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# Decomposition analysis and the mean-rate-of-change index

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## Abstract

The mean-rate-of-change index (MRCI) is a recent addition to the suite of decomposition analysis (DA) methods. In addition to the arithmetic mean used by its originators, the MRCI can be formulated incorporating any type of mean. When the logarithmic mean is used, the MRCI is equivalent to the logarithmic mean Divisia index. The MRCI is said to produce plausible decompositions, and to be able to handle negative values. However, regarding the sign and magnitude of decomposition terms, the MRCI is affected by the same distortions and inconsistencies as other DA methods, and generally does not produce more plausible results. Moreover, the MRCI's ability to handle negative values is not necessarily an advantage in DA studies using input–output data. Finally, the MRCI is not robust.

*Keywords:* Mean-rate-of-change index; Decomposition analysis

## 1. Introduction

Decomposition analyses (DA) of energy-use time series are aimed at identifying driving factors for changes in energy use over time. Two strains of decomposition techniques can be found in the literature: index decomposition analysis (IDA) and

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structural decomposition analysis (SDA). Both are comparative static methods that use either aggregate sector-level or country-level data (IDA), or input–output data (SDA). IDA is generally less data-intensive, but also less detailed since indirect inter-industry effects cannot be resolved. Even though IDA and SDA have developed independently, their techniques and indices can be mutually applied [1,2]. IDA and SDA studies have been carried out on a wide range of variables, such as energy, $CO_2$ emissions, labour, productivity, imports, and many others. A number of comprehensive literature reviews have been completed.[1]

A recent addition to the DA suite of methods is Chung and Rhee's [11] mean-rate-of-change index (MRCI). In addition to being exact, that is residual-free, the MRCI is said to have advantages over previously conceived approaches, amongst which are

- the ability to handle negative values in the underlying data set; and
- the decomposition results being more plausible, because less distorted in the sense that their sign and magnitude follows more closely those of changes in the determinants of the function to be decomposed.

This work has three goals: first, to develop a formulation of the MRCI that is more general than that presented by Chung and Rhee; secondly, to take a closer look at the above issues of plausibility and negative values; thirdly, to compare the MRCI with other DA methods. The article is laid out as follows: Section 2 gives a brief introduction into the terms and mathematics of DA, explains the concepts of *residual* and *ceteris-paribus* terms, and describes two other relevant DA methods: the Dietzenbacher–Sun–Albrecht (DSA) method, and the logarithmic mean Divisia index (LMDI). Section 3 introduces the MRCI, and develops its non-parametric formulation. It also comments on the plausibility of MRCI decompositions as compared with those from DSA and LMDI, and on the sense of negative values.

## 2. DA methodology

### 2.1. General approach of decomposition analyses

The basic approach to additive[2] structural decompositions of a function $y(x_1,x_2,\ldots,x_n)$ of $n$ determinants is through its total differential

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[1] See [3], p. 41 in [4], Sec. 6 in [5], and [2]. Rose and Casler [6] (summary in [7]) discuss additional issues such as trade changes, price changes, model closure, hybrid units, projection and forecasting, and the relationship to neoclassical production functions. Ang [8] deals with method selection, the zero-values problem, periods versus years, and sector aggregation. Ang [9] gives a historical overview, lists 124 studies, and classifies these according to application area, indicator type and decomposition scheme. Ang [10] reviews selection criteria and application areas, and attempts a taxonomy of methods.

[2] In the case of energy or emissions studies, most authors choose additive over multiplicative decompositions, because the former are generally easier to interpret. An exception is in [12]. For a comparative review, see [1,3,13,14].