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INCOME INEQUALITY AND ITS EFFECT ON MASS VIOLENCE

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The size distribution of income, or income inequality, has long been of a concern to scholars in many disciplines for different reasons. Statisticians have approached the distribution of income among individuals as a stochastic process. Economists have sought to explain income distribution by means of economic and institutional factors. More recently, economists have been interested in the effects of economic growth and government policies on income distribution. Sociologists and political scientists have thought income inequality as a major source of social revolt or political violence.

Discussion on income distribution for any reasons involves the measurement of income distribution or income inequality. The various measures of income inequality have been suggested mainly by statisticians and economists. Since each measure has different characteristics and relative merits, the choice among the various measures of income inequality should depend upon the purpose of analysis. Once this purpose is determined the different measures can be compared according to theoretical criteria and the measure(s) appropriate for the analysis can be selected. In the absence of clear criteria for selection among the various measures, some researchers have made their choice on the basis of convenience or familiarity. This has been especially true when social scientists have analyzed the relationship between income ineqiuality and political violence.

The purposes of this paper are : 1) to discuss necessary and desirable properties for the measures of income inequality, 2) to compare the various measures of income inequality according to these criteria, 3) to see whether the choice can really make a difference in empirical applications by examining simple correlations and rank order correlaltions among the various measures, 4) to develop a new measure of income inequality, which not only indicates the overall degree of income inequality, but also reflects the notion of class polarization emphasized by Karl Marx, and finally to empirically test the new measure along with existing measures for the analysis of income inequality and political violence.

I. PROPERTIES FOR MEASURES OF INCOME INEQUALITY

Among the vaious axioms or properties that have been suggested for measures of income inequality, the following two are proposed here as necessary properties. Property 1 : The measure should be independent of the scale of measurement or scale-invariant. It should make no difference whether income is measured in dollars and cents or in some other foreign currency:the inequality measure should remain

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unaffected if each income is altered by the same proportion. Since inequality is a relative concept, then as long as relative difference is not changed, the inequality remains the same.

Property 2 : The transfer of income from one income group to another should be reflected by a change in the measure. In other words, the inequality measure should be sensitive to transfers at all levels of income. This property is generally called the Pigou-Dalton principle of transfers.

In addition to these two necessary properties, the next property may be especially desirable for examining the inequality-violence relationship.

Property 3 : If the measure has varying sensitivity to transfers at different levels of income, it should be more sensitive to transfers at lower levels of income.

Kakwani (1980) and others have suggested that the measure should have upper and lower bounds or that the measure should lie in the range from zero to one.[1] However bounds should imply no preference, since simple and nonunique transformations can produce any desirable bounds.[2] Various writers, including Ord, Patil and Taillie (1981), have also suggested that the measure should be Lorenz-order preserving. However, the Lorenz curve itself being a partial ranking, even the Gini coefficient derived from the Lorenz curves cannot preserve the ranking if the Lorenz curves to be compared do intersect. While decomposability of the measure into between-group and within-group inequalities may be desirable in analyzing factors of income inequality according to certain socio-economic characteristics, this feature is not vital for the measure of overall inequality. It is obviously essential that the measure of inequality should remain unaffected with any permutation of the order in which individuals are ranked within the distribution. However, it is not discussed here as a necessary property because all of the measures of income inequality meet this criterion.

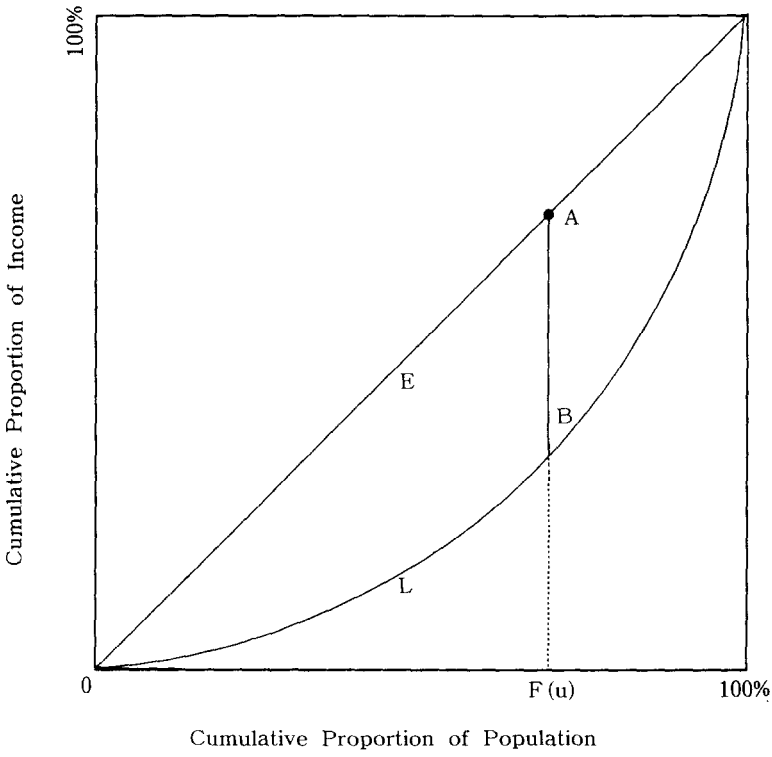
Ⅱ. COMPARISON OF MEASURES OF INCOME INEQUALITY

The various measures of income inequality can be broadly placed into the following four categories; 1) measures related to the Lorenz curve, 2) measures based on the notion of entropy, 3) measures incorporating a social welfare function, and 4) other dispersion or share measures. The Lorenz curve represents the relationship between the cumulative proportion of income units and the cumulative proportion of income received when units are arranged in ascending order of their income (see Figure 1). Among those measures related to the Lorenz curve, the most widely used measure of inequality is the Gini index, G. This index proposed by Gini (1912) is defined as

$$(1) \quad G = \{(1/n\ (n-1))\ \Sigma\Sigma\ |x_i - x_j|\} \ /\ 2u$$

where x_i is the income of the i-th unit ($i = 1, \ldots, n$) and u is the mean income.

1) Kakwani (1980), p. 69.
2) Allison (1978), p. 869.



[Figure 1] The Lorenz Curve, the Eqalitarian Line and the Maximum Discrepancy between Them

This index is the ratio of the arithmetic average of the n(n-1) income differences taken as absolute values to the maximum possible arithmetic average of income differences. In other words, the Gini index is a measure of dispersion divided by twice the mean. The Gini index is equal to one minus twice the area under the Lorenz curve, or the area from the egalitarian line(E) to the Lorenz curve (L), divided by the total area berween the egalitarian line and the two axes, horizontal and vertical. The Gini index is invariant with respect to scale and sensitive to income trnasfers at all different levels of income. However, the Gini index gives more weight to transfers near the mode of the distribution than at the tails, thus not satisfying property 3.

The relative mean deviation proposed by Bresciani-Turroni(1910) is defined as

(2) $R = \{(1/n) \Sigma |x_i - u|\} /2u$

This index is the arithmetic average of the absolute deviations from the mean income divided by twice the mean income. It has been proven that the relative mean deviation is equal to the maximum discrepancy between the egalitarian line (E) and th Lorenz curve (L), which is shown as the length AB in Figure 1.

Schutz(1951) and kuznets(1957) proposed alternative inequality measures. The Schutz index is defined as

$$(3) \quad S = \int_0^{F(u)} \{E'(F(x)) - L'(F(x))\} F(x)$$
$$= \int_0^{F(u)} \{1 - L'(F(x))\} F(x)$$

where $F(x)$ is the proportion of units having an income less than or equal to x. This index is calculated by summing the differences between the slope of the egalitarian line, which is always 1, and the slopes of the Lorenz curve at various points. Formula (3) can be reduced to $F(u) - L(F(u))$ which is equal to the maximum discrepancy between the egalitarian line and the Lorenz curve.

The Kuznets index is defined as

$$(4) \quad K = (1/n) \Sigma |d|$$

where $|d|$ is the absolute deviation between the percentage shares in population and the percentage shares in income. Kakwani (1980) has shown that Kuznets index in the continuous case can be expressed as $1/2 \int_0^1 |1 - L'(F(x))| F(x)$ which can be reduced to $F(u) - L(F(u))$. In this instance, the Kuznets index is also identical to the relative mean deviation. The relative mean deviation as well as the Schutz index and the Kuznets index are not affected by a change in scale, nor are they sensitive to income transfers on the same side of the mean. Consequently, theses measures do not satisfy properties 2 and 3.

Kakwani (1980) proposed an inequality measure based on the length of the Lorenz curve. The Kakwani index is defined as

$$(5) \quad L = (l - \sqrt{2}) / (2 - \sqrt{2})$$

where ℓ is the lenght of the Lorenz curve. This index lise between zero and one and is scale-invariant. He proved that this index is not only sensitive to income transfers at all levels of income, but also more sensitive to transfers at the lower levels of income, thus satisfying all three properties.

Theil (1967) proposed an inequality measure based on the notion of entropy in information theory, which was originally used to measure the quantity of disorder in thermodynamics. This indes is defined as

$$(6) \quad T = (1/n) \Sigma (x_i/u) \ln(x_i/u)$$
$$= \Sigma y_i \ln(n\, y_i)$$

where y_i is the income share by the ith unit. A similar measure was proposed by Marfels (1971). This index is invariant with respect to scale and satisfies the Pigou-Dalton principle of transfers. Ord, Patil and Taillie (1981) have pointed out that the Theil index is scale-variant, in the sense that the measure depends upon the size of population for its upper bound. However the scale that they discussed is different from the scale of measurement currently being considered. Furthermore, the upper limit can be transformed into any desirable bounds. Theil's measure is also sensitive to transfers at the lower incomes, thus satisfying property 3.

Dalton (1920) and Atkinson (1970) were not satisfied with the positive measures of income inequality and proposed normative measures of income inequality incorporating a social welfare function. Dalton's inequality measure, D, is based on the assumptions that social welfare is the sum of individual utilities which are functions of their respective incomes and that each individual has the same utility function. Thus the aggregate welfare will be maximum when all incomes are equal and that the proportional welfare loss resulting from income inequality can be measured as the formula given below.

$$(7) \quad D = 1 - \{(\Sigma w(x_i)) / n\, w(u)\}$$

where w represents the utility function.

Atkinson proposed a measure based on the concept of the equally distributed equivalent level of income (Xede), which if received by every individual would result in the same level of social welfare as the present distribution. The measure is expressed as

$$(8) \quad A = 1 - (Xede/u)$$

which can be further specified with the assumption of homothetic utility function as

$$(9) \quad A = 1 - \{\Sigma(x_i/u)^{1-\varepsilon}\}^{\frac{1}{1-\varepsilon}}$$

where $i=1,\ldots\ldots,\ n$ for n discrete income categories and $\varepsilon(>0)$ is a measure of the inequality aversiveness.

Dalton's measure is not independent of the units of measurement, though it may satisfy properties 2 and 3 depending on the utility function specified. With some restrictions on the form of the utility function, Atkinson's measure satisfies property 1 and depending on the specified magnitude of inequality aversiveness (ε), his measure satisfies properties 2 and 3. As ε rises, more weight is attached to transfers at the lower end of the distribution. Measures of inequality incorporating a social welfare function have practical problems of choosing a specific utility function and selecting the appropriate value of ε.

Other measures include the coefficient of variation, standard deviation of logarithms, and income share measures. The coefficient of variation is defined as

$$(10) \quad V = \sigma / u$$

The standard deviation (σ) divided by the mean (u), this coefficient is invariant with respect to scale and attaches equal weights to income transfers at different levels of income, thus satisfying properties 1 and 2. However, this measure fails to meet property 3 because it gives equal weight to any income transfer regardless of the levels of income.

While use of the coefficient of variation as a measure of inequality is based on the assumption that incomes are normally distributed, actual income distributions are typically skewed to the right with long tails on the high income side. In this case, transformation of income into the form of logarithm would be normally distributed.

Therefore, standard deviation of logarithms, incorporating both skewness and variance, is defined as

(11) $\sigma_{\ln x} = \{(1/n)\Sigma(\ln x_i - \overline{\ln x})^2\}^{\frac{1}{2}}$

This measure is invariant with respect to scale and attaches greater weight to income transters at lower income levels, thus satisfying the properties 1 and 3. However, this measure does not satisfy the Pigou-Dalton principle of transfers by discounting distribution at high income levels.

All of the measures discussed above require actual data of the income distribution or at least knowledge of income frequency distribution for their calculation. In instances of limited information, several simpler measures have been suggested. The measures most frequently used by social scientists include the top 20% income share, the bottom 20% income share or the ratio of these two shares. All of these measures satisfy only property 1.

From the above comparison of the various measures of income inequality, it is shown that the entropy index and the kakwani index satisfy all three properties and that the Gini index and the coefficient of variation satisfy the two necessary properties. Other measures fail to satisfy one of the two necessary properties.

Ⅲ. CORRELATION ANALYSIS

In order to see whether choosing among the various measures of income inequality can really make a difference in practice, simple correlations and rank order correlations among the different measures are examined. Income inequality data have been collected by several compilers (Adelman and Morris (1973), Paukert (1973), Ahluwalia (1974), Jain (1975), World Bank (1983)). Among them, Jain's compilation is the most extensive in its coverage of countries as well as in its number of different measures of income inequality considered. Even Jain's compilation does not cover all the indices discussed in this study. Jain uses the Gini index, the Kuznets index, the entropy index, and income shares according to population decile. [3]

Table 1 shows the Pearson correlation coefficients among six diffferent measures of income inequality : the Gini index, the Kuznets index, the entropy index, the top 20% income share, the bottom 20% income share. and the ratio of the top 20% income share to the bottom 20% income share. [4] As can be seen from Table 1, the Gini index, the Kuznets index and the entropy index are very highly correlated with coefficients around .98 ~ .99. Correlation coefficients of these three index with the top 20% income share are shown around .96 ~ .97. On the other hand, the bottom

3) The Gini index was calculated by the beta functional estimation of the Lorenz curve derived by Kakwani and Podder (1973) as $G=2\int_0^{\sqrt{2}} c\pi^a(\sqrt{2}-\pi)^b\,d\pi = 2c(\sqrt{2})^{1+a+b}\,B(1+a,\ 1+b)$. The Kuznets index is computed for the case of twenty intervals using the formula, $K=\Sigma|d|/(20\times 9.5)$ where $|d|$ is the absolute deviation of the income share of each 5 percentile group from 5 percent. The entropy index is calulated by using Marfels' (1971) formula, $E = 1 - \text{Antilog } H(y)/n$ where $H(y) = -\Sigma\, y_i \log y_i$, and y_i is the income share of the ith individual.

4) The sample size consists of 62 observations, one observation per nation for 62 countries.

[Table 1] Pearson Correlation Coefficients

	Correlation Coeffcients / significance / N=62					
	GINI	ENTROPY	KUZNETS	TOP	BOTTOM	RATIO
GINI	1.00000	0.99123	0.99612	0.95925	-0.76506	0.32458
	0.0000	0.0001	0.0001	0.0001	0.0001	0.0026
ENTROPY	0.99123	1.00000	0.98134	0.95463	-0.71456	0.43591
	0.0001	0.0000	0.0001	0.0001	0.0001	0.0001
KUZNETS	0.99612	0.98134	1.00000	0.97446	-0.80223	0.30257
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0090
TOP	0.95925	0.95463	0.97446	1.00000	-0.71355	0.35538
	0.0001	0.0001	0.0001	0.0001	0.0001	0.0012
BOTTOM	-0.76506	-0.71456	-0.80223	-0.71355	1.00000	0.15176
	0.0001	0.0001	0.0001	0.0001	0.0000	0.1723
RATIO	0.32458	0.43591	0.30257	0.35538	0.15176	1.00000
	0.0026	0.0001	0.0090	0.0012	0.1723	0.0000

Note : TOP, BOTTOM, and RATIO represent the top 20% income share, the bottom 20% income share, and the top 20% income share devided by the bottom 20% income share respectively.

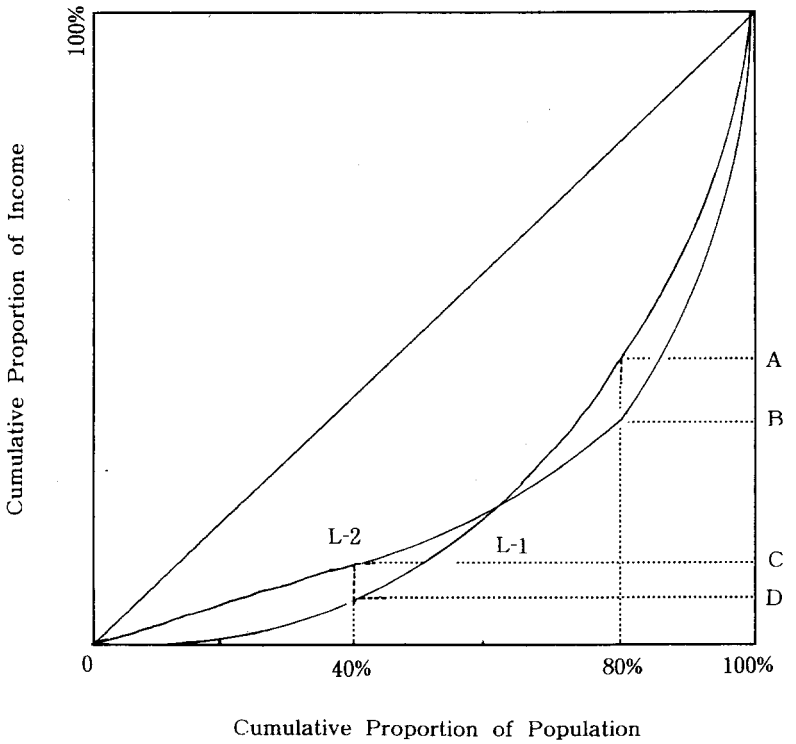
20% income share and the ratio of the top 20% income share to the bottom 20% income share are somewhat poorly correlated with other four variables.

Among these measures, the Gini index and the entrpoy index satisfy the two necessary properties for income inequality measures discussed above. Therefore, these two may serve as the standard by which other measures can be judged for practical use. Tow measures, the bottm 20% income share and the ratio variable are not recommended as a proxy variable for the following reasons. First, they do not satisfy the nesessary theoretical properties of income inequality measure. Second, they are not highly correlated with those measures that are supported theoretically. The other two measures, the Kuznets index and the top 20% income share, while not satisfying one of the necessary properties, can be used as substitutes in case the more desirable measures cannot be obtained.

When Spearman correlation coefficients, which repersent correlation coefficients among the ranks of the values of the variables, are used, essentially similar results are obtained. Correlation coefficients are generally improved because ranks instead of actual values of the variables are used.

Ⅳ. NEW INCOME INEQUALITY MEASURE

The Lorenz curve or the Gini index derived from the Lorenz curve indicate the overall degree of income inequality but have little to say about the income differences bentween ecomomic classes. Karl Marx emphasized increasing class conflict and antagonism due to polarization of two classes - the haves and the have nots - as



[Figure 2] The Skewness of the Lorenz Curve and the Share of the Middle Class

capitalistic society grows to its maturity. The emergence of the middle class in the post-industrial societies has weaken the predictive power of the Marxian theory. Since Aristotle, the important role played by the middle class for the stability of the society has been recognized. This view has been more recently expounded by Lipset (1959). The middle class may have a different perception of and attitude toward class struggle and mass violence depending on its relative position in the overall income distribution. In one instance, the middle class may function as a buffer in reducing social tension and class antagonism. In another instance, this majority may be mobilized for support and participation in revolutionary activities.

When the effect of unequal income distribution on political violence is considered, both the overall index of income inequality as well as the inequality between different economic classes are important. This is especially true in the case of mass violence. However, there is no consensus on how to define the middle class or how to measure its income share. Instead of trying to measure such figures directly, an alternative way is to measure the skewness of the Lorenz curve.

Figure 2 contains two Lorenz curves corresponding to two different income distributions. These curves are obviously not symmetric with respect to the egalitarian

line. Lorenz curve L-1 is skewed toward the upper right corner of the diagram while Lorenz curve L-2 is skewed toward the lower left corner of the diagram. Comparing the two Lorenz curver, the top 20% income share is larger with Lorenz curve L-2 than with Lorenz curve L-1, and the bottom 40% income share is larger with Lorenz curve L-2 than with Lorenz curve L-1. Combining these results, it follows that the intermediate group has a larger income share with Lorenz curve L-1 than with Lorenz L-2 (shown as AD vs. BC in Figure 2). This intermediate group covering 40% population may not be exactly identified as the middle class. Nevertheless, however the middle class is defined, a relatively more affluent middle class is indicated by Lorenz curve L-1.

Kakwani (1980) has shown that the skewness of Lorenz curve can be measured by the ratio of two coefficients, a and b, from the beta functional specification of income distribution.[5] The Lorenz curve is symmetric if $a=b$, skewed toward the lower left corner of the diagram if $a>b$ and skewed toward the upper right corner of the diagram if $a<b$. Thus, a larger magnitude of the ratio of a and b indicates the case of class polarization and a smaller magnitued of the ratio indicates a larger base of the middle class. In order to incorporate the class stratification of the society in the measuremnt of income inequality, the following measute is proposed.

$$\text{Composite index (COMPO)} = \text{the Gini index} \times (a/b),$$

where a/b is the skewness coefficient of the Lorenz curve.

COMPO abjusts the Gini index by the degree of skewness of the Lorenz curve. Since $a>o$ and $b>o$, the ratio of a/b could be anywhere from zero to infinity theoretically. However, the actual coefficient, a/b, ranges from .83 to 1.72 for a sample of 62 countries used in this study. This new measure of income inequality may serve better for the analysis of income inequality and political violence.

V. REGRESSION RESULTS

In order to empirically test different measures of income inequality for the analysis of inequality and political violence, an appropriate indicator for political violence is needed. The most well-kown compilation in this area was done by Taylor and Jodice (1983). They compiled various indicators of collective violence such as armed attacks, deaths from domestic violence, riots, and political strikes. Among the various indicators of political violence in Taylor and Jodice, 'deaths from domestic violence' is chosen because this variable represents not only the incidence of political violence but also the intensity and magnitude of political violence better than the other variables.

A factor limiting the sample size is the income inequality data. while indicators of political violence are typically available for more than 100 countries, the availability of income inequality data is more limited. Even Jain's compilation covers only 81

5) The Lorenz curve is expressed as $n = c\pi^a(\sqrt{2}-\pi)^b$, where $n=(F-FI)/\sqrt{2}$, $\pi=(F+FI)/\sqrt{2}$, F=the cumulative percentage of population shares, and FI=the cumulative percentage of income shares.

countries. Excluding non-independent territories and communist nations dwindles the sample size down to 62 countries. For most countries, income inequality measures are available for different geographical areas as well as different population units for many years. In these instances, the nationwide surveys on household incomes in the early 1970s are used. Even though the income inequality index does not change much over time, it has been attempted to measure income inequality around the mid-point of 1968-1977, the period for which the dependent varibles are computed.

Beyond the two key variables, two additional varables that are logically associated with the magnitude of political violence are considered. These are GNP per capita and population in 1975 available from Taylor and Jodice (1983). GNP per capita is considered to see the effect of the overall level of well-being of the society compared to the effect of relative well-being (income distribution). There are two different ways of considering population for the estimation model. One way is to standardize the dependent variable and GNP by population or to unstandardize any variables, thus using population and GNP as independent variables. The other way is to include population as a control variable while using GNP per capita as an independent variable. The number of violent events of deaths is likely to be higher in more populous nations, but not necessarily proportional.

Therfore, it is desirable to include population as a control variable in the model rather than to use population as a standardization variable.

Based on the information obtained from the correlation coefficients table, two

[Table 2] Regression of Mass Violence on Population, GNP per Capita, and Income Inequality

Dependent Variables : Death from Domestic Violence (log)

	Regression					
	1	2 Gini	3 Entropy	4 Kuznets	5 Top	6 Compo
Constant	6. 734**	3. 215	4. 536	3. 012	1. 501	3. 257
	(2. 236)	(2. 956)	(3. 062)	(2. 622)	(2. 539)	(3. 116)
Population	. 499**	. 743**	. 766**	. 750**	. 806**	. 712**
(log)	(. 163)	(. 239)	(. 225)	(. 207)	(. 251)	(. 246)
GNP per	-1. 523**	-1. 486**	-1. 298**	-1. 423**	-1. 357**	-1. 077**
Capita (log)	(. 272)	(. 253)	(. 275)	(. 297)	(. 242)	(. 201)
Income		6. 246	5. 248*	8. 123*	. 080*	5. 425*
Inequality		(3. 215)	(2. 512)	(3. 993)	(. 032)	(2. 507)
R^2	. 435	. 471	. 478	. 476	. 485	. 497
F	20. 2**	17. 3**	17. 5**	17. 1**	18. 3**	18. 0**

Note : Regression 1 is estimated without any income inequality index and regressions 2-6 are estimated with each of five different measures of income inequality. The first entry for each variable is the coefficient estimate and the second in parenthesis is the standard error of the estimate. * indicates significance at the 5% level and ** at the 1% level.

measures of income inequality, the bottom 20% income share and the ratio of the top 20% income share to the bottom 20% income share were discarded. A new measure COMPO wich incorporates the skewness of the Lorenz cureve was added. Results from a series of multiple regressions where 'deaths from domestic violence' is regressed on population, GNP per capita, and each measure of income inequality are given in Table 2. Six regressions have been estimated; regression 1 without any income inequality index, and regressions 2-6 with each of five different measures of income inequality.

Lower R^2s are expected because of the nature of cross-section analysis. The magnitude of political violence is strongly related to population size. GNP per capita has a significant negative effect on political violence operationalized by 'deaths from domestic violence'. Major concern here is the relationship between income inequality and political violence. The size of the regression coefficient for each income inequality measure varies because each index has a different distribution or scale. However, the addition of any measure of income inequality tends to increase the explanatory power of the model (R^2) by .04-.07(or 10-17%) depending on the specific inequality measure used. Futthermore, the regression coefficients for the various income inequality measures are significant at the level of .05 with one exception. Even the regression coefficient fot the Gini index, which is the only index that fails to meet the significant level of .05, are significant at the level of .06.

When the Gini index, the Kuznets index, the entropy index, the top 20% income share, and the COMPO index are compared, the latter two perform marginally better than the others with respect to improvement of R^2 and the significance of the coefficient. The important effect of class polarization on political violence can be observed. The top 20% income share, which is a theoretically inferior indicator of income inequality, contains a rough degree of class polarization. The COMPO index, being loaded with the skewness coefficient of the Lorenz curve, also contains the degree of class polarization. Empirical evidence supporting the use of the new measure for the analysis of income inequality and political violence can be seen from the comparison of the results of regressions 2 and 6. The regression coefficient for the income inequality operationalized by the Gini index fails to meet the significance level of .05. However, when this index is weighted by the skewness coefficient of the Lorenz curve, it shows a significant coefficient and improves the explanatory power of the model.

Ⅵ. SUMMARY

In this paper, various measures of income inequality, which have been used by social scientists in analyzing the relationship between income inequality and political violence, have been compared according to necessary and desirable properties. The entropy index and the Kakwani index satisfy all three properties, and the Gini index and the coefficient of variation satisfy the two necessary properties. In order to see

how each index is correlated with other, simple correlations and rank order correlations among the six measures available from Jain's (1975) compilation have been examined. The Gini index, the entropy index, the Kuznets index, and the top 20% income share are very highly correlated while the bottom 20% income share and the ratio of the top 20% to the bottom 20% are poorly correlated with these four indices.

A new measure of income inequality which not only represents the overall degree of income inequality but also contains the degree of polarization has been suggested for the analysis of income inequality and political violence. This measure is obtained by adjusting the Gini index (representing the overall degree of income inequality) by the degree of skewness of the Lorenz curve (representing the degree of class polarization). This measure has been empirically tested along with other measures and has shown to be a better indicator in interpreting the events of political violence. The findings in this study are tenuous and there are possible problems of imprecise and inadequate measurement of income inequality and political violence. Additional work will be needed in the future when more recent and precise data of the two variables become available.

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