The Sen-Shorrocks-Thon Index of Poverty Intensity

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The Sen-Shorrocks-Thon (SST) index is an index of poverty intensity. It is also called the modified Sen index of poverty intensity. This index is proposed by Shorrocks (1995) as an extension of the Sen (1976) index. As noted by Zheng (1997), the resulting index is consistent with the limit of another index proposed by Thon (1979). Because of this interesting intellectual history, Xu (1998) calls this index the Sen-Shorrocks-Thon (SST) index. Now it is one of the widely used indicators of poverty in a society (see Haughton and Khandker, 2009, pp. 74-76). The SST index measures poverty *incidence*, *depth*, and *inequality* jointly and hence is a comprehensive poverty measure. In addition, this index can be decomposed into its constituting parts transparently.

According to Osberg and Xu (1999, 2000) and Xu and Osberg (2002), the SST index of poverty intensity can be calculated as the product of three poverty measures during a certain period of time: (1) poverty rate, (2) average poverty gap, and (3) 1 plus Gini coefficient of poverty gaps *for the population*:

SST index = (poverty rate) ×(average poverty gap) × (1 + Gini coefficient of poverty gaps for the population).

The first measure of the SST index defined above is the poverty rate (or the head count). It is the proportion or percentage of the population whose incomes are below a predetermined poverty line. This measure provides the information on poverty *incidence* or shows how wide spread poverty occurs in a society. The higher the poverty rate is, the more people suffer from poverty in a society.

The second measure is the average poverty gap (or simply the poverty gap) of the poor. The average poverty gap is the average income shortfalls below the poverty line as the percentages of the poverty line for the poor. In the population, the poor have positive poverty gaps while the non-poor have zero

poverty gaps. Because the average poverty gap is only for the poor, this measure provides the information on poverty *depth* of the poor or show how deep poverty occurs among the poor. The higher the average poverty gap is, the deeper the poor are in poverty.

The third measure is 1 plus Gini coefficient of poverty gaps *for the population*. Here the Gini coefficient is calculated for non-zero and zero poverty gaps. Unlike the Gini coefficient for incomes for the population which measures *income inequality*, the Gini coefficient of poverty gaps for the population measures *poverty inequality* in a society. Therefore, the higher this Gini coefficient is, the higher poverty inequality the society faces. Adding 1 to this Gini coefficient does not change the nature of, the information provided by, this Gini coefficient.

The above multiplicative decomposition of the SST index is a simplification proposed by Osberg and Xu (1999, 2000) and further explained by Xu and Osberg (2002). This multiplicative decomposition shows that the SST index measures jointly poverty *incidence*, *depth*, and *inequality*.

The original expression of the SST index proposed by Shorrocks (1995) is a mathematical equation which links more closely to the Sen (1976) index. Prior to Sen's (1976) proposal, most analysts focused on the poverty rate and/or the average poverty gap. However, Sen (1976) notes that these poverty measures have undesirable properties and, in some cases, may lead to unreasonable policy choices. For example, to reduce the poverty rate, the policy maker could enhance the income levels of those who are least in poverty. For example, to reduce the relative poverty gap, the policy maker may provide social assistance to all poor people equally or arbitrarily without thinking of their different income levels and hence their different needs. All of the above possible policy choices are not sound but they do bring down poverty measured by the poverty rate and/or the average poverty gap.

The key part of Sen's (1976) proposal is that he proposes a set of sound axioms for designing poverty measures. In particular, his proposal emphasizes the importance of the distributional aspect of incomes and income shortfalls. The theorist should design poverty measures that are consistent with a set of sound axioms. Hence Sen (1976) proposes the Sen index of poverty intensity.

Shorrocks (1995) shows that the SST index and the Sen index are closely related but the SST index has more desirable properties. The Sen index does not satisfy the strong upward transfer and continuity axioms but the SST index does. The strong upward transfer axiom says that that a regressive transfer from a poor person to a rich person must always cause a poverty measure to fall even if, in the process, the beneficiary crosses the poverty line. The continuity axiom says that a poverty measure must vary continuously with incomes. This axiom ensures that a poverty measure is a well behaved function of incomes and does not have unwanted jumps.

Although as the SST index, the Sen index of poverty intensity in its original form is not formulated as the product of poverty incidence, depth, and inequality, Xu and Osberg (2002) show that the Sen index also measures these three dimensions of poverty jointly: (1) poverty rate, (2) average poverty gap, and (3) 1 plus Gini coefficient of poverty gaps *for the poor*:

Sen index = (poverty rate) × (average poverty gap) × (1 + Gini coefficient of poverty gaps for the poor).

Clearly, the Sen index differs from the SST index because it uses the Gini coefficient for poverty gaps for the poor whereas the SST index uses the Gini coefficient for the whole population.

Xu and Osberg (2002) also show that based on the Sen index and two of its constituting components (poverty rate and average poverty gap), one can always compute the SST index from the Sen index as follows:

SST index = (poverty rate) × (Sen index) + 2 × (poverty rate) × (1 – poverty rate) × (average poverty gap).

While calculating the SST index and Sen index using micro survey data with sampling weights is transparent, it is relatively straightforward to use the bootstrap method to compute the standard errors for the SST and Sen indices and their constituting components for the purpose of statistical inferences (Osberg and Xu, 1999, 2000).

Because the SST index is the product of the poverty rate, poverty gap, and 1 + Gini coefficient of poverty gaps for the population, the percentage change in the SST index over time (ΔSST index) can be expressed as the sum of the percentage changes of its constituting parts over time (Δ (poverty rate), Δ (average poverty gap), and Δ (1 + Gini coefficient of poverty gaps for the population)) (Osberg and Xu, 1999):

ΔSST index = Δ (poverty rate) + Δ (average poverty gap) + Δ (1 + Gini coefficient of poverty gaps for the population).

Some empirical studies on the percentage change of the SST index over time (Osberg & Xu, 1999, 2000, 2008) find that the percentage change of 1 + Gini coefficient is often very small while the percentage changes of poverty rate and poverty gap are often large. Because of this empirical observation, Osberg and Xu (2008) propose the use of *the poverty box* in a unity box to better communicate with the public about main contributing factors to changes in poverty intensity. The poverty rate is illustrated by the poverty box width (on the horizontal axis) while the poverty gap is shown by the poverty box height (on the vertical axis). The overall poverty intensity is roughly indicated by the size (or area) of the poverty box. If a study involves multiple periods, the researcher can trace the changes of poverty boxes over time to infer the changes in overall poverty intensity (box size changes) and in poverty rate and gap (box width and height changes) over time.

Cross-References:

Poverty

Poverty measurement

Poverty lines

Sen index

Poverty rate

Head count

Poverty gap

Poverty box

Gini coefficient

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