On the choice of technique and distribution in a finite world

Topic: Input-Output Theory and Methodology - II
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Be it the climate and biodiversity crises, the corona-virus pandemic, or the slashed grain and gas supply ensuing the war in Ukraine - global change and challenges require economies to adapt and to mitigate. On the supply side of such necessary transformation, technological change â€“ and technical change more broadly â€“ as well as substitution effects constitute important aspects. Technical change, however, also occurs without the immanent presence of crises but simply because of development, and substitution may be driven by different causes, including technical change. Similarly, the distribution of goods and services is not only affected in times of need but also by other factors.

Often, multiple alternative methods of providing goods and services are available, some of them more established than others. In addition to the great variety of incumbent establishmentsâ€™ input and distribution patterns, obsolete and emerging alternatives are often known, with ever more of the latter arising. The primary and intermediate requirements of such a great spectrum of production and distribution means can vary widely and often in not obvious ways. It may thus happen that, contrary to original intention, some of these alternatives exacerbate existing socio-economic and environmental challenges through direct and indirect repercussions.

Input-output (IO) analysis allows for examining such changes in production structure on a sectoral level. The basic IO framework was extended in a series of studies to also cover environmental considerations (Ayres & Kneese, 1969; Leontief, 1970; Duchin, 1990). The underlying demand-driven model is deterministic and relies on a square technology matrix where it is assumed that each commodity is produced by exactly one sector. Although one can now modify the input structure of each sector one-by-one so as to create counterfactuals (e.g. Rose, 1984; Wilting et al., 2008; Moran et al., 2020), it is not possible to represent alternative input structures for the same homogeneous output simultaneously without altering the matrix along both dimensions.

Under the term choice of technique, a variety of considerations were brought to paper concerning the choice among different production methods in an IO setting. Among these, Carter compared in a seminal study the competitiveness of alternative technologies when researching structural change in the US economy. Duchin and Levine (2011) then condensed her model into a more parsimonious and general set-up. While Carter (1970) employed her model for retrospective analyses, Duchin and Levine (2011) articulated theirs as a tool for sustainability scenario-modelling. Since then, the so-called rectangular choice of technology model, or RCOT, has been applied in various case studies.

In a world experiencing polycrises of increasing intensity, alternative means of production and distribution need to be examined and valued against biophysical and other limitations. RCOT is a tool that allows, under certain assumptions, to capture snapshots of optimal production structures. In my present contribution, I ask: Are the model assumptions underlying this demand-driven, resource-constrained single-production model timely? Can its formalism be adapted to answer questions regarding optimal distribution? And what extensions are required to make its use for analysing future structural changes more meaningful and its implications more plausible?

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