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SOCIETAL LCA

In search of income reference points for SLCA using a country level sustainability benchmark (part 1): fair inequality. A contribution to the Oiconomy project

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Abstract
Purpose This paper is part 1 of our twin articles on income reference points for Social Life Cycle Assessment (SLCA). Preventative costs based LCA systems, such as the EcoCost system and the Oiconomy system, need targets (performance reference points) to determine the marginal preventative costs, the costs of the most expensive measure that globally needs to be employed to reach the target. To extend the EcoCost system for social issues, targets are required for issues like fair wages and fair inequality of wages, issues for which no agreed standard, no effect level or target exists. One way of setting targets is to take best practices as benchmark, e.g. the practices of a group of best performing countries. The purpose of this part 1 article is to first develop a well-founded benchmark group of the 20 % best performing countries and thereafter propose a well-founded target for the issue of inequality for preventative costs based SLCA, which can also serve as performance reference point for SLCA in general and for other uses. In part 2, for the same purposes and using the same benchmark group, we propose targets for fair minimum wages for every country.
Methods A benchmark group of countries for the setting of targets was determined by an assessment of available country performance indicators, based on 5 criteria. Thereafter, we derived a proposal for a maximum inequality ratio based on existing democratically determined inequality ratios in the benchmark group.
Results and discussion The Sustainable Society Index–Human Wellbeing proved the best indicator for a country benchmark for preventative cost-based SLCA. Using the average of maximum democratically determined income differences in a benchmark group of countries determined by this index, a performance reference point for SLCA for the issue of fair inequality was derived and proposed, resulting in a maximum ratio of income differences for governmental institutions of 14.1, for government ruled companies of 18.3 and for industry of a factor 23.8.
Conclusions It proved possible to derive a target for maximum inequality of wages, based on democratic choices in a benchmark group of the 20 % best performing countries. The target for governmental institutions may be called objective, and proposed augmentations for government ruled companies and industry, though value choices, seem reasonable for the consumer who requires prevention of all possible harm as consequence of his purchase choices and who, as a voter, contributes to governmental standards.

Keywords Country benchmark · ESCU · Externalities · Indicators · Inequality · Oiconomy standard · Preventative costs · Social LCA · Sustainability · Sustainable Society Index

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Abbreviations

ANS	Adjusted net savings
EF	Ecological footprint
ELCA	Environmental Life Cycle Assessment
EPI	Ecological Performance Index
ESCU	Eco Social Cost Unit
ESI	Environmental Sustainability Index
EYR	Emergy Yield Ratio
FBR	Footprint Biocapacity Ratio
GDP	Gross Domestic Product

GEI	Government Effectiveness Index
Gha	Global Hectares
GNI	Gross National Income
GS	Genuine Savings
HDI	Human Development Index
HLY	Happy Life Years Index
HPI	Happy Planet Index
HSDI	Human Sustainable Development Index
ISEW	Index of Sustainable Economic Welfare
JRC	Joint Research Centre of the European Committee
LCA	Life Cycle Assessment
LCIA	Life Cycle Inventory Analysis
MEW	Measure of Economic Welfare
NAMEA	National Accounting Matrix including Environmental Accounts
MAIR	Maximum Acceptable Inequality Ratio
OECD	Organization for Economic Cooperation and Development
PRP	Performance Reference Point
SEEA	System of Environmental-Economic Accounts
SLCA	Social Life Cycle Assessment
SMEW	Sustainable Measure of Economic Welfare
SSI	Sustainable Society Index
SSI EcW	Sustainable Society Index - Economic Wellbeing
SSI EW	Sustainable Society Index - Environmental Wellbeing
SSI HW	Sustainable Society Index - Human Wellbeing
UNDP	United Nations Development Program
UNEP	United Nations Environment Program

1 Introduction

Disputes concerning global labour practices are at the core of contemporary debates regarding globalization and sustainable development. Critics have charged multinational enterprises with the unjust exploitation of workers in the developing world (Arnold and Hartman 2006). It is increasingly recognized that companies, e.g. (Chouinard et al. 2011), can make a major contribution to sustainable development by being environmentally and socially responsible and that tools associated with these concepts can enhance their competitiveness and economic performance. It is believed to be a new imperative to develop sound sourcing and fair trading relationships. This includes issues associated with fair trade (including issues of human rights, fair wages, inequality, sustainability reporting procedures and ethics) and associated tools (guaranteed prices, codes of conduct and end-price audits) (Welford et al. 2003).

Davies et al. estimated for the year 2000 that the richest 2 % of adult individuals in the world owned more than half of global wealth, with the richest 1 % alone accounting for 40 % (Davies et al. 2008). In 2014, 0.7 % owned 44 % (Shorrocks et al. 2014), indicating that inequality is rising. Although inequality is gradually decreasing across countries, it is especially rising within countries (Sala-i-Martin 2002; Belser and Sobeck 2012). The Davos Economic Forum in 2011 considered economic disparity and global governance as amongst the world's greatest challenges (Davis et al. 2011, p.6). Although the causal relations are debated, there is strong evidence of significant correlations between inequality and social unrest (Wayne Nafziger and Auvinen 2002; Justino 2012; Wilkinson and Pickett 2009). Especially uncertainty and perceived injustice is suggested to be a cause of extremism (Doosje et al. 2013; Hogg et al. 2013). There is also strong evidence of a significant correlation between inequality and negative health impacts (Bocoum et al. 2015; Wilkinson et al. 2010). Because health is considered an important endpoint category in Life Cycle Assessment (LCA) (Jolliet et al. 2004) and Social Life Cycle Assessment (SLCA) (Klöpffer 2008; Norris 2006; UNEP and SETAC 2009), and human wellbeing is considered the main area of protection to assess social impacts of products (Neugebauer et al. 2014), it is important to include inequality in SLCA. Boccoum et al. even describe a pathway between child mortality as health indicator and the GINI coefficient as inequality indicator, for potential use in SLCA, but they also note that many more of such pathways on social issues need to come available before a complete SLCA can be made. The use of the GINI coefficient for SLCA purposes was suggested before by (Finkbeiner et al. 2010).

Current LCA systems, if applied on consumer products, are very dependent on reliable data on the upstream supply chain. Missing specific supply chain data, in environmental LCA (ELCA), can often be found in generic databases. The impact of social issues however may be site specific (Parent et al. 2010; Benoît et al. 2010), or even personal (Jørgensen et al. 2010) and therefore extremely difficult to quantify. Current damage based Life Cycle Inventory Analysis (LCIA) on social issues are therefore at best nominally quantitative, which is useful for its original purpose of assessing alternatives on a limited number of issues, but not for the comprehensive assessment of complete products.

Key questions are how to characterize and how to determine performance reference points (PRPs) and weight the impact of different social issues, not only weighting them against other social issues but also against environmental issues, and thereafter how to standardize these in order to make assessments by different practitioners comparable.

In Environmental Life Cycle Assessment (ELCA), a large step towards normalization and objective and comparable assessment is the EcoCost system (Vogtländer et al. 2000) by not measuring damage, but marginal preventative costs, providing one sustainability-measuring unit for the different issues. However, a preventative cost based system is not available, and seems unthinkable, for social issues without a system of onsite verification.

UNEP and SETAC (2009. p.37) defines SLCA as “a social impact assessment technique”. Major issues with impact assessment in SLCA are the complexity, the lack of data, especially on the specific supply chains (Lehmann et al. 2013, p.1590), and the vague nature of international standards, at the most allowing for semi-quantitative indicators (Parent et al. 2010, p.167). Key missing approaches in SLCA in general and surely for the issue of inequality are methods for reliable collection of data and determination of concrete quantitative PRPs.

The “Oiconomy system” however, developed by Croes and Vermeulen (2015a), makes it possible to extend the EcoCost system with social issues because it is based on certification. This certification allows to make many data “foreground” because they are verified data on the specific supply chain, where they otherwise would have been “background” data from databases, which usually are averages. Where the goal of most LCAs is to compare different product related alternatives, usually on a limited number of sustainability issues, the Oiconomy system is designed to measure the comprehensive (un)sustainability of end products, destined for the consumer or user. The system copies standard bookkeeping and price build-up in the value chain for the hidden costs, or the product-embedded externalities. Every actor in the supply chain calculates the hidden preventative costs in a normalized way and transfers these to the next link by means of a monetary unit, the “Eco Social Cost Unit (ESCU)”.

Where, due to the difficult quantification of social damage, most SLCAs are qualitative or at the most nominally quantitative, the Oiconomy system makes it possible to quantify data on social issues with the interval indicator of preventative costs.

Both the EcoCosts system and the Oiconomy system use the cost distance to a target as (un)sustainability indicator for every issue. Therefore, we use the word “target”, although it expresses almost the same as a PRP, more commonly used in SLCA (Benoît 2014, p.263; Parent et al. 2010, p.166–167). The difference is that in the EcoCosts and Oiconomy systems, it really concerns a target to which an interval quantitative distance is determined, where in impact based LCA, it just serves as a performance reference to which any system of comparison may be used. Where the EcoCost system is a more conventional system always using predetermined data in a database, the Oiconomy system allows the practitioner to provide case specific, onsite verified data. This means that the EcoCost system is always based on *marginal* preventative costs, the costs of the last and most expensive employed preventive measure to globally reach the target, assuming that the cheapest measures are employed first. The Oiconomy system only uses the marginal preventative costs as default values, to be used if the practitioner cannot demonstrate more specific, but onsite verified data.

For most environmental issues and for various social issues, such targets are provided by conventions, legislation and standards, however not for all. There is for instance no international standard for the important social questions of what is a “fair wage” and a “fair inequality”. Without an existing standard industry often seeks best practices as benchmark (e.g. Fiksel et al. 1999).

A concept in the system, essential for the subject of this paper is the “Oiconomy consumer”, who requires full sustainability as a quality aspect of the product and wants to know the cost distance to the sustainable product. Considering poverty, all current theories on poverty analysis and all current countries’ choices are based on the assumption of continuation of the existing fierce competition on labour costs, even below the poverty line. The Oiconomy consumer however requires all hidden costs of sub-fair wages and too high inequality to be included in the price of the product, with the consequence that competition is limited to above a threshold standard.

For the issue of inequality of wages, countries seem the best performing units. We propose to use the practices in a benchmark group of the 20 % top performing countries; but first, we need to select the indicator best suited to develop that benchmark.

The purpose of this part 1 article is to first develop a well-founded benchmark group of the 20 % best performing countries and thereafter, based on practices in this benchmark group, propose a well-founded benchmark for the issue of inequality of wages, for preventative costs based LCA, but also for SLCA in general and for other uses. In a part 2 article, we make a proposal for fair minimum wages (Croes and Vermeulen 2015b).

2 Methods

In order to propose a well-founded benchmark of the 20 % best performing countries, in the sections 3.1 and 3.2, we first give an overview of relevant country-level sustainability indicators, first discussing monetary indicators and thereafter non-monetary indicators. In Section 3.3, we made an assessment for a proposal for the indicator to be used for the benchmark for LCA purposes in general and SLCA purposes particularly. The assessment criteria were based on the following ideal indicator properties:

- Regular updating and available for a large majority of countries
- Comprising both environmental, social and economic aspects of sustainable development
- Measuring strong sustainability in a sense that social and environmental issues may not compensate each other

- Because of our goal of a target for policies we prefer governance and policy measuring indicators over status measuring indicators
- Adequate sensitivity and sound normalization, aggregation, and weighting methods

In Section 3.2, using the 20 % top performing democracies in the selected indicator, and assuming that the ratio between the highest and lowest remuneration in democratic governments represent a democratic concept of "fair inequality", a benchmark for fair inequality in governmental wages was determined based on the average ratio in our benchmark group. Using cautious developments in some top performing countries towards wider limitation of top wages, we made a proposal for top ratios for governmentally ruled companies and for industry, and finally, we made a proposal of how to use these as inequality PRP in preventative costs based SLCA.

Because the 20 % benchmark size is an assumption of the authors, also proposed in the Oiconomy system, we compared the results of this choice with calculations based on lower percentages.

3 Results

3.1 Reviewing monetary indicators

3.1.1 GDP and derivates

Most common indicators for the measurement of welfare and economic progress are the Gross Domestic Product (GDP) and its variations. The GDP is a monetary measure of the goods and services annually produced by domestically located factors of production (Lawn 2003, p.106). A variation on GDP is the Gross National Income (GNI), which includes international financial flows like interest and cross border incomes (Lequiller and Blades 2006, p.285). The Gross National Savings (GNS) is the GDP minus the gross national expenditures or consumption (Kaufmann et al. 2011), in other words, an indicator for the profitability of a country. Data on the GDP and GNI are readily available and updated for all countries, e.g. by the World Bank and the International Monetary Fund.

3.1.2 Greening national account systems

Because of a growing concern about the purely economic character of these politically important indicators, totally disregarding the hidden parts of the economy, national account system alternatives including externality measurement were developed.

In the last decade of the twentieth century in the Netherlands, the National Accounting Matrix including Environmental Accounts (NAMEA) was developed (De Haan and Kee 1996), and in 1993, in an international cooperation, the System of Environmental-Economic Accounts (SEEA) (United Nations et al. 2003). The NAMEA provides objective national statistics on both economic and environmental data, without weighting or interpretation; the SEEA also includes social data. By both input- and output-based flow data, and stock differences, the SEEA provides an overview of a country's developments in economic, social and environmental performance. The data are not aggregated or presented in a comprehensive indicator, but in matrix form. As purely statistical data, the NAMEA and SEEA leave assessment and the construction of comprehensive indicators to politicians. The NAMEA and SEEA are applied by a limited number of, mainly OECD, countries only.

Also in the late twentieth century, comprehensive monetary alternatives for the GDP were developed. The first work into this direction was by Nordhaus and Tobin (1972). They argued that not production, which the GDP is based on, but consumption is the goal of economic activity and use national consumption as the base of their Measure of Economic Welfare (MEW). Positive contributions to national consumption (such as leisure and work at home) are added and negative subtracted. Where the flow of such contributions cannot be measured directly, capital stocks at the start and end of the year are compared. This lead to the Sustainable MEW (SMEW), a measure of welfare while preserving capital stock. But Nordhaus and Tobin found themselves struggling to collect the required data and valuing the stocks of environmental capital.

Gradually different methods were proposed for valuing these environmental externalities, such as for ecosystem services, expenditures for environmental protection and hypothetically invested resource rents for new discoveries and for changes in resource stocks.

Using the idea of adding positive contributions and subtracting the negative, the World Bank developed the Adjusted Net Savings (ANS) or Genuine Savings (GS) as an indicator for economic progress. Starting from Gross National Savings (GDP minus local consumption), subtracted are depreciation of physical capital, the rent from depletion of natural resources and the damage from CO_2 emission. Added are expenditures on education (Bolt et al. 2002, p.5). One of the most important criticisms against the GS is that it is based on "weak sustainability". The concept of weak sustainability finds its origin in the idea that the value of extracted non-renewable resources can be reinvested in produced capital (Dietz and Neumayer 2007, p.5). Weak sustainability assumes full substitutability between different types of capital or issues and for instance allows to compensate forest loss with education and allows environmental degradation if compensated. By contrast, strong sustainability means that ecological capital remains intact (Pillarisetti 2005, p.600). In addition, where for depletion of resources, only the rent is subtracted, the full expenditures of education are added. This, in our view, is not consistent because education capital is continuously lost (people forget, get pensioned and die), and a quantity of expenditures is required for maintaining a constant level of education capital, which should not be counted as savings. Also, Pillarisetti argues that education takes too much weight in the GS, making it an unbalanced indicator. MEW and SMEW are hardly used; the World bank maintains data on the GS for 110 countries but because the GS only comprises environmental and economic indicators, it therefore is not suited for our purpose.

A far more comprehensive GDP alternative is the ISEW, created by Cobb and Daly, or Genuine Progress Indicator (GPI), (Cobb and Daly 1989; Talberth et al. 2007). The ISEW first applies to the GDP a correction coefficient to personal consumption expenditures for inequality because high inequality can be detrimental to welfare. Thereafter, like the MEW and GS, the ISEW corrects for positive and negative impacts. Augmentations are for estimated values for the services of households and volunteer labour, consumer durables, community services like streets and some private and community investments. Subtractions are for a list of issues like health and education expenditures, investment in consumer durables, car accidents, the costs of various types of environmental degradation and pollution, loss of wetlands and forests, depletion of non-renewable resources, costs of crime and underemployment. Positive for our purpose is that the ISEW includes environmental, economic and social aspects. Mentioned shortcomings of the ISEW are about the specific calculation methods, choices of included index components and the fact that this indicator is also based on weak sustainability. The ISEW is used by a limited number of countries only.

A general shortcoming of environmental issues comprising national accounts is that they are by far not practiced by a majority of countries, and, due to lack of coordination and standardization, not in a harmonized way.

3.2 Reviewing non-monetary indicators

There are too many non-monetary indices on country sustainability performance to discuss them all. Many reviews are available, such as (Mayer 2008; Olafsson et al. 2014; Parris and Kates 2003; Mori and Christodoulou 2012; Singh et al. 2012; Saisana and Philippas 2012; Adelle and Pallemaerts 2009; Böhringer and Jochem 2007; Phillis and Kouikoglou 2010; Booysen 2002; Street and Sharpe 1999; Stiglitz et al. 2009). We narrow our selection to those indices that include more than 100 countries and are regularly updated (listed in Table 1).

3.2.1 Ecological footprint

The Ecological Footprint (EF) measures the global hectares (gha) that are required for something, heavily weighting carbon emission and the impact on the environment (Ewing et al. 2010). As unilateral the economic indicators are on the economic aspects, as unilateral is the EF on ecological aspect and even more on the climate issue. The EF can be calculated on all levels, from products to countries. Best performing 10 countries (with lowest EF) are developing countries with low life satisfaction and low government effectiveness.

An interesting indicator is the EF-Biocapacity Ratio (FBR), providing a measure of the overshoot of a country. In 2008, the global Footprint per capita was 2.7 gha with a range from 0.44 gha (Timor) to 11.7 gha (Qatar). The globally available biocapacity per capita was 1.78 gha (Grooten et al. 2012, p.141). At a minimum, sustainability requires the avoidance of global overshoot, or a FBR no greater than 1. The top 10 performing countries (lowest FBR) consist of 8 developing countries and Brazil and Argentina, and not far below, one finds Australia and Canada, indicating that country size and population density play a cardinal role in the results measured by this indicator. Menke developed a monetary variation on the ecological footprint. By dividing the global GDP by the globally available productive global hectares, he derived a value of US$ 4500 (2009) for 1 gha by which a footprint can be expressed in a monetary unit (Menke 2010, p.26). The EF and FBR are by far the most used ecological indicators.

3.2.2 Ecological performance index

A very different indicator is the Ecological Performance Index, developed by the Yale Centre for Environmental Law and Policy and Columbia University (Esty et al. 2006), predeceased by the Environmental Sustainability Index (ESI). The EPI aggregates 20 indicators, divided in two categories (subdivided in 6 policy subcategories): human health-impacting environmental issues and ecosystem vitality. All indicators are determined by country ranking on a distance to target scale, where the targets are determined by international conventions. In the aggregation, subcategories and indicators are quite evenly weighted. Using policy categories and targets, the EPI is, far more than the EF, a governance oriented indicator and therefore more suitable for SLCA purposes. However, also the EPI is a purely environmental indicator. In addition, its ranking principle is criticized for presenting developed countries performance optimistically (Stiglitz et al. 2009, p.238). Best scoring are, very different from the EF, developed countries like Switzerland, Luxemburg, Australia and Singapore.

3.2.3 Emergy

Emergy is calculated as the solar energy that is needed or used up to create a resource. Emergy is an indicator on the embodied energy of something, or nature's effort required to create a

Table 1 Regularly updated SD indices including >100 countries. Data used from (Booysen 2002; p.132–137; Singh et al. 2012, p.296–297; Van de Kerk and Manuel 2012, p.7)

Index	Developers	Dimensions (S = social; E = environmental)	Countries (and regions)	Number of indicators	Last report
Ecological Footprint	Wackernagel & Rees	E	232	6	2012
Environmental Performance Index	Columbia and Yale Universities	E	132	22	2014
Emergy	University of Florida	E	105	1	2008
Human Development Index	UNEP	S	187	4	2013
Human Sustainable Development Index	UNEP	S + E	163	5	2013
Happy Life Years Index	Veenhofen, R. Erasmus University	S	155	2	2009
Happy Planet Index	Friends of the Earth; New Economics Foundation	S + E	151	3	2011
Government Effectiveness indicator	World Bank	S	210	18	2013
Sustainable Society Index	Kerk & Manuel	S + E	151	21	2012

resource. Where the EF is an indicator on the consumption end of the economy, emergy is about the origin of everything. The concept was developed by Odum (Odum 1996) and further developed and maintained by Emergy Systems, University of Florida (Center for Environmental Policy and U. of F 2008). Important advantage of the emergy concept is that it provides a scientifically sound and objective quantification of almost any desired product or activity, where other indicators usually apply more subjective weighting of different issues (Hau and Bakshi 2002, p.4). Emergy objectively quantifies both natural resources and human activities.

An emergy-derived performance country indicator is the Emergy Yield Ratio (EYR), a measure for the released (or lost) emergy per invested emergy. Best (lowest) scoring are Belgium, Switzerland, Belarus, Israel, Finland, Lithuania and Denmark, but Canada and the USA score much lower. In principle, emergy is an ecological indicator expressed in the "solar equivalent joule", but, like the EF, emergy can be monetized by comparison with the GDP. Although the EYR seems one of the most objective country indicators, it currently lacks data, especially from developing countries, is highly debated, and insufficiently regularly updated to become our current country indicator.

3.2.4 HDI and HSDI

With the UNDP scheme of International Human Development Indicators (UNDP 2013), everyone's preferred indicator can be composed from a large choice of indicators on the aspects of health, education, income, inequality, poverty, gender and sustainability. The Human Development Index (HDI) is UNDP's widely recognized choice, consisting of life expectancy representing health, years of schooling representing education, and the GNI per capita as indicator for income, equally weighting health, education and income with one third. Ranking countries to the HDI results in a list headed by high-income countries like Norway, Austria, The Netherlands, the USA and New Zealand. The UNDP considers the group of countries with an index score of 0.8 (on a scale from 0 to 1) highly developed countries.

Major criticism on the HDI is the lack of an environmental indicator. Therefore, recently, the Human Sustainable Development Index (HSDI) (Togtokh and Gaffney 2010) was created by the addition of the CO_2 emission per capita. Comparing the HSDI with the HDI, we see the USA and Canada sinking from 3 th and 8th place to 24th and 23th and Australia from 2nd to 10th. However, because only 6 out of 36 countries are replaced in the top 20 % and both replacing and replaced countries are developed countries, this top 20 % does not significantly change.

Wackernagel plots the HDI against the EF (Wackernagel et al. 2005, p.11) and draws two lines as thresholds or targets, as presented in Fig. 1. One is the UNDP 0.8 criterion for high human development and the other is the 1.8-ha global biocapacity per capita expressed in the available arable land per capita. Wackernagel demonstrates that human development and footprint do not match and that currently not any country has reached both human development and footprint thresholds which is demonstrated by the empty quadrant on the right below.

3.2.5 Happy life years index

A long and happy life probably is the most common wish of human beings. Happiness is a subjective emotion subject to fast change and depending on conditions, but by regular measuring on large groups, a reasonably reliable indicator was created by Veenhoven by his Happy Life Years Index (HLY), measured by multiplying life expectancy with a 1–10 happiness score. Happiness is measured as experienced

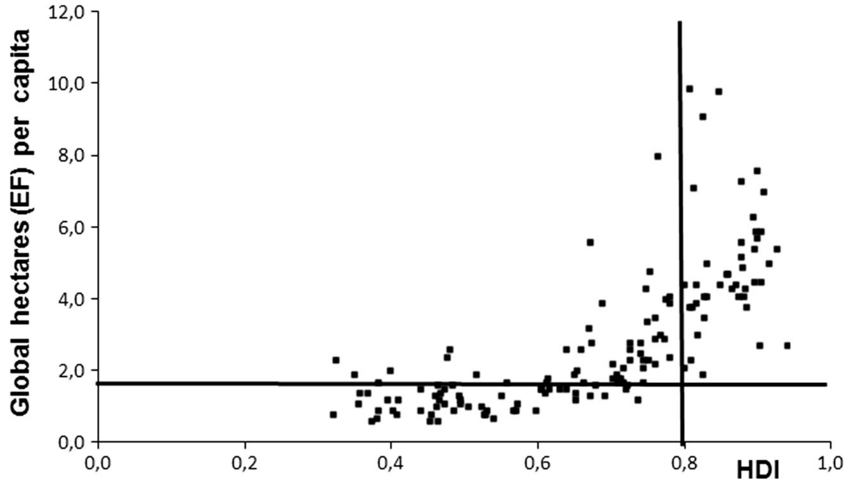

Fig. 1 Economical Footprint versus GDP per capita (our version). (2009 data from Global Footprint network and 2010 data from UNDP (covering the 2009–2010 span)

wellbeing (Veenhoven 1996, 2012). The top ten happiest countries, according to this index, are Western European countries with the exception of Costa Rica that is heading the index. The index is an indicator on current happiness saying little about the sustainability of that happiness.

So far, indicators were discussed that are rather unilateral, either on aspects of the economy, environment or happiness. For our purpose, we need more comprehensive indicators. As mentioned above, UNEP presents a tool to compose a personalized indicator. A wealth of reliable data is available from the World Bank, IMF, Central Intelligence Agency (CIA) and the United Nations (UN) and using these and other data, various authors have developed composite indicators.

3.2.6 Happy planet index

The Happy Planet Index (HPI) is the product of life expectancy and life satisfaction, measured globally by the Gallop Poll (Deaton 2008), divided by the ecological footprint. Top ranking are Southern and Middle American countries like Costa Rica, Colombia, Belize, El Salvador, Jamaica and Panama, accompanied by Vietnam. The HPI reflects the average years of happy life produced by a given society per unit of planetary resources consumed (Abdallah et al. 2012), or in other words, in terms of the ecological price paid.

3.2.7 Government effectiveness indicator

The World Bank Government Effectiveness Indicator (GEI) measures the quality of governance in a country by a large series of aspects effecting living conditions (Kaufmann et al. 2010). This is a limited indicator on the effectiveness of a government in people's daily life or on how well a country is organized. It is part of a series of World Bank governance indicators measured for 215 countries and regions, also comprising voice and accountability, political stability, regulatory quality, rule of law and control of corruption. Sustainability indicators mostly tell something about the status of a country, but most are poor indicators on the reasons for that status. The GEI is an indicator on the extent that a status is coincidence or the consequence of governance, and that is the reason we discuss this indicator. Not surprisingly, all top GEI ranking countries are developed high income countries, like the USA and Canada, western European countries, New Zealand and Australia, Japan and South Korea.

3.2.8 Sustainable society index

The Sustainable Society Index (SSI) is a composite indicator, equally weighting society aspects (Van de Kerk and Manuel 2008, 2012). This index does not measure experienced wellbeing, but more objectively, 21 components of human, environmental and economic wellbeing. Top ranking in the SSI are developed countries like Switzerland, Sweden, Norway, Austria and New Zealand. The SSI actually is a composite of 3 indices: the SSI Human Wellbeing (SSI HW), the SSI Environmental Wellbeing (SSI EW) and the SSI Economic Wellbeing (SSI EcW), all 3 composed of a balanced variation of indicators. The SSI HW is composed of indicators on sufficient food and drink supply, safe sanitation, health, clean air, clean water, education, gender equality, income distribution and good governance (GEI). The SSI EW is composed of air quality, biodiversity, renewable water resources, consumption, renewable energy and greenhouse gasses. The SSI EcW is composed of organic farming, genuine savings, GDP, employment and public debt. Unfortunately, the SSI does not include population growth and recently emerged financial issues.

The idea of separately presenting human and environmental wellbeing was earlier proposed by Prescott Allen who presented his human and environmental wellbeing indices in his influential book *the Wellbeing of Nations* (Prescott-Allen 2001). However, these indices were only published ones.

3.3 Indicator assessment

On social issues, like fair payment and inequality, we propose to use the "best practice" benchmark made by the practices in the 20 % top performing countries, exactly as we proposed in the Oiconomy system (Croes and Vermeulen 2015a). In order to determine which group of countries make that benchmark, these indicators will now be further assessed on their applicability for the purpose of a PRP for SLCA.

Economic indicators, such as the GDP and GNI per capita, show clear correlations with key sustainability issues. Clearly positive (but in effect negative) is the correlation of the GDP with the ecological footprint (Fig. 2). This correlation is linear and indicates that at "business as usual", the footprint per person rises with about 1.12 ha for every € 10.000 of yearly income. The GDP and GNI are purely economic indicators, and all existing greening national accounting systems lack uniform execution in a majority of countries. The EF, EPI, Emergy and LPI are purely environmental indicators. All of these indicators disregard social issues and are not suited for the creation of our intended top 20 % country benchmark.

The Happy Life Years Index seems a better indicator for the current wellbeing of the people of a country than the economic indicators because it relates to the ultimate goal of all human beings, a long and happy life. However, happiness must be sustainable and available to future generations which is not measured by this indicator. Also, the Happy Planet Index is of limited value for SLCA because it is composed of too few aspects and neglects most sustainability and economic issues.

The HDI, as a combination of health, educational and economic indicators currently is the most used composite indicator for human development, but does not include environmental indicators. The HSDI only includes one limited environmental aspect of sustainability: CO_2 emission.

The Sustainable Society Index (SSI) demonstrates why one comprehensive indicator for all issues currently is not very discriminative on country performance. The SSI HW (human wellbeing), plotted against the SSI EW and the SSI EcW (Figs. 3 and 4), shows a positive correlation with economic wellbeing and a negative correlation with environmental wellbeing. Human wellbeing goes well with economic wellbeing, but not with environmental wellbeing. The relevance for the assessment of indicators is that indicators on human and economic wellbeing can easily be exchanged or combined, but the aggregation of either of them with an environmental indicator will not make a sensitive benchmarking indicator. This is confirmed by the footprint quadrant method described above that already showed that there currently are no countries with satisfactory scores on both human and environmental wellbeing.

Remarkable is that most of the composite sustainability or development indicators do not consider the issue of population growth, which undoubtedly is one of the core sustainability issues. Another major limitation of all described indicators is that they are just aggregations of data and may not really represent what is the result of countries' governance. e.g. The footprint-biocapacity ratio gives a very high ratio to the Congo. Such countries have a good environmental performance simply because they have a low population density and low development and not because of their good governance. They are anything but a policy benchmark.

LCA is intended to help make policies and decisions, and therefore, we need a benchmark group of countries that has accomplished best performance as a result of their governance. The government effectiveness indicator plotted against SSI HW and SSI EW (Fig. 5) shows that countries' governance currently has a strong positive correlation with human wellbeing, and the last important observation is that the indicators HDI and SSI HW have a relation that, with a very high correlation coefficient of 0.80, is following the formula SSI HW = 9.05 * HDI (Fig. 6), which means that either can be used, but also that the HDI, composed of few indicators, matches the much more complete SSI HW. Although the HDI and SSI HW have the elements of health and education in common, the SSI issues not included in the HDI seem not to disturb this correlation. This suggests that good governance

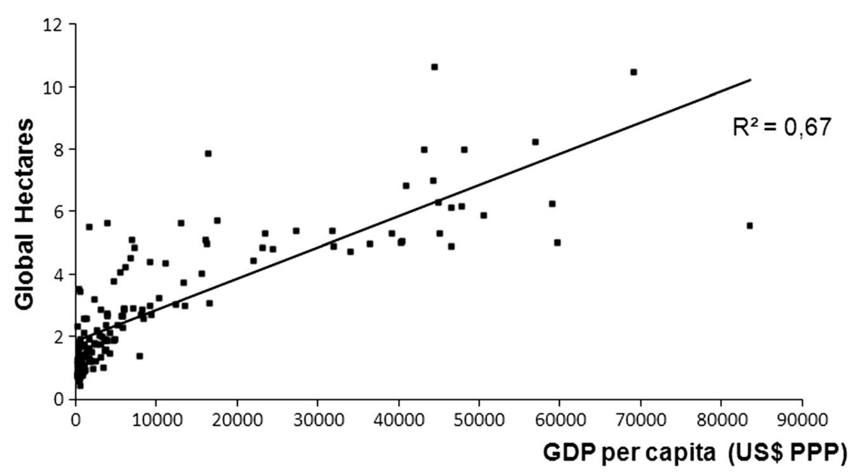

Fig. 2 Economical Footprint versus GDP capacita Data for 2007 used from the global footprint network and World Bank

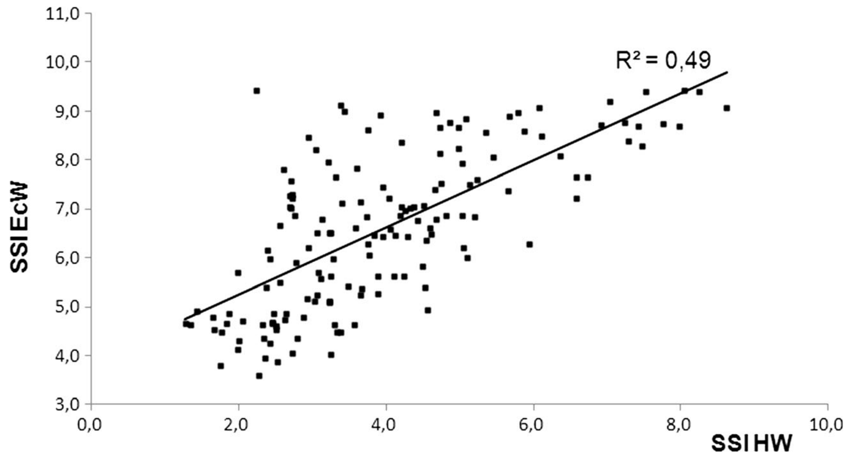

Fig. 3 SSI Economic Wellbeing (SSI EcW) versus SSI Human Wellbeing (SSI HW). Data for 2012 used from Van de Kerk and Manuel 2012

may be the ruling indicator. Also, the CO_2 emission including HSDI has a strong positive correlation with the SSI HW. Considering the negative correlation of the HDI and ecological footprint, this suggests that the environmental weight in the HSDI simply is insufficient to make a difference, which clearly shows the importance of weighting in such composite indices.

We conclude that the indicator to be used for the benchmark group of countries cannot be one, and the same for all sustainability issues, but can best be selected per issue category. For social issues, both the HDI and the SSI HW can be used. Because the SSI HW is the most complete index of both and has a well-balanced relation with the 2 sister indices on environmental wellbeing and economic wellbeing, the SSI seems the best option for the country benchmark. The 2 sister indices can be used when a country-level indicator is required for setting benchmarks for environmental and economic issues without currently available standards. The SSI was audited and approved by the JRC on its sound methods, normalization, aggregation and sensitivity (Saisana and Philippas 2012), which completes our assessment requirements. As a last check, we would like to plot the SSI HW against social unrest and people's happiness. On social unrest, insufficient reliable data are available. However, the SSI shows a strong positive correlation with happiness, if plotted against the Happy Life Years Index (Fig. 7). Considering all discussed arguments, we conclude that the SSI HW is the best currently available indicator for determining benchmark group of countries for setting targets for social issues for which no agreed targets exist. The 20 % top performing countries in this index are listed in Table 2.

3.4 Inequality of wages

In the absence of an international standard on inequality, we apply the above developed 20 % best country benchmark. We can now look what is actually happening nowadays in this group of countries. In June 2012, France's finance minister announced plans to limit executive pay at state-owned companies to € 450,000 per year (Visot 2012). The measure is meant to hold executive pay to a maximum of 20 times the average of the lowest salaries at the main state companies.

In Switzerland, extremely high CEO salaries lead to a Swiss vote for shareholder determination of CEO salaries (Schweizerische 2013).

In November 2013 in Switzerland, an initiative (Schweizerische Bundeskanzlei 2012) to cap maximum

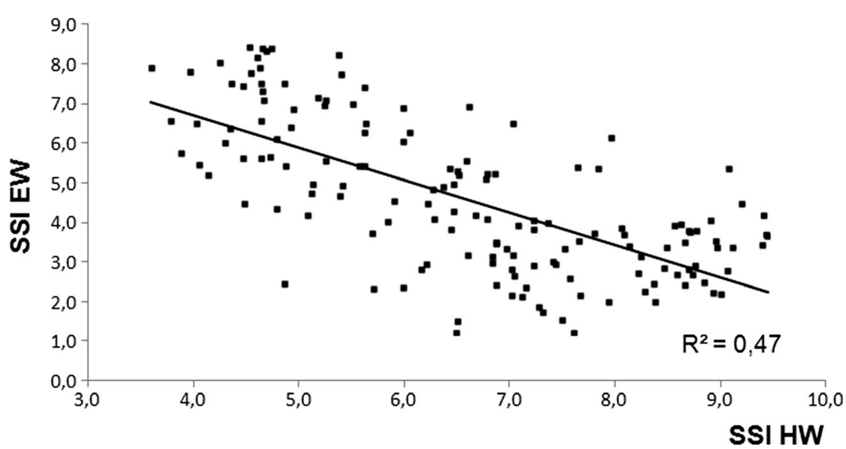

Fig. 4 SSI Environment Wellbeing (SSI EW) versus SSI Human Wellbeing (SSI HW). Data for 2012 used from de Kerk & Manuel 2012

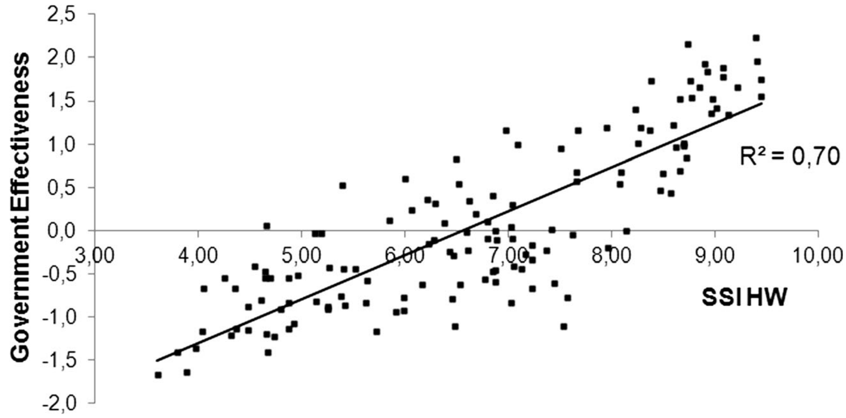

Fig. 5 SSI Government Effectiveness versus SSI Human Wellbeing (SSI HW). Data for 2012 used from Van de Kerk and Manuel 2012, and (Kaufmann et al. 2012)

salaries in industry to 12 times the lowest salaries was rejected by 65 %, but also voted in favour by 34 %.

The Netherlands legally set the "Balkenende standard", which is the highest allowed governmental income, expanded to governmental ruled companies with a 30 % extra allowance, (Staatsblad van het Koninkrijk der Nederlanden 2012). It can be argued that the Netherlands democratically determined a maximum acceptable inequality ratio (MAIR) between the highest income and the lowest income for governmental and semi-governmental functions at about a factor of 10.

In March 2014 in Italy, premier Renzi announced a salary cap of € 238,000 for the public sector and € 311,000 for government-ruled companies (La Gazetta del Mezzogiono 2014).

In Sweden, one of the world's most competitive countries, industry executives have very moderate salaries, and the issue of maximum salaries is widely discussed in many other countries. Bankers bonuses are widely considered to have contributed to shortermism and are now limited in various countries. High bonuses in general regularly cause outrage.

In order to improve corporate governance, avoid shortermism and enhance long-term sustainability, the European commission announces a similar proposal (European Commission 2014). Although the commission is not proposing a binding cap on executive's remuneration, the measure would lead to more transparency and give shareholders more "say on their pay".

Even outside the group of top 20 % countries, we see similar developments. In June 2014, Egypt's president El Sisi announced a salary cap of about 35 times the minimum wage for public sector employees (Esterman and Charbel 2014).

Expanding the idea of setting a maximum ratio between the highest and lowest salaries, one could argue that the existing ratio between the income of the highest governmental official and the minimum wage in other democratic countries is their MAIR because both are under direct influence of the countries' parliaments. For 90 countries, the premiers or president's salary could be found on the Internet. In our benchmark group of 20 % top SSI HW countries (2012), for 26 countries, data on both president's salary and statutory minimum wage were available, creating a benchmark of 26 countries. The MAIR of the benchmark group varies from 3.7 to 31.0 with an average of 14.1. Top ratios are found in Switzerland, Austria and the USA and lowest ratios in some former eastern European countries. Outside the benchmark group, the ratio's go up to 180 for Mexico and 515 for Kenya.

The Netherlands has set a 30 % higher MAIR for semi-governmental institutions. This results in a ratio of $1.3 * 14.1 = 18.3$, reasonably close to the French planned ratio of 20. Following the Dutch reasoning, it seems reasonable to

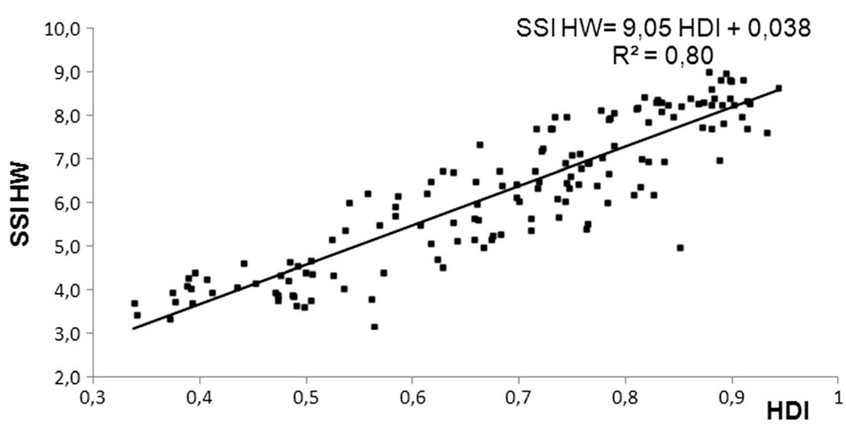

Fig. 6 SSI Human Wellbeing versus HDI. Data for 2013–14 used from Van de Kerk and Manuel 2012; UNDP 2013

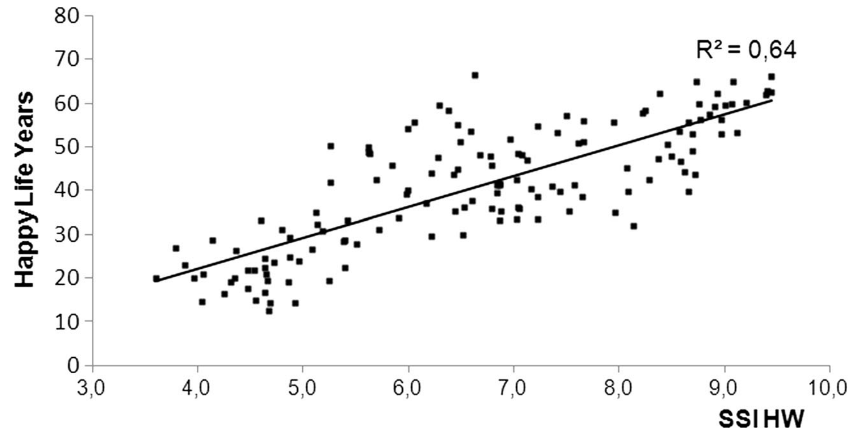

Fig. 7 SSI Human Wellbeing versus HDI. Data for 2013–14 used from Van de Kerk and Manuel 2012 and UNDP 2013

grant another 30 % for private enterprises, which makes MAIR = 1.3 * 1.3 * 14.1 = 23.8, or in other words, the lowest wage within a private organization should not be below 1/23.8 or 4.2 % of the highest, which figures we propose as a standard for the maximum inequality of wages. These last 30 % percentages are of course value choices, for which other values can be chosen.

4 Discussion and conclusions

In the introduction, we argued that the issue of inequality should be addressed in SLCA. As one of the key missing approaches, we identified a method to identify concrete and quantitative PRPs. The debate on income inequality however is a highly political issue, also in relation to LCA. Discussing ethical values in LCA, Guinée et al. (2009) compare the positions of Brundtland (United Nations World Commission on Environment and Development 1987) and Rawls (1971). Brundtland puts the highest priority at the poor because the poor suffer the most from environmental degradation. Rawls argues that if allowing higher inequality improves the position of the poor, a trade-off between criteria may be made. Because of the political nature, an objective performance reference point in SLCA for the issue of inequality must be based on democratic choices and practices. In absence of an agreed standard or PRP for "fair inequality", we therefore elaborated the use of average democratically chosen practices in a benchmark group of the 20 % best performing countries as the benchmark. Because environmental and social issues are very much interrelated (Dreyer et al. 2006, p.1), one of our criteria for an ideal indicator for such benchmark was the inclusion of both environmental and social issues. One of the results of our indicator assessment was that such ideal indicator would not be very sensitive because indicators environmental and social issues are negatively correlated. However, in the Sustainable Society Index, a well-balanced composition of 3 indexes was found, together covering the total sustainability spectrum of environmental, social and economic issues, the separate use of which we propose to use. A satisfying country indicator for target setting purposes for SLCA was found in the Sustainable Society Index Human Wellbeing.

However, our choice of using the indexes separately depending on the issue has consequences. The fact that environmental and social indexes are negatively correlated calls for cautious application of ELCA and SLCA separately. If sustainable production is considered as activities that meet the needs of the current generation without compromising the wellbeing of future generations, we need to stress the importance of assessing product sustainability as comprehensively as possible, applying both ELCA and SLCA. In our opinion, this limitation applies to LCA in general, if used to assess product sustainability. Assessing any issue individually, not considering the consequences for other issues, may provide useful information on the various alternatives considering that issue, but does not say much about the comprehensive sustainability of a product or an activity.

Using democratically determined inequality ratios in the benchmark group, it proved possible to derive an objective target for inequality in governmental institutions. Our proposed augmentations for government-ruled companies are in a range that some countries are already proposing. Considering the further augmentation for industry, which is a value

Table 2 List of the benchmark group of countries, representing the top 20 % sorted by the SSI HW 2012 from (Van de Kerk and Manuel 2012)

Austria, Belarus, Belgium, Bulgaria, Canada, Croatia, Cyprus, Czech
Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary,
Iceland, Ireland, Italy, Japan, South Korea, Lithuania, Luxembourg, Malta,
Montenegro, Netherlands, New Zealand, Norway, Poland, Portugal, Serbia,
Slovakia, Slovenia, Sweden, Switzerland, Ukraine, the UK.

choice, we should keep in mind that the goal of sustainability measurement of products is not to set a political standard but to provide the inequality conscious consumer with a measure of the costs of preventing harm from his purchase choices. For this consumer, that considers a harm-free product a quality requirement of the product, and who is, as a voter, a contributor to governmental standards, the here proposed maximum inequality ratios of 14.1 for governmental organizations, 18.3 for government ruled companies, and 23.8 for other organizations, seem very reasonable. These proposals are for inequality of wages and do not include income from a companies' ownership.

In current damage-based LCA, concrete interval quantification of social issues in one comparable unit is hardly possible. The preventative cost-based LCA systems of EcoCosts quantifies issues by the marginal costs to prevent the damage, and the Oiconomy system, based on onsite verification, extends the applicability of this system to social issues. In principle, inequality above the target can be prevented by either lowering the top wages or by raising the bottom wages. Because marginal costs are "the highest cost of all measures needed to be employed to reach the target", for these preventative cost-based LCA systems, the authors of this paper propose to use as measure of unsustainability the costs necessary to raise all remunerations in an organization and related to the measured product, to a level of 1/23.8, or 4.2 % of the highest. Of course, the proposed reference points and method of determination of future reference points can be used in other types of SLCA and for instance by fair trade organizations, but it is out of the scope of this article to elaborate on these possibilities.

Finally, we discuss the validity and some limitations of our proposed method and data. First, the presented incomes of top governmental officials are just indicative, probably including many differences in extra allowances, tax regimes and corruption. However, since the benchmark group mostly consists of good governance countries, transparent about governmental incomes, most of which top salaries are reported by a reliable source (Wage Indicator 2013), the top gross salaries in this group may be considered fairly reliable. Because these publically known presidents/premier salaries fairly well represent the people's idea of their president's income, we propose to use these data until reliable better data are available.

Second, the benchmark comprises relatively high-income countries only. Therefore, one may question if these ratios can equally be applied to inequality of wages in low-income countries. We argue that they can because there are several middle- and low-income countries with governmental ratios within the 3.7–31 range of the benchmark countries, e.g. China, India, Bangladesh, Nepal, Egypt, Ecuador, Cambodia, the Philippines, Sri Lanka.

Third, we investigated the consequences of our choices of using the standard average instead of the population weighted average, of the fairly wide top 20 % benchmark group instead of a smaller group, and even of choosing the SSI HW instead of the therewith highly correlated HDI.

Our calculations are based on the SSI HW data report 2012 (Van de Kerk and Manuel 2012).

In 2014, the composition of the index was changed due to availability of data. Due to this, together with the change in the scores of some countries, some countries in our benchmark group of the top 20 % performing were replaced by others. The USA, the largest country in the 2012 group, fell out of the group. We calculated the MAIRs based on different benchmark group options and methods of averaging, but all based on the income data. Table 3 demonstrates the results. Considering the effect of the type of average, the standard average gives a MAIR that is not very sensitive to the indicator choice and in- or exclusion of the USA. Not unexpectedly, however, using the population weighted average, the sensitivity becomes considerably higher, which is mainly caused by the in- or exclusion of the USA and higher influence of a small number of big countries.

Considering the size of the benchmark group, we see that the MAIR becomes lower with a smaller SSI–HW based group, but not so with a HDI based group. This is due to the fact that in the SSI HW, some of the countries with high MAIRs are in the bottom of the SSI HW group, but score higher in the HDI.

The standard average represents a more democratic principle between countries and lower dependence on a few large countries, but is less democratic considering the total population of all benchmark countries. Concluding, because the standard average gives a more stable indicator than the population weighted average we stick to our proposal of using the top 20 % performing countries in the SSI HW as benchmark.

Table 3 Maximum acceptable inequality ratio's (MAIR) related to size of the country benchmark group, the index it was determined from, and the type of averaging

		Top 20 % countries		Top 15 % countries		Top 10 % countries	
Year	Indicator	Average	PW average	Average	PW average	Average	PW average
2012	SSI HW 2012	14.1	17.6	13.8	13.8	11.4	12.7
2014	SSI HW 2014	14.2	14.8	13.8	13.2	12.0	13.1
2013	HDI 2013	13.4	17.5	13.2	17.9	13.1	19.0

PW average population weighted average

And last, we need to stress that one of the disadvantages of a best practice-based method is that the data need regular updating. However, following the methods of this paper, they are not difficult to determine, especially not if countries' top governmental incomes would become better documented.

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