# The Path Extraction Method and its Application to Machinery and Equipment

Topic: Input-Output Modelling: Sustainable Production and Consumption policies (3)
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Two methods from input-output analysis, the Hypothetical Extraction Method (HEM)(1,2) and Structural Path Analysis (SPA)(3,4), are combined to create simplified analytical representations of production processes. The aim is to use detailed sector-level input-output data to produce unit process descriptions of identifiable product groups such as agricultural machinery. The approach relies on HEM to distinguish the contribution of the direct inputs of materials, energy, capital, transport services to the multipliers of each industry. SPA is then applied to identify contributions of direct suppliers to a given industry in question, investigating those paths (a.k.a. supply chains) which contribute significantly to the overall indicator in question. We illustrate the application of path extraction (PEX) to the greenhouse gas emissions (GHGE) of the production of construction machinery using the US environmentally extended input-output table with capital accounts (USEEIO-CA). Further, we further apply the method to compare electrical machinery production in China, Japan, Korea, and the United States. In the US example, the inclusion of the supply chain impacts of the direct use of materials, energy, transport, and capital in addition to direct emissions of each production process significantly simplifies the structural path analysis. Cut-off criteria need to be set to less than 0.5% of total impacts to consider more than the first tear of suppliers to each of the investigated production processes. Our comparative analysis shows surprising differences in the contribution of materials and energy in the four countries investigated which are then reflected in the multiplier. It also shows common patterns of suppliers and overall impacts.
Based on the analysis, we discuss how the PEX method can be applied to represent the production of detailed products using inputs of materials, energy, transport, and capital from more widely available and annually updated data sources such as EXIOBASE and how it could help to represent the dynamic material stocks of machinery, equipment, and structures used by various industries.
The research was prompted by the recognition that the second most important metal use is for machinery and equipment (ca. twice as important as vehicles and transport equipment)(1), but that there was a lack of a systematic top-down understanding or empirical bottom-up analysis of this sector. The recognition led to review papers(5,6) and an ongoing modelling exercise(7,8), which addresses both empirical aspects and scenario modelling. Our work shows that there is appreciable differences in the material use and energy use for producing different types of machinery and equipment which are grouped together into a single category in the European NACE classification and hence EXIOBASE. Using more detailed data sources is hence sensible.

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