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On the Interpretation (and Misinterpretation) of Inequality Decompositions by Income Sources

by

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Summary

This paper discusses interpretations of different inequality decomposition rules when inequality is decomposed by income sources. It argues that authors of a recent article based their conclusions on misinterpreted decomposition results. It also argues that marginal effects, derived as elasticities of inequality with respect to uniform increases in income from each source, are easily interpreted and can be compared across different decomposition rules.

Keywords: income inequality; income sources; decomposition; interpretation; marginal effects.

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Summary

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Introduction

In a recent article, Davis et al. (2009) examine, among other things, the effect of rural nonfarm activities on income inequality in a number of developing and transition countries, using a well-known methodology of inequality decomposition by income sources. Their results "…suggest that non-farm income induces greater income inequality in rural areas…" The purpose of this note is to show that this conclusion is based upon a common misinterpretation of the decomposition results, and that a correct interpretation of the results could very well lead to the opposite conclusion. In doing this, this paper follows Podder and Chatterjee (2002), who stated that "…the disaggregation of inequality by factor components … is probably the most misused and misunderstood concept in the income inequality literature (p. 3)." Unfortunately, misinterpreted decomposition results are still common in the development literature and this is why this note is in place.

The next section describes the inequality decomposition methodology, and the following section discusses the different interpretations of the decomposition results. The final section concludes.

Inequality decomposition by income sources: general methodology

Shorrocks (1982) was the first to offer a unified approach to inequality decomposition by income sources. Earlier, Fei et al. (1978) and Pyatt et al. (1980), among others, offered a decomposition of the Gini index of inequality by income sources, but this happens to be a special case of Shorrocks' (1982) approach. Specifically, Shorrocks (1982) suggested focusing on inequality measures that can be written as a weighted sum of incomes:

$$(1) \qquad I(\mathbf{y}) = \Sigma_i a_i(\mathbf{y}) y_i,$$

where a_i are the weights, y_i is the income of household i, and $\mathbf{y}$ is the vector of household incomes. These include as special cases the Gini index as well as the class of Generalized Entropy indices. If income is observed as the sum of incomes from k different sources, $y_i=\Sigma_k y_i^k$, the inequality measure (1) can be written as the sum of source-specific components S^k:

$$(2) \qquad I(\mathbf{y}) = \Sigma_i a_i(\mathbf{y}) \Sigma_k y_i^k = \Sigma_k [\Sigma_i a_i(\mathbf{y}) y_i^k] \equiv \Sigma_k S^k.$$

Dividing (2) through by $I(\mathbf{y})$, one implicitly obtains the proportional contribution of income source k to overall inequality as:

(3) $$s^k = \Sigma_i a_i(\mathbf{y}) y_i^k / I(\mathbf{y}).$$

where $\Sigma_k s^k = 1$.

Interpreting inequality decomposition results

Shorrocks (1982) noted that in principle, the weights $a_i(\mathbf{y})$ can be chosen in numerous ways, so that "…the contribution of any factor expressed as a proportion of total inequality can be made to give *any* value between plus and minus infinity (p. 202)!" In other words, the decomposition formula (3) yields an infinite number of potential decomposition rules. In his empirical work, Shorrocks (1983) used three different decomposition rules, each based on a particular inequality index: (a) the Gini index, with $a_i(\mathbf{y})=2(i-(n+1)/2)/(\mu n^2)$, where i is the index of observation after sorting the observations from lowest to highest income, n is the number of observations and μ is mean income; (b) the squared coefficient of variation, with $a_i(\mathbf{y})=(y_i-\mu)/(n\mu^2)$; and (c) Theil's T index with $a_i(\mathbf{y})=\ln(y_i/\mu)/n$. Morduch and Sicular (2002) and Kimhi (2007) also compared the results of these three decomposition rules, while Davis et al. (2009) used only the rules based on the Gini and Theil's T inequality indices. Paul (2004) did the same for these and several other decomposition rules. All these authors found that the decomposition results vary across the decomposition rules, sometimes quite considerably.

The question that emerges is, therefore, are we obtaining different answers to the same question or to different questions? In other words, what is the meaning of the inequality decomposition results? Shorrocks (1983) answers this in part by noting that "This turns the calculation of inequality contributions into a meaningless exercise… (p. 315)." Shorrocks (1982) responds to this challenge by adding intuitive restrictions on the choice of decomposition rule, and comes up with a unique decomposition rule based on the squared coefficient of variation inequality index. Fields (2003) reached the same conclusion in a different way. One of the restrictions imposed by Shorrocks (1982) is that $\Sigma a_i(\mathbf{y})=0$, implying that "…the contribution of a factor to total income inequality is zero if all individuals receive the same income from that source (p. 201)." This is satisfied by the decomposition rules based on the Gini and squared coefficient of variation inequality indices. Shorrocks (1982) himself is not completely happy with this restriction, noting (in a footnote) that it is "…perhaps questionable, since we may feel that identical positive lump sum transfers are an equalizing force and hence should be associated with a negative contribution to inequality (p. 202)."

Morduch and Sicular (2002) took Shorrocks' (1982) footnote seriously. They defined the *property of uniform additions* of an inequality index in the following way. An inequality index is said to satisfy this property if adding a fixed amount of income across the entire population decreases inequality. It is easy to agree that this is a desired property of inequality indices. Morduch and Sicular (2002) then took a further step and adopted this definition to inequality decomposition methods, so that the property is satisfied if the contribution to inequality of a positive equally-distributed income component is negative. Paul (2004) makes the same argument and calls it *the negativity property*.

The question whether the *property of uniform additions* is a desired property of inequality decomposition rules brings us back to the question of what is the meaning of the inequality decomposition results and how they should be interpreted. Shorrocks (1982) also emphasized the need "…to examine in detail the intuitive interpretations normally attached to statements of the form 'factor X contributes Z percent of total inequality' (p. 203)." The answer may not be the same for all decomposition rules. Shorrocks (1982) has shown that for the decomposition rule based on the squared coefficient of variation, the inequality contribution of an income source is equal to the average of two quantities: the inequality that would be observed if this income source was the only source of inequality, and the amount by which inequality would fall if inequality in this income source was eliminated. Hence, the decomposition results reflect the variability in each income source. Lerman and Yitzhaki (1985) have shown that in the case of the decomposition rule based on the Gini inequality index, the relative contribution of each income source can be written as $s^k = 2\text{cov}(\boldsymbol{y}^k,F)/\mu)$, where $\text{cov}(\boldsymbol{y}^k,F)$ is the covariance of income source k with the cumulative distribution of income, F. Consider a multiplicative mean-preserving spread in $\boldsymbol{y}^k$ that does not change the cumulative distribution F, i.e., $a(\boldsymbol{y}^k-\mu^k)$ where a is a small positive scalar. This clearly increases the absolute value of the covariance and of s^k by a factor of a. Hence, the Gini-based decomposition results also reflect the variability in each income source.

This leads to the conclusion that inequality decomposition results reflect changes in the variability of income sources, at least for these two decomposition rules. Hence, it makes perfect sense that the contributions to inequality of income sources with zero variability are zero. Interestingly, the literature does not offer similar intuitive results for

the inequality decomposition rule based on Theil's T inequality index, which satisfies the *property of uniform additions*. This comes as no surprise if one examines carefully the logic that underlies this property. This was based on the idea that an *increase* in an equally-distributed income source reduces inequality. But such an increase in not mean-preserving, and this is why it reduces overall inequality. Perhaps, then, the results of inequality decomposition rules that satisfy the *property of uniform additions* do not reflect mean-preserving changes in income source. If results based on different decomposition rules reflect different questions, it comes as no surprise that these results could be quite different from each other, as was obtained by Morduch and Sicular (2002), Paul (2004) and Kimhi (2007), as well as Davis et al. (2009).

In their conclusions, Morduch and Sicular (2002) noted that "the aggregate Gini coefficient falls if an income source is increased by a constant amount for all members of the population, but none of the components of the standard decomposition of the Gini are affected (page 104)" and thus conclude that "it is of limited use in describing causes of inequality (page 105)." In fact, increasing income by a constant amount has the same effect on inequality regardless of the particular income source that is increased. The logic of the *property of uniform additions* may lead to the absurd conclusion that all inequality contributions should be negative!

The question that Morduch and Sicular (2002) perhaps had in mind is what happens to inequality as a result of a uniform increase in a particular income source. Shorrocks (1983) has noted that comparing s^k and μ^k/μ, the share of income from source k in total income, is useful for knowing whether the k^{th} income source is equalizing or disequalizing. In the case of the Gini decomposition rule, $s^k=0$ if k stands for an equally-

distributed income component. Hence, it follows that the effect of a uniform increase in this income component on the Gini index is unambiguously negative. Lerman and Yitzhaki (1985) have shown that the elasticity of the Gini inequality index with respect a uniform percentage change in $\mathbf{y}^k$ is s^k-μ^k/μ, which supports the logic of Shorrocks (1983) for the case of the Gini decomposition rule. Paul (2004) derived equivalent elasticities for other decomposition rules. These "marginal effects" are more informative than the proportional contributions to inequality s^k when one wants to know whether a particular income source is equalizing or disequalizing (Podder, 1993). In fact, both Paul (2004) and Kimhi (2007) found that the marginal effects obtained from different decomposition rules are much more similar than the decomposition results.

In this sense, the statements of Davis et al. (2009) that positive proportional contributions indicate inequality-increasing effects are not correct. Consequently, their empirical conclusion, that non-farm income induces greater income inequality in rural areas, is not necessarily true. If fact, it is easy to derive the marginal effects of income sources on inequality based on the Gini decomposition rule as s^k-μ^k/μ, using μ^k/μ from table 2 and s^k from table 5 in Davis et al. (2009). The results are shown in table 1 below. In essence, the conclusions of Davis et al. (2009) are found to be mostly correct, in the sense that non-agricultural activities have positive marginal effects on inequality in most cases. However, several specific results are found to be wrong. For example, crop income in Pakistan is not inequality increasing but rather has a negligible effect on inequality, while non-agricultural wage income is an equalizing income source. This is not surprising, given that the conclusions of Davis et al. (2009) are based on misinterpretation of the decomposition results.

Summary and conclusions

This paper critically reviewed interpretations of inequality decompositions by income sources. Different decomposition rules give different results simply because they do not measure the same things. Therefore, there is no meaning in deriving conclusions from these results. In contrast, marginal effects of income sources on inequality are easily computed and easily interpreted, and therefore should be used to determine whether particular income sources are equalizing or disequalizing. Despite this, the major conclusions of Davis et al. (2009) are not changed after computing the marginal effects. However, several particular results are completely different.

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Table 1. Marginal Effects of Income Sources Derived from Davis et al. (2003) Results

Country	Crop	Livestock	Ag wage	Non-Ag wage	Self-emp	Transfers	Other
Malawi	-13.0	3.9	-6.5	14.4	6.6	-5.2	0.0
Madagascar	-13.5	2.5	-2.5	-4.2	21.6	-3.6	-0.3
Bangladesh	-9.4	-0.1	-20.1	1.3	20.3	12.7	-4.7
Nepal	-13.5	-6.4	-12.4	15.3	6.3	8.1	2.6
Ghana	-29.2	-2.1	0.1	5.0	32.7	-6.0	-0.4
Tajikistan	4.1	9.0	-7.6	0.1	2.7	-8.9	0.5
Vietnam	-34.0	-10.9	-4.6	-3.2	57.6	-4.7	-0.1
Nigeria	-34.0	-2.6	18.1	17.8	2.3	-1.2	-0.3
Pakistan	1.0	-1.8	-7.5	-8.5	13.8	-3.5	6.5
Nicaragua	-12.8	-5.5	-10.0	13.4	17.2	-2.2	-0.1
Indonesia	-16.0	-0.3	-1.8	21.5	12.2	-14.8	-0.9
Guatemala	-19.5	-1.3	-8.5	22.6	12.7	-7.2	1.0
Albania	-10.4	-18.7	1.5	10.9	31.9	-15.0	-0.2
Ecuador	16.6	-1.0	3.6	-20.1	4.9	-7.3	3.4
Bulgaria	1.6	0.5	3.0	20.3	5.2	-30.2	-0.3
Panama	-13.3	-0.7	-7.7	27.9	-0.8	-5.7	0.4

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