Comment on ‘From the Paris Agreement to corporate climate commitments: evaluation of seven methods for setting “science-based” emission targets’

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Abstract

A study from Bjørn et al (2021) suggests that methods to allocate emissions to companies proportionally to their economic growth are consistent with equity-related principles and are effective at conserving a global emissions budget while the science based targets initiative’s (SBTi’s) absolute contraction approach (ACA) fulfills neither qualification. Here we identify four areas of concern with the study and propose a more comprehensive approach to science based targets (SBT) method evaluation. We respond that first, the authors’ method characterization does not differentiate between the emissions allocation that occurs in mitigation scenarios and that which is normatively caused by method formulae, and it misinterprets the drivers of emissions allocation in scenarios. Second, we note that the authors evaluate a method formula for ACA that does not match its use by the SBTi. Third, we acknowledge that allocating emissions based on economic growth can yield incoherent results by comparison to published climate change mitigation scenarios and suggest the authors also evaluate whether methods are effective at conserving sub-global emissions budgets. Fourth, we observe that although the study is framed as an evaluation of SBT methods, it relies almost entirely on assessments of one characteristic. We conclude by proposing a set of principles that should be met by effective SBT methods and a high-level assessment of SBT methods against these principles.

1. Introduction

It is more important than ever to use science as a tool in efforts to halt the climate crisis; the question is ‘how?’ While integrated assessment models (IAMs), bottom-up sectoral studies, and other research describe visions of system-wide transformations that could meet the aims of the Paris Agreement, their outputs are illustrative rather than instructive (Edenhofer and Kowarsch 2015). Science-based targets (SBT) methods are used to calculate greenhouse gas (GHG) emissions reduction targets deemed compatible with a global climate goal, supporting companies to steer the ambition of their climate efforts.

In ‘From the Paris Agreement to corporate climate commitments’ (Bjørn et al 2021), the authors propose a characterization and evaluation of seven SBT methods. In doing so, they introduce a metric called emission imbalance (EI), which describes how closely global emissions would approximate the emissions pathway of a desired scenario if all companies were to reduce emissions in-line with a method. EI captures an important quality of SBT methods, and we look forward to its use in the broader effort to compare SBT methods.

As the team behind the science based targets initiative (SBTi), we are mindful of the need to consider SBT methods systematically and holistically.
Although Bjørn et al is guided by several important questions, we encountered four issues with the authors’ analyses and conclusions:

(a) The summary of method characteristics (Bjørn et al’s table 2) is in some cases incorrect and does not differentiate between the emissions allocation that occurs in scenarios and that which is normatively caused by SBT method formulae.

(b) The SBT method formula used for the absolute contraction approach (ACA) does not match the SBTi’s application of ACA (pp 12–17). If the authors had used the SBTi’s application of ACA, the method would have received a favorable EI score.

(c) The authors do not acknowledge that allocating emissions based on economic growth, which is a principle underlying four of the seven methods, can yield incoherent results by comparison to published climate change mitigation scenarios.

(d) Although the paper is framed as an evaluation of SBT methods, it relies almost entirely on assessments of one characteristic (EI) without assessing other characteristics of interest or providing adequate context as to why they might be important.

We start by reviewing the elements that combine to form an SBT method. Next, we address each of the four issues in sequence and, where possible, share alternative approaches that we believe are more appropriate for evaluating SBT methods. We conclude by proposing a set of principles that should be met by effective SBT methods and a high-level assessment of SBT methods against these principles.

2. Background: elements of an SBT method

SBT methods involve four elements, which we adapt from Faria and Labutong (2019):

- Input variables: information companies must provide for their targets to be calculated.
- Parameters: the targeted temperature increase above pre-industrial levels and the global or sector scenario chosen to define target ambition.
- Model: allocation principles upon which the method determines how the global GHG emissions budget is disaggregated to the individual company level, and the allocation formula used to calculate targets from input variables and parameters.
- Output results: the features that define how a target is expressed as a result of all the information above.

Some SBT methods include sector or regional differentiation. Likewise, IAMs and cross-sector scenarios are used to explore the differentiated options and implications of a full-system transformation that meets climate goals (Weyant 2017, Wilson et al 2017).

2.1. Issue 1: characterization of SBT methods

We see importance in ‘systematically identifying the characteristics’ of SBT methods (p 3); however, we believe the approach proposed by Bjørn et al is unclear and in some cases incorrect. In this section, we propose a characterization of SBT methods (table 1) that differentiates between the characteristics of granularity, formula allocation, and scenario choice, instead of combining these to derive a set of allocation principles (p 4). We use granularity to indicate whether global, regional, or sectoral pathways are used; formula allocation to describe how the relevant pathway is allocated to companies; and scenario choice to indicate which scenario is used. Grunarlity and scenario choice collectively determine which specific global, regional, or sectoral pathways are used, while formula allocations determine how a pathway is translated into a company target. The distinction between these characteristics is important because scenarios allocate emissions across regions and sectors independently of company input data, while method formulae use company input data to calculate targets based on a subset of Bjørn et al’s allocation principles. We adopt this subset of allocation principles in our characterization but refer to them more specifically as formula allocation principles.

Examining formula allocation and granularity separately is insightful in several ways. It shows that the greenhouse emissions per unit of value added (GEVA), British Telecom–Carbon Stabilization Intensity (BT-CSi), Corporate Finance Approach to Climate-stabilizing Targets (C-FACT), and Center for Sustainable Organization (CSO) methods use the same type of allocation formula and formula allocation principles but vary in whether the formula is used to allocate a global or regional pathway to companies (supplementary text 1 available online at stacks.iop.org/ERL/17/038002/mmedia). The characterization also illustrates that one could readily use the absolute contraction formula type with a regional or sectoral emissions pathway, as is the case with the information and communication technologies sector absolute contraction approach (ICT-ACA) that was jointly developed by the International Telecommunication Union, GeSI, the GSM Association and the SBTi in 2020 (ITU/GeSI/GSMA/SBTi 2020). This method was not included in Bjørn et al’s assessment but has been included in our characterization.

Our characterization keeps granularity entirely separate from scenario choice instead of combining these as ‘derived characteristics’ (Bjørn et al’s figure 1). This separation reflects that scenario choice is largely independent of the allocation model, and it avoids inaccurate generalizations. For example, Bjørn et al incorrectly assume that regional differentiation
Table 1. Our SBT method characterization.

| Type of allocation formula | Formula allocation principles | SBT method and description | Granularity | Scenario choice | Reference |
|----------------------------|-------------------------------|-----------------------------|-------------|------------------|-----------|
| Legacy entitlement (or grandfathering) | X | Economic contribution | Global | None | ITU, GESI, GSMA and SBTi (2020) |
| Economic contribution | X | Physical production | Regional | X | Sub-sector classification | ITU, GESI, GSMA and SBTi (2020) |
| Physical production | X | Company variables required in addition to base year, base year emissions, and target year | Sectoral | X | ICT sub-sector emissions re: sub-sector based on a 43% ICT sector emissions reduction by 2030 from 2020 levels | ITU, GESI, GSMA and SBTi (2020) |
| Economic intensity contraction | X | X | Global emissions (and intensity): 75% (91%) reduction by 2050 from 2010 (2017) levels | Global emissions (and intensity): 86% (96%) reduction by 2050 from 2015 levels | Randers (2012), ITU, GESI, GSMA and SBTi (2021) |
| British Telecom Carbon Stabilisation Intensity (BT-CSI) | X | X | Country development status | Developed country emissions (and intensity): 80% (99%) reduction by 2050 from 1990 (2007) levels | Tuppen (2008) |
| Corporate Finance Approach to Climate-stabilising Targets (C-FACT) | X | X | Country development status, projected change in value added | Developed country emissions: 85% reduction by 2030 from unspecified levels. Developing country emissions: 50% reduction by 2030 from unspecified levels | Stewart and Deedhar (2009) |
| Center for Sustainable Organizations' Context-Based Carbon Metric (CSO) | X | X | Base year value added, projected change in value added | Global emissions (and intensity): 86% (96%) reduction by 2030 from 2015 levels | CSO (2020) |
| Modified absolute contraction | X | X | Sector classification, projected change in sector’s market share | Sector reduction opportunity: varies by sector based on a 23%–48% reduction in developed country emissions by 2020 from 1990 levels | WWF/CDP 2013 |
| Physical intensity convergence | X | X | Sector classification, base year output, projected change in output | Sector emissions: varies by sector based on an 86% reduction in energy and industrial process CO₂ emissions by 2030 from 2014 levels | Krieger et al. (2013), ITU, GESI, GSMA and SBTi (2021) |
| Sectoral decarbonisation approach (SDA) | X | X | Company variables required in addition to base year, base year emissions, and target year | Global emissions: 0.9% reduction by 2035 from 2020 levels (SBTi’s ‘1.5°C envelope’) | ITU, GESI, GSMA and SBTi (2020) |

Absolute contraction approach (ACA): companies reduce annual absolute emissions by a linear rate calculated from the underlying global pathway between a fixed baseline year and future year.

ICT sector absolute contraction approach (ICT-ACA): companies reduce annual absolute emissions by an amount calculated from the underlying sector pathway over the company target timeframe. Only suitable for the ICT sector.

Greenhouse emissions per unit of value added (GEVA): companies reduce annual emissions per unit of value added by a compound rate calculated from the underlying global pathway between a fixed baseline year and future year.

British Telecom-Carbon Stabilization Intensity (BT-CSI): companies reduce annual emissions per unit of value added by a compound rate calculated from the underlying regional pathway between the regional emissions peak year and a fixed future year. Only suitable for developed countries.

Corporate Finance Approach to Climate-stabilizing Targets (C-FACT): companies reduce annual emissions per unit of value added by a compound rate calculated from the underlying regional pathway and a projection of the company’s economic growth between a company base year and fixed future year.

Center for Sustainable Organizations’ Context-Based Carbon Metric (CSO): companies reduce annual emissions per unit of physical output by an amount calculated from the underlying global pathway and company input data over the company target timeframe.

The 3% Solution: Companies reduce annual absolute emissions by an amount calculated from the product of the company’s business as usual emissions and the sector’s reduction opportunity between a fixed baseline year and future year. Only suitable for specific sectors in developed countries.
is synonymous with the principle of responsibility-based emissions allocation (‘or Right to development or Capabilities’) (pp 10–11). In fact, regional variation in some emissions pathways occurs for efficiency-driven reasons such as unequal population growth and differential access to material or energy resources (Marcucci and Fragkos 2015, Riahi et al 2017). Similarly, Bjørn et al incorrectly assume that sectoral differentiation is synonymous with cost optimization (p 11). Many scenarios, including those produced by the International Energy Agency (IEA), are not fully cost optimized, and cost optimization does not exclusively affect sectoral variation.

We note that although scenario choice is an important method characteristic, it is also challenging to summarize uniformly across methods and frequently updated by method developers. Our method characterization includes a ‘scenario emissions and emissions intensity reductions’ column based on the most recent citation per method from Bjørn et al. Columns could be added for scenario choice indicators such as temperature classification and shared socioeconomic pathway, but these have a less direct impact on company targets. Lastly, our characterization includes a few minor corrections to the ‘company variables required […]’ column and combines the ‘application constraints’ column with the ‘SBT method and description’ column.

2.2. Issue 2: the SBT method formula used for ACA does not match the SBTi’s application of ACA

In their analysis, Bjørn et al use an ACA method attributed to the SBTi where minimum ambition is calculated based on the timeframe 2020–2050. However, the SBTi calculates the minimum ambition of ACA based on the timeframe 2020–2035.

As explained in ‘Foundations of Science-based Target Setting,’ 1.5 C scenarios used by the SBTi are ‘highly pathway dependent’ such that ‘linearization over a longer timeframe can result in cumulative emissions more than 30% higher than prescribed’ (Bjørn et al’s citation SBTi 2019a). Bjørn et al reach a qualitatively similar conclusion, noting that EI is caused by the assumption of a linear global emissions pathway (p 14) and showing that cumulative EI is highest for their ACA method when an exponential emissions pathway is used (p 12).

It seems as if Bjørn et al and the SBTi are in agreement on the importance of these findings. Indeed, the SBTi’s choice to calculate the minimum ambition of ACA using a 2020–2035 timeframe which ‘aligns with the lifetime of an SBT that is assessed by the SBTi and minimizes distortion’ (Bjørn et al’s citation SBTi 2019a) can also be described as a choice to minimize ACA method EI over the timeframe of SBTs validated by the SBTi.

2.3. Issue 3: allocating global emissions based on economic growth yields incoherent results

Out of the seven methods assessed in ‘From the Paris Agreement to corporate climate targets,’ five of them rely on the economic contribution formula allocation principle. This principle holds that ‘a company’s absolute decrease in emission should be smaller the more it is expected to increase its value added’ (p 10).

To demonstrate the problematic nature of the economic contribution allocation principle, consider that it requires fast-growing sectors to reduce emissions slower than slow-growing sectors, which seems inconsistent with the consensus in academic literature. For example, some sectors with emissions dominated by electricity use (e.g. software) are growing revenue faster than the market average while some sectors involved with transportation (e.g. air transport and trucking) are growing revenue slower (Damodaran 2021); however, virtually all climate change mitigation scenarios rely on electricity decarbonizing faster than global emissions, while transportation often decarbonizes more slowly, as per our analysis of mitigation scenarios in the IPCC Special Report on Global Warming of 1.5 °C (sup. tables 1 and 2).

These consequences are not captured in Bjørn et al partly because the authors only calculate EI relative to a global emissions scenario (p 6, equation (1)). We believe it would also be useful to calculate EI relative to differentiated sector or region pathways to capture the imbalance between aggregate SBTs in a sector/region and that sector/region’s allowable emissions.

Even between companies in the same sector, it is unclear why a company with slow economic growth would be required to reduce emissions faster than a company with high economic growth. It can also be argued that companies with high economic growth should reduce emissions faster (e.g. due to greater capability to pay)4. Moreover, although Bjørn et al assume that company economic growth rates are similar to GDP (p 5), the ‘typical’ large company may actually grow much more quickly, about 8.9% per year if equal to the growth of the global market (Damodaran 2021). Consequently, applying the CSO method to a sample of ‘typical’ large companies could allow emissions to increase by more than 30% over five years (sup. text 2), which is an outcome significantly worse than expected for the economy in the absence of additional company targets (IEA 2020).

4 Herein lies another reason to separate formula allocational principles from granularity: Bjørn et al state that BT-CSI and C-FACT rely on the Capabilities principle due to the use of regional pathways (p 10) but the allocation formula itself seems to contradict said principle.
2.4. Issue 4: incomplete evaluation of SBT methods
Although Bjørn et al is framed as an evaluation of SBT methods, its evaluation focuses on one characteristic (EI) without providing adequate context on the importance of other SBT method characteristics. While the authors rightly point out that allocation principles are an important aspect of SBT methods (p 16), the appropriateness of different allocation principles is not evaluated. Moreover, the principles themselves are described incorrectly and incompletely, as we discuss in Issues 1 and 3. Against this backdrop, readers may have accepted the results of Bjørn et al’s analysis as a reflection of overall method integrity.

3. Principles to evaluate SBT methods
Clearly stated principles should guide the evaluation of SBT methods. Here we propose three assessment principles that collectively provide a robust framework for SBT method evaluation.

3.1. Principle 1. Target volatility is minimized
Methods should minimize target volatility that results from formula allocation except where target volatility is a consequence of increasing production of low-GHG commodities or energy services from heavy-emitting sectors.

3.2. Principle 2. Target indicators are consistent and robust
Indicators used to measure SBT ambition and assess SBT progress should be consistent and robust over time such that changes to its value reflect the elimination or abatement of emissions sources in a company’s reporting boundary or the replacement of higher-GHG commodities or energy services with lower-GHG alternatives inside or outside a company’s reporting boundary.

3.3. Principle 3. Relevant emissions budgets are conserved
If all companies in a sample apply the SBT method, a relevant emissions budget for the sample should not be significantly exceeded for the evaluation timeframe. Thus, for companies in a high priority sample (e.g. heavy-emitting sector), relevant mitigation challenges and demands for the sample may be reflected.

While these principles primarily address SBT methods for energy and industrial process-related mitigation, we recognize that similar principles could be developed to evaluate SBT methods for agriculture, forestry, and land-use mitigation. Details of how we assess each principle are included in Sup. Text 3.

5 Drawing from Bjørn et al’s standardization of SBT method formulas (Bjørn et al’s Supplementary Material), we define ‘target volatility’ as the amount that company SBTs vary in terms of the annual emissions reduction between a base year and target year.

When applying these principles to assess SBT methods, it is important to consider the intended user groups for these methods. Among companies, it is valuable to distinguish two groups:

(a) Companies in heavy-emitting sectors
(b) All other companies.

Emissions from companies in Group 1 predominantly result from GHG-intensive activities such as road transport, aviation, electricity generation, or basic materials production. Companies in Group 2 typically have emissions from a more diverse range of sources that cannot be generalized.

4. Evaluation of SBT methods against principles
In this section, we assess the methods evaluated by Bjørn et al against the principles listed above for each group of companies (table 2).

4.1. Principle 1. Target volatility is minimized
ACA (applicable to both groups) and ICT-ACA (applicable only to Group 1) do not result in target volatility for companies in either group. SDA, which mainly applies to Group 1 companies, does result in target volatility; however, targets with a lesser reduction in annual emissions than the sector average reflect the addition of energy, commodities, or services that have a lower physical emissions intensity than the sector average. GEVA, BT-CSI, C-FACT, and CSO all rely on the economic contribution allocation principle, which results in highly volatile targets without assessing whether such volatility results from the increasing production of low-carbon energy, commodities, or services. Thus ACA, ICT-ACA, and SDA meet Principle 1, while the latter four methods do not.

4.2. Principle 2. Target indicators are consistent and robust
Annual emissions is used as an indicator, or as part of an indicator, in all SBT methods evaluated here. Accounting standards such as the GHG Protocol are meant to ensure that emissions accounting is consistent between companies and that changes to a company’s emissions inventory over time reflect the elimination of emissions sources (scope 1) or replacement of high-GHG purchased energy service and commodities with lower GHG alternatives (scopes 2 and 3), rather than changes to its company structure or accounting methodology (WRI & WBCSD 2015).

We note the following for each SBT method:

- ACA and ICT-ACA use annual emissions by itself as an indicator and thus meet Principle 2.
- SDA uses an indicator with annual emissions in the numerator and its associated emissions-generating
Table 2. Summary of SBT method evaluation against assessment principles (roughly ordered from simplest to most complex as in Bjørn et al’s table 2).

| SBT method | Principle 1 met? | Principle 2 (relevant and reliable target indicators) met? | Principle 3 (effectiveness in aggregate) met? | Relevant emissions budgets are conserved |
|------------|-----------------|----------------------------------------------------------|--------------------------------|--------------------------------------|
| ACA        | Yes             | Yes                                                     | Group 1: Depends on the sector | Group 2: Yes |
| ICT-ACA    | Yes             | Yes                                                     | Group 1: Yes                     | Not applicable to Group 2 |
| GEVA       | No              | Group 1: Depends on sector and indicator                 | Group 2: No                     | Group 2: Yes |
| BT-CSI     | No              | Group 1: Depends on sector and indicator                 | Group 2: No                     | Group 2: Yes |
| C-FACT     | No              | Group 1: Depends on sector and indicator                 | Group 2: No                     | Group 2: Yes |
| CSO        | No              | Group 1: Depends on sector and indicator                 | Group 2: No                     | Group 2: Yes |
| SDA        | Yes             | Yes                                                     | Yes                             |                                      |

activity or energy service metric in the denominator. For example, $tCO_2e$ per ton of steel produced, $tCO_2e$ per MWh of electricity generated, or $tCO_2e$ per passenger kilometer served. Because the denominator measures a physical commodity or energy service, reductions in the intensity value reflect the elimination or abatement of an existing emissions source (e.g. reduction in numerator) or the purchase or production of commodities or energy services with a lower GHG impact (e.g. increase in denominator). Thus SDA meets Principle 2.

- GEVA, BT-CSI, C-FACT, and CSO all rely on economic denominators. Whether changes in the intensity value meet Principle 2 depends on whether the denominator is a consistent and robust proxy for the amount of commodities or energy services purchased or produced. In some cases, economic indicators are subject to fluctuations that reflect changes in the market, as is the case with trading price speculation (e.g. economic bubbles) or with the impact of market distortions (e.g. monopolies, tariffs, subsidies etc) on the price of commodities and energy services. Economic indicators may also reflect changes to the mix of products or services offered by a company in cases where the emissions sources in a company’s inventory have not changed. For Group 2 companies, whose emissions sources cannot be generalized, Principle 2 is thus not met. For Group 1 companies, it is possible that for some sectors a well-designed economic intensity indicator could meet Principle 2, but we have not determined those here.

4.3. Principle 3. Relevant emissions budgets are conserved

To evaluate Principle 3, we use a generalized version of Bjørn et al’s EI metric such that it reflects the ‘imbalance between time-integrated aggregated SBTs’ (p 1) and allowable emissions for a relevant segment of the global economy. We also evaluate the Principle for a timeframe consistent with SBTs (2020–2035).

For Group 1 companies, EI is evaluated for each heavy-emitting sector, which ensures that if a sector emissions budget would be exceeded by the use of an SBT method, Principle 3 is not met. For Group 2, EI is evaluated based on global emissions (as in Bjørn et al).

We note the following for each SBT method:

- SDA meets Principle 3 by intentional design for companies in both groups.
- ACA meets Principle 3 for Group 1 companies in sectors where the emissions reduction suggested by scenarios is less than or equal to the global average and for all companies in Group 2.
- ICT-ACA, applicable only to Group 1 companies, meets Principle 3.
- GEVA, BT-CSI, C-FACT, and CSO all rely on the economic contribution formula allocation principle and may over-allocate or under-allocate emissions to a sector by comparison to mitigation scenarios. At the global level, these methods do not significantly exceed allowable emissions. Thus, these methods meet Principle 3 for Group 1 companies in some sectors and for all companies in Group 2.
5. Conclusion

In this reply letter, we have addressed four main issues in the analyses and conclusion published in Bjørn et al. We have also aimed to provide more clarity on SBT methods and the principles that we believe should guide their evaluation. We are grateful to Bjørn et al for their contributions to a necessary and productive dialogue between the academic community and the business climate action community. In particular, Bjørn et al’s standardization of SBT method formulae and development of a formal ‘EI Index’ definition are insightful and productive contributions.

On behalf of the SBTi, we welcome further engagement with the scientific community to continually enhance the rigor and transparency of SBT methods. Topics for further research include quantifying ex-post emissions mitigation impacts related to various methods and target formulations; social and distributive implications of sub-global approaches; the relationship between anticipated company growth and SBT method results; and policy mechanisms to support SBT implementation. As company emissions and performance data become more widely available, stakeholder and academic scrutiny can help to keep SBTs on track to support climate stabilization.

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