Energy and environmental studies: when to use which method of decomposition?

Topic: Drivers of energy consumption

Author: Paul de Boer

In many studies in the field of energy and environmental studies an aggregate change in a variable V is decomposed into a certain number of factors. It takes on two different forms: a multiplicative one (V^1â•„V^0), where the superscript 1 denotes the comparison period and the superscript 0 the base period, and an additive oneã€– (Vã€—^1-V^0).

This paper considers six widely used methods, all of them sharing the property of being â€˜idealâ€™, i.e. they satisfy the requirements of â€˜time reversalâ€™ and â€˜factor reversalâ€™. The latter property ensures that a unique solution is obtained. Five of them were already known in the field of index theory . The following table summarizes the names used in both fields.

Multiplicative		Additive	
Decomposition	Index	Decomposition	Indicator
SDA or generalized Fisher	Fisher	SDA or Sun-Shapley	Bennet
LMDI- I	Montgomery-Vartia	LMDI- I	Montgomery
LMDI- II	Sato-Vartia (S-V)	LMDI- II	Additive S-V

In a previous paper De Boer (2018) deals with the multiplicative and additive SDA decomposition; in terminology of index theory with â€˜Fisherâ€™ and â€˜Bennetâ€™. He uses the generic formula of Siegel that generalizes the Fisher index, originally designed for the decomposition of total consumption expenditure into two factors (price and quantity), to the general case of n factors. By collecting duplicates the computation of the unweighted average of n! permutations (â€˜elementary decompositionsâ€™) is reduced to the computation of the weighted average of 2^(n-1) combinations. Since both decompositions use the same combinations and weights one Matlab program, given in the paper, suffices to deal with both of them. In the illustrative example he deals with a decomposition of carbon dioxide emissions in the Netherlands into five factors so that the computation of 120 elementary decompositions is reduced to the computation of 16 combinations.

In this paper we apply the four LMDI methods to the very same example. We give one Matlab program that deals with these four methods at the same time. As expected, the methods for the multiplicative decomposition (Fisher, Montgomery-Vartia and Sato-Vartia) and the additive one (Bennet, Montgomery and Additive Sato-Vartia) yield similar results.

Based on theoretical and empirical arguments, we propose an answer to the question when to use which method.

Reference: De Boer (2018) Structural decomposition analysis when the number of factors is large: Siegelâ€™s generalized approachâ€™ written for presentation at the 9th Input-Output Workshop in Bremen (15-16 March 2018.)