



# Relevance of attributional and consequential information for environmental product labelling

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## Abstract

**Purpose** Considering the general agreement in the literature that environmental labelling should be based on consequential modelling, while all actually implemented environmental labelling schemes are based on attributional modelling, we investigate the arguments for this situation as provided in the literature, and whether a dual label, representing on the same label the attributional and consequential results for the same product, can be a relevant solution or at least contribute to a more informed discussion.

**Methods** We developed a dual label for three hypothetical, comparable products and presented this for a small test audience, asking three questions, namely “Which product would you choose?”, “Was the attributional information useful?” and “Would you accept to have only the attributional information?”

**Results and discussion** From this small pilot exercise, it appears that informed consumers may have a strong preference for consequential information and that the main problem in communicating consequential results is that they are perceived as less trustworthy and more uncertain due to the fact that the consequences are located in the future. It thus appears important to build into a consequential label some increased level of guarantee of future good behaviour.

**Conclusions** We propose to apply the above questions to a more statistically representative audience to confirm or refute the findings of this little test exercise.

**Keywords** Additivity · Consumer acceptance · Environmental labelling · Past environmental impact · Product comparisons · Product improvements · Scale of decision · Uncertainty

## 1 Introduction

Attributional and consequential models in life cycle assessment (LCA) provide different perspectives on the same products, reflecting differences in the purpose of the assessment. The two modelling paradigms can lead to very different results when applied to the same product, see, e.g. Weidema (2017) and Schmidt and de Saxcé (2016).

In most applications of LCA, the information is ultimately intended for making improvements to the studied systems and the applied model should therefore compare the consequences of choices between different improvement options. The ILCD Handbook also recommends that when LCA is used as decision support, the LCI model should reflect the consequences of the decision (JRC-IEA 2010, p. 37).

An Environmental Product Declaration (EPD) can, as expressed by Rydin (2014), “be seen as means for the customer to influence the environmental impact of the purchased products, which gives a requirement on the EPD that it reflects the expected environmental consequences of buying the declared product compared not to buying it”, thus making the information from a consequential model the most relevant. For a customer that seeks information with this intention, an environmental label based on attributional modelling may be misleading, as was already pointed out by Weidema (2001). Also, Tillman (2010) recognises that “purchasing inherently involves decisions, and according to the logic described

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above, information intended to support it, such as eco-labels, carbon footprints and environmental product declarations, should be based on consequential LCA”.

Yet, all actually implemented EPD schemes specify that an attributional modelling approach should be applied (see, e.g. EPD International 2015), i.e. a modelling where the aggregated impacts are those of the specific or average market suppliers of the inputs to the production, traced backwards in the value chain or supply chain, using one or more specific product properties, often economic value. We have not been able to find any clearly expressed reasons for this choice in the documents of the EPD schemes, but descriptions in other sources, cited below, allow us to speculate several explanations:

- Product declarations in general, especially those of content or origin, usually imply a tracing of the history of the specific product, rather than any consequences of purchasing and consuming it. When transferred to the area of environmental impacts, this could intuitively appear to imply that an EPD should be a declaration of the past environmental impact of the specific product and its expected use and disposal phase, but not specifically intended to indicate the environmental consequences of buying the declared product (Rydin 2014).
- Each environmental label is provided for one specific product only and therefore does not immediately seem to indicate any comparison to any other product, and even though the information is only actionable after the customer has done such a comparison, the sender of the information does not know what comparisons the customer will make (Tillman 2000, 2010). However, as pointed out by Weidema (2003, p. 17): “a consequential LCA may very well assess the consequences of production, use and disposal of a defined quantity more or less of the investigated product. This can be done independently for any product, without prior knowledge on the specific comparison that each assessment may later be used for. Later, when specific comparisons are required, these may be obtained simply by subtracting the individual product systems. These comparisons will be valid as long as the product quantities studied are small.”
- The individual purchases of labelled products may appear so small that it can be counter-intuitive to think that the purchase will have any consequences at all beyond a simple change in capacity utilisation of the existing production infrastructure, cf. the idea that “if I stay at home instead of flying, the plane will fly anyway”. The fault in this logic is of course that any additional purchase sends a signal to the producers and the sum of all the small signals is what eventually will lead to changes in production capacity (Weidema et al. 1999), e.g. the purchase of an extra aeroplane. The faulty logic is parallel to the idea of a voter that stays at home with the argument that “my vote will not change anything”. This logical error also appears in the statement in the ILCD Handbook (JRC-IEA 2010, p. 39) that “small-scale marginal consequences alone are not strong enough to overcome thresholds and trigger large-scale consequences in the market” which leads to the recommendation to use average data rather than marginal data for “micro-level decisions”, such as environmental labelling, in spite of the Handbook’s general recommendation to use marginal (consequential) modelling when LCA is used for decision support. The statement begs the question why an environmental label is relevant at all if it is not expected to contribute to any large-scale (and long-term) consequences? The ILCD Handbook misrepresents the model for “micro-level decisions” as being “attributional”, when in fact it is applying consequential modelling of co-production (popularly known as system expansion), although with average data instead of marginal. This misrepresentation may be the reason for more recent publications conveying the misunderstanding that attributional models already “describe the effect of changes” while consequential models should only be relevant “when changes are made to established processes” (Muthu 2014, p. 115).
- An important feature of EPD information is additivity, i.e. that an EPD of an assembled product can be calculated as the sum of the life cycle impacts of the assembled parts plus the impacts from the assembling activity itself. That only an attributional model should provide such additivity is postulated by Tillman (2000), a postulate that is repeated in Tillman (2010) although already Weidema (2003, p. 16–17) pointed out that this feature is also inherent to consequential models. The reason for the misunderstanding may be the (unrelated) fact that the sum of consequential LCA results for all products in the world does not sum to the total global impact of all human activities, because the impacts of a marginal product are different from the impact of the corresponding average product.
- Consequential EPDs include market-mediated impacts, and ideally also rebound effects (Christiansen et al. 2006), which may sometimes show results that can be seen as surprising or counter-intuitive. Schmidt and Poulsen (2007) suggest that counter-intuitive results may lead to non-acceptance by consumers, although this has not been tested in practice. In contrast to this, one could argue that if results were always intuitive, there would be no need for EPDs.
- Also applicable to environmental labelling, Vessia (2013) and Brandão et al. (2014) suggest that for some policy implementations, as opposed to policy development, precision may be more important than accuracy, and Wardenaar et al. (2012) suggest that consistency of the assessment with the policy objective may be less important than robustness, where robustness is understood as

invariance of the assessment outcomes to uncertainty and changes in real-life conditions, e.g. by choosing a physical allocation key that does not change over time. However, the robustness of a decision is not normally understood as a decision that ignores real-life uncertainty and requires precise and fixed outcomes, but rather as a decision that remains valid under uncertainty and changes in real-life conditions. This can be obtained by combining consequential modelling with robust decision methods (see, e.g. Hall et al. 2012). And if precision or invariance of assessment outcomes is required for a specific policy implementation, this can more simply be obtained by applying temporarily fixed assumptions and background data to the same consequential model that is used to provide assessments consistent with the policy objective.

- While popularity is not an argument for validity or relevance, it may be a strong argument for practical decision-making, as evidenced by “the much stronger history in use” (Henry et al. 2016, p.61), i.e. that it “is more commonly used at present” (ibid, p.6), being used as argument for choosing an attributional approach for the guidelines for LCA of wool textiles—including also other applications than environmental labelling—although “it is anticipated that Guidelines for consequential LCA for wool [...] will be developed in future. This will help to overcome the inherent limitations associated with attributional LCA that constrain use of results” (Henry et al. 2016, p. 63).

Both the theoretical literature reviewed above and the practical application in EPD schemes show that the relevance of attributional and consequential information for environmental labelling is still a debatable issue. In this article, we therefore investigate whether a dual label, i.e. representing on the same label the attributional and consequential results for the same product, can be a relevant solution or at least contribute to a more informed discussion.

## 2 Methods

As shown in Fig. 1, we developed a dual label and applied this to three hypothetical products, A, B and C. The three products are comparable, i.e. they all deliver the same performance and have the same functional unit. The LCA results are hypothetical, to illustrate clearly different results, but they are still realistic, i.e. it would be possible in real life to encounter three comparable products with such LCA results. The top label for each product is the attributional label, while the bottom label is the consequential label.

We now used the representation in Fig. 1 to solicit answers to the question “Which product would you choose?” using a test audience composed of 19 Ph.D. students with a thorough

LCA background. Given the very small and not randomly selected audience, the intention of this test was not to obtain unbiased or statistically representative answers, but simply to obtain a first indication of the potential relevance of such a dual label. Before explaining further, we would urge the reader to consider the question in Fig. 1 to obtain a first-hand experience of the thoughts that this question can provoke.

Our test audience was presented with a variant of these labels where the unit was “hours of forced labour” instead of “kg CO<sub>2</sub>-equivalents”, with the expectation that this would provoke more distinct answers and arguments.

The test audience was then asked in plenum to articulate their deliberations and arguments for their choice. After some plenum discussion on the arguments, two more questions were asked: “Was the attributional information useful?” and “Would you accept to have only the attributional information?”

After the initial test, the same questions, using the labels in Fig. 1, were applied with a larger audience at the SETAC-Europe LCA case studies symposium in Barcelona, November 2017, as well as with another group of 25 Ph.D. students, in both cases using anonymous answering via the Web Clicker online response system.

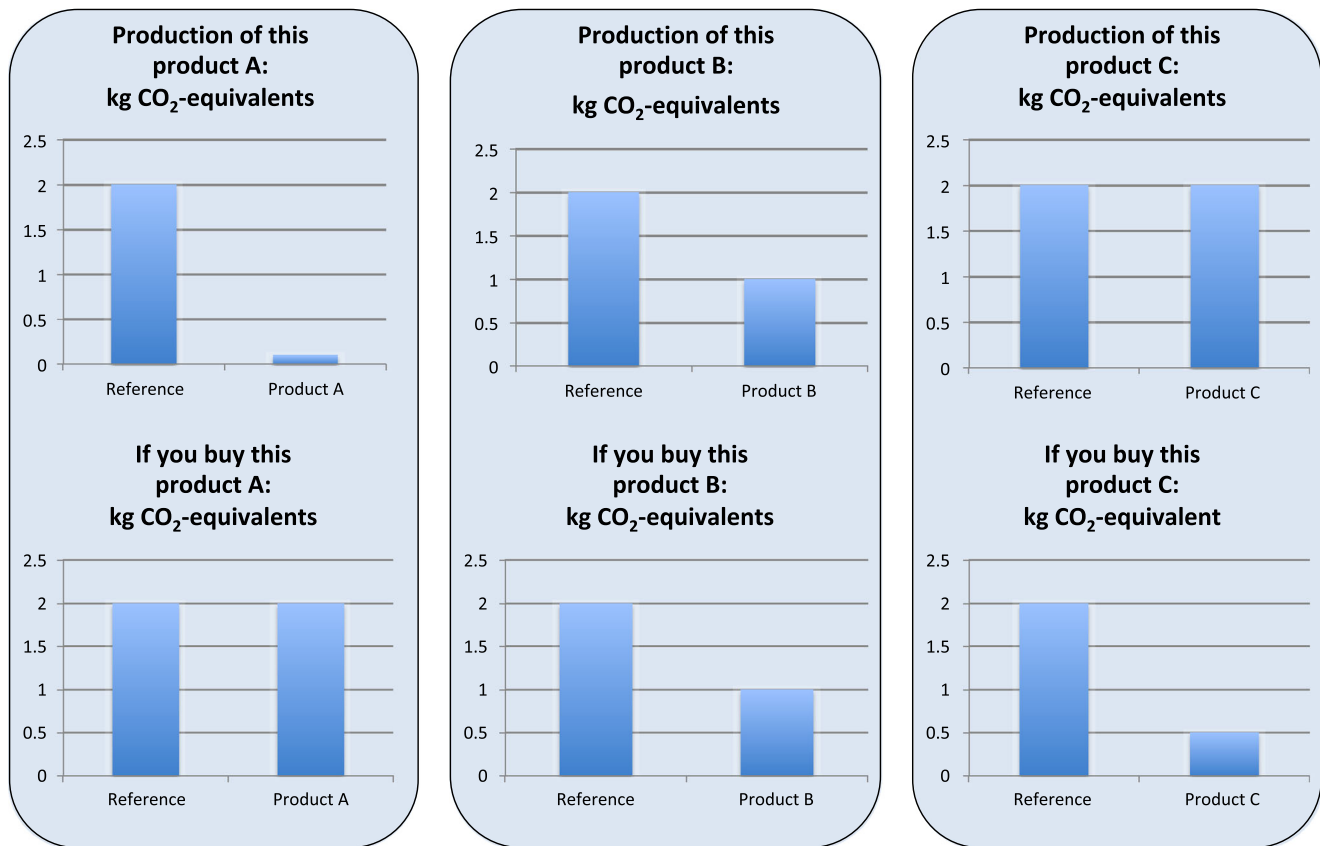
## 3 Results

After some time for deliberation on the first question (“Which product would you choose?”), 16 out of 19 students answered that they would choose product C, two would choose product A, and one would choose B. This distribution between response options was largely confirmed by the later application to the two other audiences.

Given the very small and not randomly selected audience, what is interesting here is not so much the distribution of the answers, but rather the arguments given afterwards, especially the arguments for the “deviating” preferences for products A and B. While the preference for product C was supported by the argument that this would lead to the largest improvement, the preference for product B was supported by the argument that both labels showed an improvement, thus giving less uncertainty. The exclusive argument given for the preference for product A was that a low impact reported by the attributional label indicated past good behaviour, which was perceived as a providing a good indication for the expected future impact, while it was perceived as more uncertain whether the improvement indicated by the consequential label could actually be trusted to happen. Interestingly, traceability was not used as an argument in favour of the attributional label.

In the following discussion, it was pointed out that the reason for the relatively low attributional impact of products A and B does not need to be the result of past good behaviour, but can simply be the result of products A and B by chance

# Which product would you choose?



**Fig. 1** Three dual labels: For each of the three products A, B and C, which provide the same functional unit, a dual label is provided. The top labels are attributional, while the bottom labels are consequential

being located in a supply chain with a lower occurrence of impacts. One example given was that of average Norwegian electricity being dominated by “clean” hydropower, while the marginal Norwegian electricity could be based on fossil fuels. Norwegian producers—without any active performance improvements—will thus have an attributional label with a low CO<sub>2</sub> emission relative to other countries, while the consequential label reflects that buying Norwegian products will affect the marginal electricity with its higher CO<sub>2</sub> emissions.

To the second question: “Was the attributional information useful?”, the general finding was that this information was more confusing than helpful. The dual label should thus rather be seen as a vehicle for investigation into the relevance of attributional and consequential information than as an actual proposal for providing both types of information.

To the final question “Would you accept to have only the attributional information?”, the answer was a unanimous “No”. This is of course in stark contrast to what is provided by all currently implemented EPD schemes.

## 4 Conclusions

From this little pilot exercise, it appears that informed consumers *may* have a strong preference for consequential information and that the main problem in communicating consequential results is that they are perceived as less trustworthy and more uncertain due to the fact that the consequences are located in the future. This is in spite of the knowledge by the respondents that the attributional and consequential labels are based on the same data from the recent past (but respectively representing the recent past average and the recent past marginal) with the same degree of data quality and uncertainty. It thus appears important to build into a consequential label some increased level of guarantee of future good behaviour.

We propose to apply the above questions to a more statistically representative audience to confirm or refute the findings of this little test exercise.

## Compliance with ethical standards

**Conflict of interest** The authors declare that they have no conflict of interest.

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