Efficient production for sustainability: linear programming in an input-output framework.

Topic: Distributive consequences, allocative possibilities and resilience
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The global economic system is driving the planet toward ecological collapse. At the same time, approximately 2 billion people lack access to clean drinking water and 750 million suffer from hunger. Faced with these issues, several authors have explored the potential of redistributive policies and technological progress at a global scale to meet the basic needs of the world population without exceeding the planet's natural limits.

This has generally been done by using input-output models to compute the natural resources required to satisfy a vector of final demand that is considered the minimum necessary for human well-being. Although the coefficients derived from input-output tables are sometimes modified for various scenarios of technical progress, most studies have paid limited attention to variations in allocative efficiency that could enhance the satisfaction of human needs in a sustainable economy, given the existing technologies.

However, in the current global economic system, this kind of inefficiency can appear at various points. At the firm, sectoral and national levels, the allocation of resources among production units may not be the one that minimises the use of physical resources, even if it is the one that maximises profits. This kind of inefficiency can also appear at the global level. In particular, countries with relatively high resource intensities may account for a large share of production, while more efficient countries can play only a limited role in meeting global demand, leading to an overall inefficient allocation of production with regards to the use of natural goods.

This article focuses on the inefficiencies that arise at this latter global level. Several authors have theoretically demonstrated that changes in the distribution and, therefore, in the production costs of different countries have an autonomous impact on firms' location decisions, beyond technical considerations (Garbellini, 2021; Oro, 2025). Therefore, it is entirely possible that profit maximization is not aligned with minimizing the use of physical resources globally.

Despite this, we are unaware of any studies that empirically investigate the possibilities of reorganizing global production chains to ensure a good life for all within planetary boundaries. The aim of this article is to fill this gap by measuring the reductions in energy, emissions and labour that could be achieved if the objective of global production was not profit maximization but rather minimizing human and environmental physical requirements, while simultaneously meeting global demand.

This is achieved using linear programming techniques within a multi-regional global input-output model and with data from the GLORIA database. More specifically, based on observed input-output coefficients, we determine the physical inputs that each industry in each country requires to produce one unit of a good, without specifying the origin of these inputs. With this technical constraint, we allow the linear program to determine the optimal location of production, minimizing environmental and human impacts while guaranteeing a minimum level of decent consumption in all countries. Of course, the analysis explicitly incorporates the transportation costs resulting from production relocation, the constraints imposed by the availability of natural resources and labor in each country, as well as the differences in quality in the various countries where goods are produced.

Therefore, this article contributes to the existing literature by exploring an additional, as yet unstudied, avenue for guaranteeing a minimum level of material goods for the entire global population while respecting the planet's sustainability.