

LESS MATERIAL PROJECT¹

Does material intensity sufficiently represent material efficiency?²

by Sedat Alataş, 20 May 2023

How can we measure the material efficiency performance of countries? Does material intensity defined as the ratio of material consumption (MC) to gross domestic product (GDP) sufficiently capture the material efficiency dynamics? If not, what are the alternative approaches and how can we show the drawback of material intensity?

Material efficiency is typically measured by the ratio of material consumption to GDP (MC/GDP), also known as material intensity. It is suggested that if the same quantity of output is produced using fewer materials, or more simply if material intensity falls, the material efficiency performance of the country will improve. Therefore, to put it more simply, material efficiency is understood as the inverse of material intensity, and these two concepts are used synonymously.

Material intensity is a convenient metric for country comparison because it is reasonably simple to calculate. This straightforward proxy, however, has several serious shortcomings that need to be properly addressed and thus does not accurately reflect a country's performance in terms of material efficiency. The most important drawback of the material intensity indicator is that it only takes into account materials and output themselves and ignores all other possible factors that might potentially affect material efficiency. In other words, by formulation, an increase or decrease in material intensity is only determined by the changes in material consumption or output. However, material efficiency might be affected by a variety of other factors that have been ignored by material intensity, such as key economic indicators (income, price change, trade structure, or exchange rate volatility), economic structure (the share of industry or carbon-intensive sectors in the economy), or resource-related issues (natural resources abundance, dependence on other countries in terms of resources). In a similar vein, changes in material

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² This blog article is based on our unpublished paper titled "Material Demand and Material Efficiency for Sustainable Development in European Union Countries: A Stochastic Frontier Analysis" (written by Sedat Alataş, Burcu Hiçılmaz, and Etem Karakaya). Please see the full paper for further information. Sedat Alataş can be reached at sedat.alatas@adu.edu.tr.

intensity are not only or necessarily driven by changes in material efficiency. Therefore, there is a tendency for the relationship between material intensity and material efficiency to be distorted and to not always present a correct picture.

There are several methods that can be considered alternatives to empirically measure material efficiency, such as Index Decomposition Analysis (IDA), Data Envelopment Analysis (DEA), or Stochastic Frontier Analysis (SFA). In our recent research article, using the SFA approach, we measure the material efficiency performance of the EU countries for the period between 1995 and 2019, compare it with the MC/GDP ratio to evaluate whether or not the mostly-employed traditional material intensity indicator is a good proxy for capturing the material efficiency performance of the countries in the sample.

Figure 1 Material efficiency and material intensity in the EU countries (1995-2019)

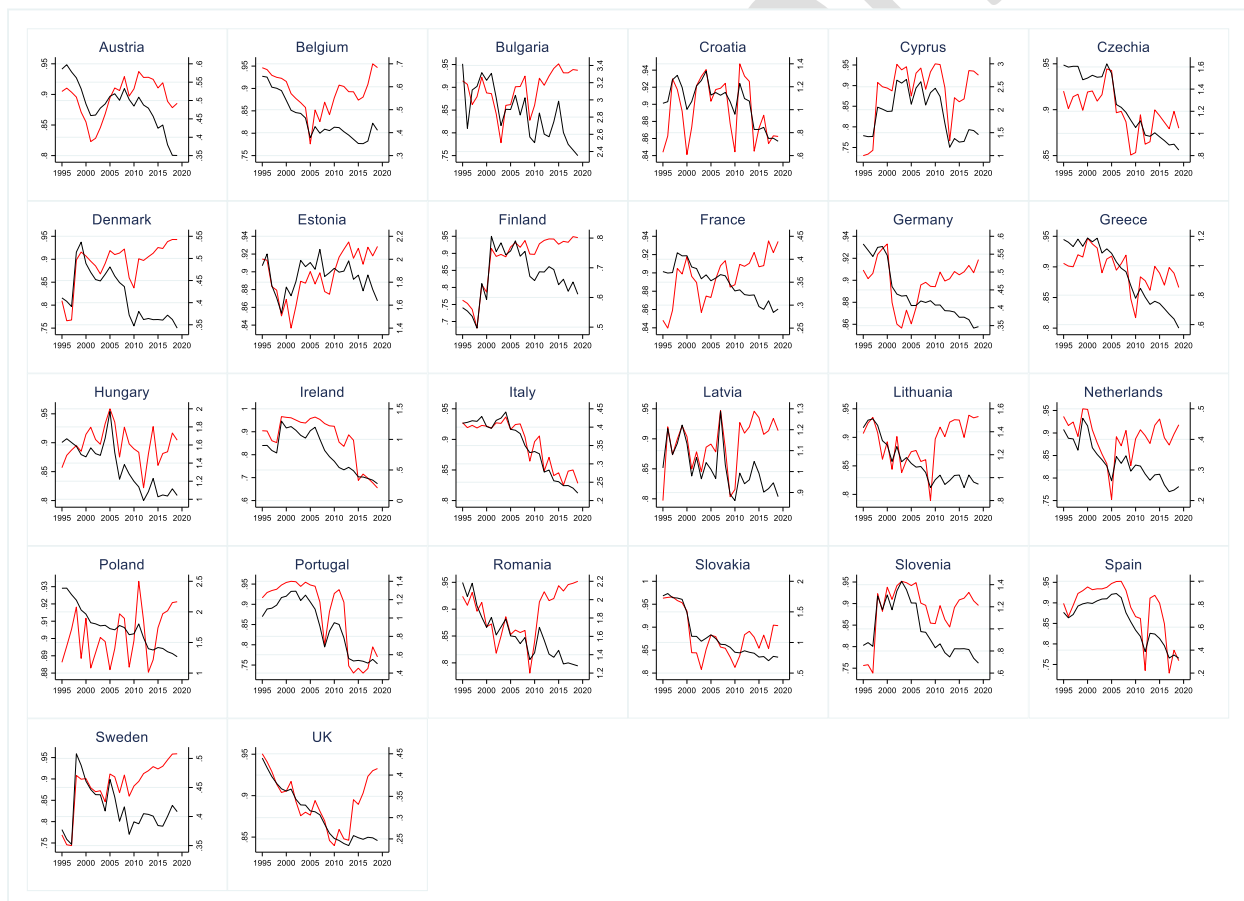


Figure 1 presents the evolution of the estimated SFA-based material efficiency (red line) and material intensity (black line) (the ratio of domestic material consumption to gross domestic product) for the period between 1995 and 2019. If material intensity were a good proxy for material efficiency, these two indicators would be negatively correlated, as discussed above.

However, as can be seen, there is no obvious inverse correlation between them, with the exception of a few countries, like France and Germany, Belgium (particularly after 2005), Denmark, Greece, the Netherlands, Romania, and Slovenia (especially after 2010). That is, material intensity may be a reasonable proxy for material efficiency in some countries (or for some specific periods), but not in others. Therefore, instead of heavily relying on a simple material intensity indicator, we must better quantify material efficiency using alternative methodologies to widen our understanding and better capture material efficiency dynamics.

References

- [1] S. Alataş, B. Hiçyılmaz, and E. Karakaya, "Material Demand and Material Efficiency for Sustainable Development in European Union Countries: A Stochastic Frontier Analysis," *Unpublished*.