A procurement tool for streamlined Input-Output sustainability Assessment

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Abstract. Data collection for supply chain sustainability analysis is a difficult and time-intensive task. We have therefore developed an application-oriented tool for streamlining sustainability analysis in the supply chain. We take monetary purchase data as starting point and feed them into an environmentally extended multi-regional input-output model, based on WIOD, EORA and Exiobase, complemented by numerous other satellite accounts based on official statistics, e.g., by ILOSTAT, Eurostat or the OECD. The tool is able to differentiate by upstream tier and to allocate impacts to the countries and sectors where they arise. Thereby, we take 188 countries and 56 sectors into account. The tool can display different scenarios (e.g., years or suppliers) and present results in charts and maps, allowing to quickly identify hotspots in the supply chain. Out of the 152 indicators, 62 measure impact in monetized values and 90 measure output in physical values. We consider economic (e.g., contribution to the gross domestic product or job creation), environmental (e.g., greenhouse gas emission, waste, water consumption and - pollution), and social (e.g., child labour or living wages) aspects. This results in both, footprints with negative effects and handprints with positive effects (e.g., employee training or job creation).

1 Introduction

Environmental, social and governance (ESG) performance along the supply chain (upstream) and their impact valuation as well as the related reporting are increasingly coming into focus of various stakeholder groups [1]. UN Global Compact states that “Supply chains continue to be one of the most important levers for business to create a positive impact in the world” [2] (p.2). This notion of holding companies accountable for the social and environmental conduct in their supply chains is increasingly being anchored in legislation, as the regulatory requirements for supply chain management keep getting more stringent and binding for a growing number of companies [1].

Upstream impacts can either be evaluated bottom-up or top-down. One popular approach to measure impact bottom-up is the process-based life cycle assessment (LCA) applied to organizations. It mainly prioritizes primary data collection at the product level and aggregates the results for the whole portfolio. Although examples for portfolio clustering methods are

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available, the time intensity of data collection is seen as one of the main challenges of LCA application on the organizational level [3, 4].

A popular methodology to calculate the upstream effect top-down is input-output (IO) analysis. With IO analysis, upstream effects can be calculated at company or organizational level [4] or for materials and material groups. For this aim, the purchase profile of a company (purchased goods and services categorized by sectoral specification and vendor country) is used as demand vector, so that the first-tier upstream effect reflects the country-sector characteristics of the company's suppliers. To calculate the effects of further supply chain tiers (tier 2-n), the average purchase profile of national industries is retrieved from input-output tables by tracing back financial transactions. Using macroeconomic data in combination with environmental indicators, IO analysis can be used to detect environmental and socio-economic hotspots in production of the whole portfolio or of specific materials or material groups with comparatively low effort. [5].

The aim of this paper was to introduce a tool for the streamlined sustainability assessment of companies' supply chains. It can be used by sustainability departments to identify hotspots as a starting point for more detailed product- or material-related assessments using primary data and process-based LCA databases as well as by procurement departments as a baseline assessment for the definition of sustainable procurement strategies.

The paper is structured as follows. Section two provides background information on the upstream impact assessment methodology. In section three, we discuss the data and data sources we fed into the model. Practical information on the visualizations and application of the tool are discussed in section four. Finally, section five identifies the limits of the tool and provides an outlook for future developments.

2 Methodological background

The Impact Valuation Tool is based on IO analysis, which was originally developed by Wassily Leontief [6] who earned the Nobel Prize in economics for the development of the IO model in 1973. Complementing the direct effects, which describe the immediate effects directly generated by a company, IO analysis allows for the calculation of indirect or upstream effects. Upstream effects arise due to the input the company consumes from other economic agents. Order placements result in an increase in economic activity at commissioned agents and their suppliers. This stimulus increases the gross value added (GVA) (can also be referred to as the contribution to the gross domestic product (GDP)), the greenhouse gas (GHG) emission, and other indicators along the supply chain, which are summarized under the term upstream effects. Other effects (e.g., employment, air emissions, water pollution, etc.) are calculated analogously using respective satellite accounts (see below). The model comes with an array of assumptions;[1] however, it is widely agreed that it is well suited for impact analysis [7].

3 Data sources

The Impact Valuation Tool is based on a hybrid model which combines WIOD (high sectoral resolution and solid economic base-data), EORA (large number of countries included) and EXIOBASE (many indicators available in the satellite accounts). In the current version, the WIOD database shows the global interdependence of 56 economic sectors. It allows the

[1] The assumptions of the Leontief model are: 1) Constant returns to scale, i.e., the same amount of inputs is required per unit of output regardless of the level of production. 2) No supply constraints, i.e., no restrictions on raw materials, services, or other inputs such as employment. 3) Fixed input structure, i.e., there is no input substitution in response to a change in output.

analysis of the international interdependencies of 43 countries and an aggregate that summarizes the rest of the world. To be able to extend the impact analysis to other countries, this aggregate was distributed among the individual countries using the information from EORA. Due to the higher country resolution of EORA, a total of 188 countries and 56 sectors can be analysed [8, 9].

The satellite accounts are an important extension of the input-output framework, which are used to link the monetary flows of goods and services to other indicators of interest [10]. The databases mentioned above already contain many economic, environmental, and social indicators, inter alia land- and sector-specific data on GVA, employment, compensation of employees, GHG, water consumption, and land use. However, since the need for indicators for a comprehensive sustainability analysis cannot be met solely with the available multi-regional input-output datasets, we collected data from various official data sources, such as ILOSTAT, Eurostat, and the OECD, built additional satellite accounts and adapted them to the sectoral and geographical structure of the multi-regional input-output table.

See table 1 for an overview of the different indicators sorted by impact area.

Table 1. The indicators sorted by impact area.

Indicator	Impact Area	Further disaggregation	Monetized
Employee benefits expense	Economic	By skill level	Yes
GDP contribution	Economic	-	Yes
Jobs created	Economic	Headcount and FTE / by skill level	No
Air pollution	Environmental	By pollutant and sociospatial structures	Yes
Carbon monoxide	Environmental	-	No
GHG	Environmental	By pollutant	Yes
Land use	Environmental	By type of use and arable crop	Yes
Waste	Environmental	Hazardousness / type of disposal	No
Water consumption	Environmental	Blue and green	Yes
Water pollution	Environmental	By pollutant	No
Child labour	Social	-	Yes
Human capital	Social	-	Yes
Modern slavery	Social	-	Yes
Occupational health & safety	Social	Nature and severity of health and safety issue	Yes
Social protection	Social	-	No

4 Visualization and application

In summary, the Impact Valuation Tool allows the user to perform a sustainability hotspot analysis within the supply chain with comparatively low effort. The results are differentiated by supply chain tier, sector, country, supplier, and material group or specification. It thus enables sustainable procurement decisions and eco-design measures in the Research and Development department by providing information on sourced materials and offering the possibility of depicting different scenarios, e.g., for different materials to be employed in product development. Furthermore, it supports companies in complying with current and upcoming supply chain regulations.

The results are additionally displayed graphically, inter alia, in a triple bottom line diagram and in a world map. The graphical representation of the results is interactive. This allows the data to be filtered and displayed by the different input variables, promoting a direct and intuitive gain of knowledge. See figure 1 for an example of the graphs and the selection options.

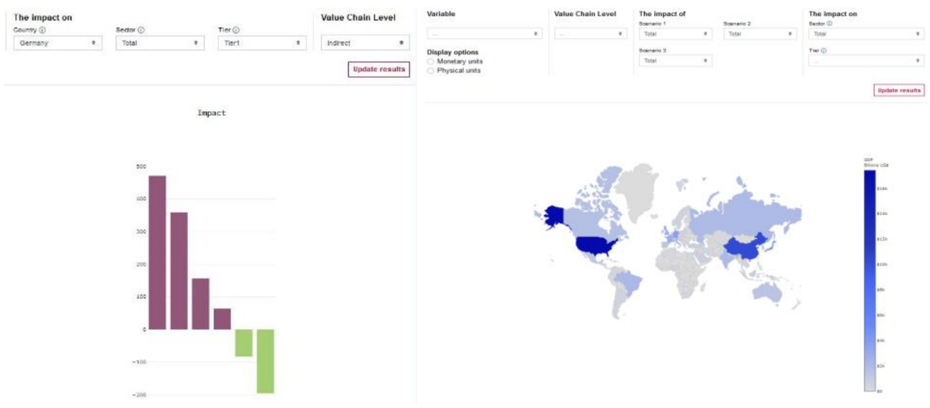

Fig. 1. Examples of 2 graphics for fictional company spend data. The left graphic shows the monetized impact of the company in Germany for six different indicators. The left four bars indicate a positive impact while the two bars on the right side indicate a negative impact. The right diagram shows the global distribution of one indicator. In this example, the impact is strongest in the USA followed by China. Both graphics interact with filters, where the underlying data can be selected dynamically.

5 Limits and Outlook

The tool can be used for a streamlined upstream sustainability assessment of a company's supply chain, considering the three domains of sustainability, social, environmental, and economic. Based on corporate purchasing data, both positive and negative supply chain effects are calculated. The tool can be used to calculate upstream effects for the whole product portfolio of a company, for specific suppliers or for specific materials. However, the tool cannot be used to analyse the supply chain effects of specific products. For product-specific analysis, process-based LCA data yield more precise results due to the higher technological specificity provided.

In the future, the tool will be expanded to include additional components. For example, it is intended that direct effects can also be calculated and displayed graphically in order to provide a more holistic picture of a company's impact. In addition, sector-specific benchmarks that allow a simple and straightforward comparison of the effects are intended to be added. Finally, we are working on the possibility to calculate scope 3 emissions according to the categorizations provided by the GHG Protocol with the tool in the future.

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