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**BURDEN DIFFERENTIATION:  
CRITERIA FOR EVALUATION AND  
DEVELOPMENT OF BURDEN SHARING  
RULES**

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**Tittel: Burden differentiation: Criteria for evaluation and Development of burden sharing rules**

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**Sammendrag:** Artikkelen drøfter ni kriterier for evaluering av regler for byrdefordeling i klimaavtaler. Tre kriterier er basert på rettferdsprinsipps, medan dei seks andre kriterier tek utgangspunkt i krav til praktisk bruk. Ut frå desse kriterier får dei to sektor-baserte reglane for byrdefordeling, "Multi-sector Convergence Approach" og "Triptych" (som er brukt til byrdefordeling innan EU), høgast poengsum. Denne studien er ein del av eit samarbeidsprosjekt mellom nederlandske ECN og CICERO om utvikling av metodar for byrdefordeling i framtidige klimaavtaler. "Multi-sector Convergence Approach" er også utvikla i same prosjekt.

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**Abstract:** This article discusses nine criteria for evaluation of potential Burden Sharing Rules (BSRs) in climate policy agreements. Three of the criteria reflect fairness principles while six of them are operational requirements. These criteria are useful for identifying potential BSRs that could be promising in future climate policy negotiations. The two sector approaches, Multi-sector Convergence Approach and Triptych, received the highest score according to the criteria presented in this article. The Multi-sector Convergence Approach was developed in the joint ECN (Netherlands Energy Research Foundation) and CICERO (Center for International Climate and Environmental Research – Oslo) project on burden sharing in climate policy agreements. This is a sector-oriented approach that comprises convergence of per capita emissions to the same level for all countries, and has a global coverage. The Triptych approach has been employed by the European Union for their internal differentiation of national abatement targets. Sector approaches have some specific advantages in linking burden sharing to the economic structure of countries. This indicates that the Multi-sector Convergence Approach could play a useful role in climate policy negotiations among a larger group of countries, and could encourage developing countries to take on greenhouse gas abatement targets.

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## CONTENTS

<b>1. CRITERIA FOR EVALUATION OF BURDEN SHARING RULES .....</b>	<b>1</b>
1.1 RELEVANT FAIRNESS PRINCIPLES IN BURDEN SHARING.....	2
1.2 OPERATIONAL REQUIREMENTS.....	3
<b>2. EVALUATION OF BURDEN SHARING RULES FROM THE CLIMATE POLICY NEGOTIATIONS .....</b>	<b>4</b>
2.1 CHOICE OF BSRs FROM THE CLIMATE POLICY NEGOTIATIONS .....	4
<i>France</i> .....	4
<i>Japan</i> .....	5
<i>Norway</i> .....	5
<i>Brazil/RIVM</i> .....	5
<i>Triptych</i> .....	5
<i>Multi-sector Convergence Approach</i> .....	6
2.2 EVALUATION OF THE BSRs .....	6
<b>3. DISCUSSION OF CRITERIA.....</b>	<b>10</b>
<b>4. CONCLUSIONS .....</b>	<b>10</b>
<b>ACKNOWLEDGEMENT.....</b>	<b>11</b>
<b>REFERENCES.....</b>	<b>11</b>

## LIST OF TABLES

TABLE 1. EVALUATION CRITERIA FOR BURDEN SHARING RULES (BSRs) .....	1
TABLE 2. EVALUATION OF BURDEN SHARING RULES (BSRs) WITH RESPECT TO FAIRNESS PRINCIPLES AND OPERATIONAL REQUIREMENTS .....	7

## 1. CRITERIA FOR EVALUATION OF BURDEN SHARING RULES

This article focuses on the policy feasibility and political acceptability of burden sharing rules (BSRs). In particular, the article aims to identify a number of criteria for assessment of the policy feasibility and political acceptability of proposals for BSRs that might be introduced into the global climate negotiations. A primary objective of a BSR would be to garner further participation in a climate policy agreement. Evaluation criteria may be applied to existing BSRs as well as to proposals for new BSRs. Like a set of guidelines, they may be used to evaluate the policy feasibility and political acceptability of BSRs.

Burden sharing negotiations involving both industrialized and developing countries can be seen as an interactive process where proposals for BSRs are put on the negotiation table, details of the proposals are negotiated, and the parties, in particular the developing country parties, decide if they are willing to accept a burden sharing arrangement and take on the resulting abatement commitments. The issue of timing, for instance in terms of ‘graduation’ schemes or other approaches to triggering developing country involvement, is not treated in this article (see for example the discussion in Berk and Elzen, 2001).

After a summary of key principles in burden sharing, the article focuses on the operational requirements of BSRs. The article first discusses if it is at all possible to identify empirical indicators and quantitative data that can be coupled to individual BSRs. An important issue is the extent to which the necessary empirical indicators and quantitative data are available. The article then discusses to what extent individual BSRs have universal applicability, could easily be made operational, are simple or complex, could undergo future refinements, would give room for flexibility, and would allow for taking country-specific circumstances into account. These criteria are important in the assessment of feasibility and acceptability of individual BSRs. The proposed evaluation criteria are numbered from A – I, and summarized in Table 1.

<b>Fairness principles</b>	<ul style="list-style-type: none"> <li>A) ‘Need’</li> <li>B) ‘Capacity’</li> <li>C) ‘Guilt’</li> </ul>
<b>Operational requirements</b>	<ul style="list-style-type: none"> <li>D) Universal applicability</li> <li>E) Easy to make operational</li> <li>F) Simplicity</li> <li>G) Allows for future refinements</li> <li>H) Allows for flexibility</li> <li>I) Allows for country-specific circumstances</li> </ul>

**Table 1. Evaluation criteria for burden sharing rules (BSRs)**

### **1.1 Relevant Fairness Principles in Burden Sharing**

It seems appropriate to construct BSRs that are based on at least one of the three principles of fairness: need, capacity, or guilt, respectively.<sup>1</sup> According to the guilt principle, the costs of undertaking measures to alleviate the climate problem – i.e. the abatement costs – should be distributed in some proportion to the degree to which actors are responsible for the climate problem. The principles of need and capacity are concerned with the impact of measures on actors (as opposed to their contribution to the problem). The first principle would distribute the costs in accordance with actors' legitimate need for economic development, whereas the second principle would distribute the cost in accordance with actors' ability or capacity to reduce greenhouse gas emissions, where a conventional yardstick is wealth measured as GDP per capita. Individual BSRs may build on one or more of these key principles of equity. However, in order to receive widespread support, any BSR intended to have an impact on international negotiations concerned with the environment and natural resources would probably need to combine at least two, and preferably three, of these principles.

It is useful to briefly consider the kind of data that would be relevant to apply these three general principles of fairness in a BSR. In the case of the first principle stressing actors' guilt in regard to a problem, we would need data that document to what degree individual actors have contributed to global warming. Data on the past and present greenhouse gas emissions of the various actors would be sufficient. Evidently, however, an important issue is responsibility for the problem. If nations were seen as the responsible actors, then national data and statistics on greenhouse gas emissions per capita would be sufficient. But if instead economic sectors were considered responsible, it would be necessary to acquire data on sector contributions of greenhouse gases. Based on analysis of emissions by sectors, a BSR might prescribe that burdens should be differentiated or weighted differently at the sector level.

Obviously, there are different ways to translate the principle of need into BSRs and different kinds of data and statistics would be needed. If we assume that all individuals have an equal right to economic welfare, and therefore an equal right to emit greenhouse gases into the atmosphere, then the international distribution of abatement costs and climate commitments should be in accord with population size in individual countries. But if we are only concerned with basic needs, which makes it necessary to distinguish between what reasonably constitutes basic needs as opposed to non-basic or more luxury needs, the amount of greenhouse gas emissions produced by the fulfillment of these fundamental needs would have to be determined. Greenhouse gas emissions caused by the fulfillment of more excessive needs would be subject to restrictive measures. While both agreeing on basic needs – a politically sensitive issue – and determining corresponding emissions could be a complex undertaking, it seems that it would not present insurmountable difficulties. Of course, another possibility is to adopt the approach taken in the UN Framework Convention on Climate Change (UNFCCC) – it distinguishes between developed countries, countries with economies in transition, and developing countries – and determines emission allowances for each of the three key groups.

In case of the principle stressing capacity and ability to pay, it would be necessary to apply data that make it possible to document and compare differences in economic wealth across countries. An obvious candidate for an indicator of wealth would be GDP per capita, possibly GDP adjusted for Purchasing Power Parities (PPP). An alternative could be to attempt to distribute abatement targets so as to equalize abatement costs as a percentage of GDP across

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<sup>1</sup> For a discussion, see Ringius, Torvanger and Underdal (1999).

countries. GDP and GDP per capita have limited value as measures of wealth to compare nations and people, but it is hard to find better alternatives that are readily available.

## **1.2 Operational Requirements**

The first operational requirement is that a BSR should be universally applicable. Rules that can be applied to all, or almost all countries, are clearly more attractive than rules that are only partially applicable because the latter raise thorny questions about supplementary rules, exemptions, or both. In these situations it becomes necessary to distinguish between those actors that should be bound by a rule and those who should not. Apart from the technical difficulties of making such distinctions between countries operational, rules that are not universally applicable may give rise to opportunistic bargaining behavior and self-serving strategies, creating additional difficulties and challenges to attempts to differentiate country commitments.<sup>2</sup> However, it is likely that well-designed BSRs that allow for exemptions based on clear and undisputable criteria do not give rise to such disputes.

The degree to which individual BSRs can be made operational is another important issue to consider when assessing their policy feasibility. In some cases it will be possible to identify empirical indicators and quantitative data that can be coupled to individual BSRs in a straightforward manner. It is likely that these rules would be widely supported. Reliable and comparable data will be important. Indicators and statistics that are internationally approved might be more readily accepted than those that are not approved internationally. At the same time it will be important that internationally accepted indicators and statistics do not differ significantly from those actors use, especially those who are pivotal to achieve agreement on proposals for international burden sharing. A related issue is to what degree necessary empirical indicators and quantitative data are available. Evidently, insufficient data would hamper the use of a BSR that would be based upon this information. Even an otherwise promising BSR – e.g. one that combines several key principles of fairness – might receive insufficient support should there be a scarcity of relevant data for operational purposes.

It should be expected that BSRs that are relatively simple to make operational would be superior to those that are more complex. Basically, both the depth and the breadth of the data increase complexity. Thus, there are many ways in which complexity could be increased (or reduced): when the need for data amounts increases (decreases); when many (few) types of data are necessary (e.g. emissions per capita, emissions per produced unit of value, emissions at sector levels), when the time dimensions are extended (shortened), etc. In some cases the data operations in themselves might add complexity. Furthermore, if large amounts of data need to be processed, this might create opportunity for selfish manipulation by actors.

It would seem self-evident that opportunities to adjust and refine the operationalization of burden sharing rules would be advantageous. Because the knowledge base regarding global warming is still evolving, it seems certain that new issues (as e.g. the cooling effect of particulates) could have an impact on our understanding of the global climate system and accordingly on the operationalization of BSRs and the need for refinement of their operationalization (e.g. refinement of GWP-values).<sup>3</sup> But although a built-in opportunity for refinement is advantageous, it would be unattractive if it reduces the extent to which a BSR could be made operational in order to address more current issues in global climate

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<sup>2</sup> One interesting example is the allocation of oil production quotas within the OPEC, see Gault, Spierer, Bertholet and Karbassioun (1999).

<sup>3</sup> GWP is Global Warming Potential, which is a measure of the radiative forcing of a greenhouse gas relative to CO<sub>2</sub> (carbon dioxide). Thus CO<sub>2</sub> has a GWP equal to 1.

negotiations. The extent to which refinement and adjustment of BSRs would mean that past burdens would be recalculated and reassessed and, in particular, that future climate commitments could and would be adjusted retroactively, is a potentially critical issue.

Yet another issue concerns flexibility. A BSR that allows for flexibility seems relatively more attractive, for example if national circumstances change unexpectedly at some point in the future. One flexibility feature is to allow for rolling over from one budget period (such as the Kyoto target period 2008-12) to the next budget period (2013-17).

A final issue concerns inclusion of country-specific circumstances. These might include criteria (e.g. inertia factors) such as structure of national energy supply system, structure of the national economy, and dependence on fossil fuel exports, population density, and population growth.

## **2. EVALUATION OF BURDEN SHARING RULES FROM THE CLIMATE POLICY NEGOTIATIONS**

### ***2.1 Choice of BSRs from the climate policy negotiations***

We have chosen proposals from France, Japan, Norway, Brazil/RIVM, and Triptych as the first candidates for testing the above evaluation criteria. In addition we have included the Multi-sector Convergence Approach developed by ECN and CICERO.<sup>4</sup> The first five proposals were singled out after a two-step selection process from a large number of proposals that were made during the negotiations leading up to the Kyoto Protocol in December 1997.<sup>5</sup> In the first step, proposals that advocated a non-differentiated, symmetric approach – that is, equal percentage reductions of greenhouse gas emissions across countries – were left out along with proposals that were not sufficiently specified to be operationalized. In the second step, the proposals that seemed most promising in future negotiations were singled out based on criteria such as political feasibility, simplicity and reliability, regional or global relevance, and the potential for further development of the method. A short description of the six proposals follows.

#### **France**

The French proposal is based on a reduction in emissions to reach an atmospheric concentration of 550 ppmv of CO<sub>2</sub> as a future goal, and has a “per capita” approach as the main element for burden sharing.<sup>6</sup> According to the Intergovernmental Panel on Climate Change’s (IPCC) second assessment report, this concentration level can be obtained if average per capita level of CO<sub>2</sub> and other GHGs emissions are in the range of 1 to 2.7 tons of carbon equivalent within the Annex I group by the end of the next century.<sup>7</sup> On this basis, France proposes that burdens should be distributed so that the emission pathways converge to similar per capita or per unit of GDP levels by 2100. The burdens are in other words defined so that countries with high per capita emissions must undertake a larger percentage reduction in emissions.

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<sup>4</sup> Confer Jansen et al. (2001).

<sup>5</sup> Confer Ringius, Torvanger and Underdal (1999) and Torvanger and Godal (2000). RIVM is an acronym for Netherlands National Institute for Public Health and the Environment.

<sup>6</sup> Ppmv = parts per million by volume.

<sup>7</sup> Annex I are industrialized countries as defined by the UNFCCC.

## Japan

During the Kyoto Protocol negotiations Japan submitted two burden sharing proposals, where the second proposal is the most interesting from our perspective. According to this proposal each Annex I country shall reduce emissions by 5% in the first budget period (2008-2012) compared to 1990 levels. However, countries with less than average Annex I emissions measured per unit of GDP or per capita receive a target that is lower than 5% in the same proportion as the deviation from the average of the Annex I group. A country is free to choose the emissions per unit of GDP option or the emissions per capita option. In addition there is a provision for alternative reduction rates for countries with high population growth.

## Norway

In this proposal a formula considers a Party's percentage reductions of greenhouse gas emissions based on three indicators: CO<sub>2</sub> equivalent emissions per unit of GDP, GDP per capita, and CO<sub>2</sub> equivalent emissions per capita. The formula is employed to calculate a country's burden as a deviation from the joint reduction target of a group of countries (e.g. Annex I). The value of each indicator is compared to the average of the group. If a country has a higher than average value on an indicator it receives a relatively larger burden, and *vice versa*. Finally, the weighted sum of the three indicators is calculated to find a country's burden.

## Brazil/RIVM

The original proposal by Brazil is designed so that Parties receive a burden that corresponds to the same Party's responsibility for contributing to climate change. In order to quantify this contribution, cumulative historical emissions are estimated. The proposal could be applied to all Parties, including developing countries. The Dutch institute RIVM developed an improved version of the Brazilian proposal, making this method preferable to the original Brazilian proposal.<sup>8</sup> The Brazilian proposal overestimated the contribution of the Annex I group to temperature change relative to non-Annex I, which is amended in the Brazil/RIVM version. Furthermore, all major greenhouse gases (including all sources and sinks) are included in the improved version. Rather than contribution to temperature changes the contribution to concentrations or radiative forcing is estimated. Finally, Brazil/RIVM considers it more equitable to use per capita contribution rather than absolute contribution.

## Triptych

This method has been employed for the differentiation of emission reduction and stabilization targets within the EU as part of meeting the commitments defined by the Kyoto Protocol. The main motivation for the approach was to develop a method that would take into account the differences in emission-producing activities across the member states. The approach not only determines the distribution of commitments but also the aggregate level of emissions from the member states. In the first step the three sectors electricity generation, internationally oriented energy-intensive industries, and domestic sectors were identified. The total consumption (and production) of electricity in the EU was set to be limited to a growth rate of 1% per year. Some extra allowance was given the cohesion countries.<sup>9</sup> CO<sub>2</sub> emissions were then distributed taking into account minimum percentages for renewable energies and combined heat and power (CHP), limitation of oil and coal use, use of nuclear power according to national preferences, and the remainder to be supplied using natural gas. The energy-intensive part of the industrial sector was allowed to increase production at a constant rate across all countries. The same energy efficient improvement rate was also applied across the member states for

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<sup>8</sup> 'Brazil/RIVM' denotes this newer version that was presented by RIVM at the 4<sup>th</sup> Conference of Parties to the Climate Convention (COP4) in Buenos Aires in November 1998.

<sup>9</sup> Consisting of Greece, Spain, Portugal and Ireland.



this sector. Emissions from the domestic sectors were distributed on a per capita base.<sup>10</sup> The main rule was that emissions per capita should converge to the same level across all countries at a certain point in the future (e.g. 2030). The emission levels were only corrected for variations in natural climate across the countries.

### Multi-sector Convergence Approach

The Multi-sector Convergence Approach has many similarities with the region-oriented Triptych approach, but has a global coverage.<sup>11</sup> Also, the Multi-sector Convergence Approach contains more sectors than Triptych, which makes it more flexible and allows for more country-specific circumstances. The sectors specified are power, households, transportation, industry, services, agriculture, and waste. The starting point for each country is its sector levels of per capita emissions in the base year (2010). Non-binding sector emission standards for each sector – expressed in per capita terms – are determined at the global level for both a base year, a convergence year (e.g. 2100) and intermediate target years. For the base year, these standards have been set equal to the world average sector GHG emissions per capita in that year. Subsequently, an annual reduction norm per sector has been set – expressed in a percentage per year – in order to derive sector emission standards in the years thereafter. Next per capita emission standards at the sector level have been added up to obtain the global per capita emission standard at the aggregated level. This implies that a country can freely distribute its mitigation efforts across sectors as long as the national reduction target is met. Finally, these non-binding sector emission levels are added up and multiplied by total population in order to determine national emission mitigation targets for the countries and years concerned. This framework for negotiating national GHG emission mitigation targets can be fine-tuned by including so-called allowance factors. These factors can be defined as country-specific circumstances resulting in variances of sector emissions among countries that are virtually impossible to influence by the governments concerned, at least in the short and medium run.

The BSRs are shown in the first row of Table 2. A BSR can often be categorized as either a top-down or a bottom-up approach. Top-down methods tend to apply more aggregate indicators – for example emissions per capita and GDP per capita. Weighting of indicators may be used, sometimes even rather explicitly, in mathematically phrased formulas. Bottom-up approaches, on the other hand, take into account sector contributions of greenhouse gases, cluster economic sectors together (e.g. domestic sector; export-oriented sector), and develop allowances at sector level. The Triptych and the Multi-sector Convergence Approach are the bottom-up methods among the six BSRs, while the other proposals, including the Norwegian one, exemplify top-down BSRs. One potential advantage of bottom-up methods is that key people in the economic sectors concerned potentially will be more involved and feel more responsible than in the case of top-down approaches. But the data requirements are usually lower for top-down methods than for bottom-up methods.

## 2.2 Evaluation of the BSRs

We are now in a position to evaluate the six BSR approaches according to criteria *A - I*. In Table 2 the proposals are scored on each criterion, by attributing either ‘+’ for criterion satisfied, ‘-’ for criterion not satisfied, or ‘0’ for inconclusive. Each criterion is weighted and the total score of the BSR is calculated by adding up the weighted scores. The applied weights

<sup>10</sup> Consisting of households, services, light industry, agriculture and transportation.

<sup>11</sup> A comprehensive presentation of the Multi-sector Convergence Approach is found in Jansen et al. (2001).

are 1, 2, and 4. To reflect the importance of the two fairness principles ‘need’ and ‘capacity’, they are each weighted as 4. The third fairness principle, ‘guilt’, is given a weight of only 2 since we believe that too much weight on ‘guilt’, especially in historical terms (that is, responsibility for historical greenhouse gas emissions), will be less acceptable for industrialized countries. Also, data and methodological uncertainties related to determining historical guilt are likely.

Note that a ‘-’ means that the score on this criterion is subtracted from the total score. For instance, a ‘-’ with weight 2 contributes minus 2 to the total score. There are separate total scores for fairness principles and for operational requirements.

	Criteria	Weight	France	Japan	Norway	Brazil/ RIVM	Triptych	Multi-sector Convergence Approach
<b>BSR type</b>	Top-down (T) Bottom-up (B)		T	T	T	T	B	B
<b>Fairness principles</b>	A) ‘Need’	4	+	+	+	+	+	+
	B) ‘Capacity’	4	0	0	+	+	+	+
	C) ‘Guilt’	2	-	-	-	+	-	-
<b>Sum, principles</b>			2	2	6	10	6	6
<b>Operational requirements</b>	D) Universal applicability	2	+	0	-	+	0	+
	E) Easy to make operational	2	+	+	+	0	0	-
	F) Simplicity	1	+	+	0	-	0	0
	G) Allows for future refinements	1	+	0	0	+	+	+
	H) Allows for flexibility	1	0	+	+	0	+	+
	I) Allows for country-specific circumstances	2	-	+	+	-	+	+
<b>Sum, operational requirements</b>			4	6	3	0	4	4
<b>Total evaluation, principles/operational requirements</b>			2/4	2/6	6/3	10/0	6/4	6/4

**Table 2. Evaluation of burden sharing rules (BSRs) with respect to fairness principles and operational requirements<sup>12</sup>**

<sup>12</sup> Where ‘+’ means criterion satisfied, ‘-’ means criterion not satisfied, and ‘0’ means inconclusive. The total evaluation or score is the sum of the weighted score for each criterion. Note that a ‘-’ means that the score on this criterion is subtracted from the total score. Thus a ‘-’ with weight 2 contributes minus 2 to the total score.

The operational criteria *D*, *E* and *I* are given twice the weight (2) of the other operational criteria. This is because it is important for a BSR to be able to handle both industrialized and developing countries in future climate policy negotiations. Criterion *E* is important since reliance on uncertain or contentious data would make a BSR less feasible and undermine the credibility of the approach. Finally, in terms of criterion *I*, a BSR must allow for country-specific circumstances to play a role in burden sharing negotiations among countries with largely different economic development and economic structure circumstances. The sum of all weights is 19, and the maximum achievable score is 10/9 (score on fairness principles/score on operational requirements).

The maximum score may not be attainable in practice due to potential conflicts between some of the criteria, leading to some trade-offs between them. One example is criterion *F* (simplicity) and criterion *I* (allows for country-specific circumstances), where there is likely to be a trade-off such that a simple BSR is only to a limited degree able to allow for country-specific circumstances, and *vice versa*. Table 2 shows that Japan is the only BSR where both these criteria are satisfied. Another example is a potential trade-off between *F* (simplicity) and *H* (allowance for flexibility). Such potential conflicts may be of less importance in negotiations since a BSR, for example, may be characterized as simple along one dimension but not along another dimension, and that simplicity of one type is not necessarily in conflict with flexibility. Furthermore, flexibility may also have more than one dimension. Thus BSRs and actual negotiations have many facets that cannot be fully represented in a simple format as in Table 2.

Ybema et al. (2000) includes preliminary findings on BSR design.<sup>13</sup> Comparing the findings on relevant criteria for evaluation of BSRs the report mentions taking into account country-specific characteristics, which are similar to our criterion *I*, and the need for transparency and simplicity, which correspond to our criterion *F*. In addition, the report emphasizes that economic structure characteristics should be an important factor to be taken into account, which implies a sector (i.e. bottom-up) approach.

Let us evaluate the six approaches according to each of the different criteria, starting with France.<sup>14</sup>

### *France*

The per-capita approach of the French proposal implies that it is supported by the fairness principle 'need'. The 'guilt' principle is not supported, whereas one can argue that the 'capacity' principle to some extent is supported due to differing starting points in per capita emissions and related differing trajectories to convergence in per capita emissions. In terms of the operational criteria it has universal applicability, is easy to make operational, simple, and should allow for future refinements. However, its flexibility is limited, and there is no allowance for country-specific circumstances, except to a limited extent in terms of different starting points of per capita emissions. The net score then comes to 2/4.

### *Japan*

In terms of score on the evaluation criteria there are some similarities between France and Japan. Since the Japanese proposal contains a reference to per capita emissions and a consideration for countries with higher than average population growth, it is supported by the 'need' fairness principle, and to some extent by the 'capacity' principle. The proposal is easy

<sup>13</sup> This is another report from the joint ECN and CICERO project on burden sharing in climate agreements.

<sup>14</sup> A more detailed description of the four proposals from the climate negotiations and Triptych can be found in Ringius, Torvanger and Underdal (1999).

to operationalize as long as GDP is accepted as a measure of wealth, is simple, and allows for some flexibility and country-specific circumstances such as emissions per unit of GDP and per capita. It is questionable if the proposal can have a universal applicability due to its limited flexibility, and the scope for future refinements seems limited. Altogether the score is 2/6.

#### *Norway*

The Norwegian proposal is supported by the 'need' fairness principle since lower than average emissions per capita means lower than average burden. Likewise the proposal is supported by the 'capacity' principle since a higher than average GDP means a higher than average burden. The proposal receives positive scores on operationalizability (since the data-requirements are quite limited), allowance for some flexibility (since the weights of the indicators can be changed), and allowance for some country-specific circumstances (in terms of the set of three indicators included in the proposal). We consider the proposal not to be flexible enough to include developing countries, so criterion *D* is not satisfied. In terms of simplicity and allowance for future refinements, the score is rather inconclusive. In sum the score is 6/3.

#### *Brazil/RIVM*

In the Brazilian proposal, countries receive a burden that corresponds to their cumulative historical emissions, and is thus supported by the 'guilt' fairness principle. In the newer version of the proposal revised by RIVM, the focus is on per capita contribution to global warming so there is an element of the 'need' fairness principle. To some extent 'capacity' is also supported since only industrialized countries are given national abatement targets according to this scheme. The score on operational requirements is weaker. The method can be expanded to give abatement targets to all countries of the world, and it allows for future refinements. On the other hand, the method is not easy to operationalize due to data and model requirements. Thus the method is relatively complicated, and there is no allowance for country-specific circumstances. Altogether the score is 10/0.

#### *Triptych*

The Triptych method employed to establish a basis for distributing national abatement targets among member states of the European Union is supported by the 'need' fairness principle since it builds on characteristics of three economic sectors in a country and emissions in a base period. There is also some concession to 'capacity' since the 'cohesion' countries in Southern Europe are given weaker targets than other EU member states. In terms of operational requirements, the method allows for future refinements, flexibility and country-specific circumstances. However, the method's score on universal applicability, simplicity and operationalizability is lower. In sum the score is 6/4.

#### *Multi-sector Convergence Approach*

The Multi-sector Convergence Approach supports the 'need' fairness principle due to convergence of national per capita emissions in some future target year. To a large extent the 'capacity' principle is supported since transition economies and developing economies are suggested as allowance factors. This implies that countries that are undergoing the process of transition to a market economy are given a relatively lower burden, and that developing countries only gradually take on binding commitments to restrict their greenhouse gas emissions. The score on operational requirements is similar to the Triptych approach, but with two exceptions due to the method's universal applicability and the larger data requirement that complicates the task of making it operational. Altogether the score is 6/4, equal to Triptych's score.

### 3. DISCUSSION OF CRITERIA

Since the theoretical maximum score is 10/9, we conclude that no single BSR was capable of meeting all or even the large majority of criteria. According to the simple evaluation procedure summarized in Table 2, the Multi-sector Convergence Approach and the Triptych approach get the highest total score because they are both supported by two fairness principles and receive a relatively good score on operational requirements. Next are the Brazil/RIVM and Norwegian proposals. Brazil/RIVM has the highest score on fairness principles. Norway has the highest score on operational requirements. The score on fairness principles is at least as high as the two sector approaches, but the score on operational requirements is lower. Japan is next, followed by France. They have the same scores on fairness principles, but France has the lowest score on operational requirements. Obviously these results are dependent on the weights of the criteria, and other possible criteria would yield different results. Nonetheless, the results give an indication of which proposed BSRs seem most promising in future climate policy negotiations according to the criteria selected in this article.

Torvanger and Godal (2000) compared the outcome of the Japanese, the French, and the Norwegian proposals, and found that Japanese came closest to the Kyoto Protocol outcome, followed by the French and Norwegian proposals.<sup>15</sup> Brazil/RIVM, Triptych and the Multi-sector Convergence Approach were not included. This stands in contrast to the present study where Japan and France received the lowest scores. The Norwegian proposal fares relatively well in both studies. This could indicate that our proposed evaluation criteria are not consistent with the implicit criteria defined by the negotiation outcome manifested in the Kyoto Protocol. This said, we should remember that no specific burden sharing method was employed in the Kyoto Protocol negotiations. The burden differentiation and provisions defined by the Protocol were rather an intricate political deal made among sovereign states and regional groups of states based on information on and beliefs about costs of reducing their emissions, other national circumstances, and each state's willingness to reduce its emissions. Finally, the sector approaches (Multi-sector Convergence Approach and Triptych) got the highest score according to our criteria, which should indicate some potential in future climate policy negotiations. After all, the European Union has successfully employed the Triptych approach in its internal differentiation of emission reductions targets.<sup>16</sup>

### 4. CONCLUSIONS

We have proposed nine evaluation criteria for burden sharing rules (BSRs). Three concern fairness principles, and six concern operational requirements. Based on the relevance and importance of the evaluation criteria chosen it is suggested that potential BSRs that score high on these criteria should be promising in future climate policy negotiations, at least in terms of proving a fruitful initial reference point for the negotiations. Thus the criteria can give valuable hints for designing new BSRs.

We should take note that the set of criteria chosen in most cases yields only limited and small differences in score among the BSRs analyzed. Furthermore, there are probably other sets of criteria (and aggregation methods to calculate the total score) that would be even better suited to identify the most promising BSRs. Consequently we should still keep an open mind about including new criteria or substituting old criteria for new ones.

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<sup>15</sup> Confer Table 9 in Torvanger and Godal (2000).

<sup>16</sup> See Ringius (1999).

The sector approaches, such as the Multi-sector Convergence Approach, got the highest score according to the criteria. Sector approaches allow for a better translation between the BSR and different circumstances at the sector level, and *vice versa*, than top-down based BSRs. This indicates that sector-based BSRs could play a useful role in climate policy negotiations among a larger group of countries, and could potentially also be helpful to incite developing countries to take on greenhouse gas abatement targets.

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