What can LCA learn from economics?

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Abstract

Life Cycle Assessment (LCA) is increasingly recognized as a complete tool that supports decisions towards more sustainable product systems. However, the variability of results which, at times, are even conflicting, questions the robustness of LCA for decision support. The discrepancy of results has continued despite numerous attempts at harmonization and standardization of LCA methods. Different modeling approaches have been put forward to contextualize the decision to be supported, but this has had the perverse effect of greater variability of results and questioned further the suitability and objectivity of LCA as an appropriate tool. This paper explores the insights from economics that LCA can adopt to make it a more realistic, relevant and robust tool with which sustainable decisions can be supported. It argues that LCA is firmly rooted in neoclassical economics and that much could be gained with insights that have already been established for a long time in that discipline.

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Introduction

Life Cycle Assessment (LCA) is increasingly recognized as a complete tool that supports decisions towards more sustainable product systems. However, the variability of results which, at times, are even conflicting, questions the robustness of LCA for decision support. The discrepancy of results from different studies has continued despite numerous attempts at harmonization and standardization of LCA methods.

Currently, LCA underpins a wide range of policies in several countries. In Europe, LCA has supported the development of the Renewable Energies Directive (2009/28/EC), the Integrated Product Policy Communication (2003), the Sustainable Consumption and Production Action Plan (2008), and several other legislative documents related to resources, critical raw materials, waste, ecodesign, industry, environmental management and ecolabels. In addition, environmental product declarations and associated product category rules attempt at providing consistent approaches in assessing and communicating the environmental impacts of products.

Several guidelines now exist for LCA in addition to the ISO14040 series of standards (e.g., for carbon footprinting and water footprinting), as well as international guidelines such as PAS2050 (2008), ILCD

Handbook (2010), IDF (2010), GHG Protocol (2011), PEF guide (2012), and more recently three more by FAO, still undergoing public consultation.

A closer look at these guidelines shows inconsistencies within and between the guidelines themselves and relative to the ISO 14040/44 standards, which precludes meaningful comparisons between studies.

The consequence of the proliferation of all these guidelines is that their individual aim of ensuring quality, standardization and reproducibility in LCA practice is not fulfilled; on the contrary. This questions the credibility of LCA studies (Weidema, 2014).

Understanding what LCA is

Some of these guidelines now allude to "decision contexts" and prescribe a certain approach to model the system under study depending on the type of decision the LCA is intended to support. The notion that modeling approaches as such are dependent on the type or scale of the decision has already been questioned (see e.g. Weidema 2003, 2014). Furthermore, many of these guidelines now recommend allocation over system expansion when dealing with multifunctional activities and thereby contradict the ISO hierarchy. This recommendation implies a misconceived perception of what LCA is and a lack of understanding of how misleading it can be to use arbitrary modeling approaches for the support of decisions that have real life consequences. This again stems from a lack of understanding of the interrelated nature of product systems in a global economy. Acknowledging the interdependence of system components is a basic feature of any systems approach.

This presentation highlights the insights from economics that LCA needs to be realistic, relevant and robust. We argue that LCA is firmly rooted in neoclassical economics and that much can be gained from applying insights that have already been established for a long time in that discipline.

Marginal utility

A fundamental concept in economics is that of marginal utility, i.e. the utility obtained from a small additional unit of a good. Marginal utility determines demand and supply, in the sense that the quantity of products produced is determined by the point at which the marginal cost (i.e. the cost of producing an additional quantity) equals the marginal utility. To analyze and compare the consequences of small variations in demand, which is essentially what we do in LCA, it is therefore necessary to understand marginal utility and its influence on supply. Since marginal utility expresses the value of a change in the availability of a good, it also plays a central role for the determination of the value of different environmental impacts. For this purpose, marginal utility is determined from willingness-to-pay studies. Because marginal utility decreases with increasing wealth (a $ is more worth to a poor person than to a rich), it is also a central concept in distributional equity assessment (who carries the burdens and how does that influence our impact assessment) and the distribution between generations (discounting of impacts).

So from this rather simple concept of marginal utility, a lot of practical assessment procedures have been derived, that are essential to LCA modeling.

Shifting of Burdens

The feature that most distinguishes LCA from other quantitative sustainability assessment tools is its comprehensiveness. LCA is characterized by an approach where the shifting of burdens will not go unnoticed, such as those between different:

- life cycle stages
- impacts
- countries
- generations

Therefore, it goes against the LCA's fundamental ethos to ignore indirect effects by excluding significant parts of the real product system. Thus, in the modelling of the targeted product, practitioners should include all impacts that may arise from the decision under study, instead of artificially truncating the system.

Indirect effects from use of products must be modeled as the consequences of the change in demand for that product. This implies a change in supply from the marginal producers, which are typically those with the lowest production costs. Detailed procedures for identifying marginal suppliers have been published, e.g. in Weidema (2003). An important concept in these procedures is that of constraints, again a central concept from economics.

Constraints

As described in ISO 14049, "the supplementary processes to be added to the systems must be those that would actually be involved when switching between the analyzed systems. To identify this, it is necessary to know (…) whether any of the processes or technologies supplying the market are constrained (in which case they are not applicable, since their output will not change in spite of changes in demand)"

Such constraints are well known. For example, hydropower supply in Norway is operating at its limit and is not able to respond to increasing demands for electricity. All the by-products of a multi-product activity are constrained by the determining product of this activity, and can therefore not react to a change in demand. The consequence is a shift to the marginal substitute for the by-product. When all suppliers to a market are constrained, e.g. when a multi-product activity has more than one determining product and these therefore become mutually constraining, the consequence is a reduction in demand by the marginal consuming activity (the one most sensitive to price changes). The modeling of these different situations is described by Weidema (2003, 2009).

An often overlooked implicit constraint in LCA is that of partial equilibrium, since overall output and consumption are fixed. All consumer expenditure is taken out as primary factors (wages, taxes, profits and rents), thus keeping the overall production output constant. To avoid violating this equilibrium assumption, it is necessary to compensate any savings in monetary spending, e.g. from a product improvement, by including the consequences of a corresponding increase in marginal spending, and vice versa for an increase in cost. The included compensation is known as a first order price rebound effect (Weidema 2008).

Dealing with trade-offs

When an LCA result shows a decrease in some impact categories and an increase in others, it is necessary to perform a weighting among impacts in order to reach a conclusion. All approaches for weighting in LCA rely on the expression of preferences, either of specific individuals (panels of experts or laymen, or politicians). Monetary valuation rests on the premise that maximizing social utility can best be done by soliciting the preferences (willingness to pay for a marginal change) of a representative group of individuals, and is common practice in similar tools, such as Cost Benefit Analysis (see e.g. Pizzol et al. 2014).

Since impacts are not distributed equally over the population, a complete assessment must include a distributional equity assessment. Here it plays an important role that marginal utility decreases with increasing wealth (so the same impact is worse for a poor person than for a rich). This implies that the impact assessment results should be corrected for the relative marginal utility of the affected population group (Layard et al., 2008).

Some of the environmental impacts occur in the future, and here it is normally assumed that the marginal utility for future generations is lower because of the general economic growth. This implies that the impact assessment results should be corrected for the decreased importance of the future impacts. This is also known as discounting. Discounting has not yet become common practice in LCA. But the example of lower characterization factors for greenhouse gas emissions (Brandão et al. 2013, Schmidt et al. submitted) shows the need for a more consistent introduction of discounting in LCA. In the scientific community of economists, consensus has been increasing on moderate and temporally decreasing social discount factors (see e.g. Gollier et al. 2008). For consistency, it is important that the discounting applies the same values for the elasticity of the marginal utility as those used in the distributional equity assessment.

Conclusions

By definition, LCA is a whole systems approach that does not artificially truncate the system under study, so that significant impacts are not ignored in decision making. Despite it being developed mainly by environmental scientists and chemical engineers, there are various insights from LCA – some already adopted to a degree – that make LCA a better tool for supporting transitions towards more sustainable systems. A narrow approach can no longer be justified since existing economic tools enable a more complete delimitation of the system boundary. These tools include consequential modeling approaches, monetarisation, equity weighting and discounting. If these are adopted, the direction towards better product systems can be identified.

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