37.71% in 2006, on

the other hand are the most effective factors for SST increase during the study period. However, the decline of the one plus Gini index from 1.9866 to 1.63398 shows that this index has had no significant role on the SST index increases during study period.

A quick review of the computed data shows that the maximum value of urban poverty intensity is 32.46% in 2006 compared with the previous year (2005) that is 17.95% and shows an 80% growth.

Like urban areas (though lesser), the amount of SST index in rural areas has increased from 14.33% in 1997 to 17.11% in 2006, indicating that the first hypothesis is not rejected. Furthermore, the SST in rural areas during the study period shows lesser changes compared with urban area that is 19% growth in rural SST index in the same period. Thus, the second hypothesis is not rejected.

A review on the components of rural SST index reveals that both poverty rate and poverty gap ratio of the poor have increased from 30.93% to 36.14% and from 25.76% to 26.76% respectively) during the study period and thus are responsible for the mentioned increase in SST index. Like previous analysis, however, the decrease in the one plus Gini index during the study period shows that this index has had no effect on the SST index changes.

The highest value of SST index during the study period 30.24% in 1998 shows that, again, it is affected by increase in both poverty rate and poverty gap ratio in 1998 compared with 1997.

In general, the research results show deterioration in socio-economic condition of Khuzestan province population during the study period. Due to economic condition of Khuzestan province that has seemingly attracted most of the investments in four economic sections (agriculture, industry, service and oil), the above results seem to be somehow inexplicable. Thus, more studies in this area are needed to examine the reason(s) for this dilemma condition.

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