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MEDEAS

MODELING THE RENEWABLE ENERGY TRANSITION IN EUROPE

Project Nr: 691287

Guiding European Policy toward a low-carbon economy. Modelling sustainable Energy system Development under Environmental And Socioeconomic constraints

Annex 7: Task 2.2.e.1. Social welfare and inequality data analysis

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Scope of document

The global aim of MEDEAS project is to provide policy makers and stakeholders with a new tool, to better assess the impacts and limitations of the EU energy production/consumption system transition to a low-carbon sustainable socio-economy. This tool will integrate energy, raw materials supply and socioeconomic behavior in an energy systems simulation model.

Specifically, Deliverable 2.2 is focused on providing the necessary analyses in selected sectors that need to be carried out in order to run the model properly: (1) Electricity sector; (2) Transportation; (3) Total primary energy extraction; (4) Industry, residential and commercial energy requirements; and (5) social welfare and environmental impacts indicators analysis.

This Annex discusses the social welfare issues in the light of the transition to a low-carbon economy. First, the trends and drivers of social welfare at global level are reviewed: Human Development Index, Gross Domestic Product, happiness index, as well as inequality issues. Secondly, the relations between these variables are analyzed and compared with other analyses, and further improvements are suggested. Finally, we discuss the integration of social welfare in the MEDEAS model framework.

It should be noted that this is a living document and that the suggested analyses will constitute a starting point for the MEDEAS model. Additional analyses might be required and some might be abandoned as the project proceeds and if new requirements are detected.

List of abbreviations and acronyms

GDP – Gross Domestic Product

GNI – Gross National income

GPI – Genuine Progress Indicator

HDI – Human Development Index

ISEW – Index of Sustainable Economic Welfare

PAVs – Partially Aggregated Variables

PPP – Purchasing Power Parity

UN – United Nations

UNDP – United Nations Development Programme

Glossary

Easterlin paradox – A concept suggesting that a higher level of a country's per capita gross domestic product (GDP) does not correlate with greater self-reported levels of happiness among citizens of a country.

Genuine Progress Indicator – The GPI is designed to take fuller account of the well-being of a nation by incorporating environmental and social factors which are not measured by GDP.

Gini index – Measure of the deviation of the distribution of income among individuals or households within a country from an equal distribution. A value of 0 represents absolute equality, a value of 1 absolute inequality.

Gross Domestic Product – A monetary measure of the market value of all final goods and services produced in a period (quarterly or yearly). Real GDP estimates are commonly used to determine the economic performance of a whole country or region, and to make international comparisons.

Gross National Happiness Index – The holistic concept of measuring subjective well-being of a country's citizens, developed in Bhutan. GNH has four pillars: good governance, sustainable socio-economic development, cultural preservation, and environmental conservation.

Gross National Income – The total domestic and foreign output claimed by residents of a country, consisting of GDP plus factor incomes earned by foreign residents, minus income earned in the domestic economy by nonresidents.

Happiness Index – The measure of happiness published by the United Nations Sustainable Development Solutions Network.

Human Development Index – A composite statistic of life expectancy, education, and per capita income indicators, which is used to rank countries according to these four tiers of human development.

Index of Sustainable Economic Welfare – An indicator intended to replace the GDP. Consumer expenditure in ISEW is balanced by factors such as income distribution and cost associated with pollution and other unsustainable costs. Similar to GPI.

Purchasing Power Parity – The concept allows to estimate what the exchange rate between two currencies would have been in case if it was at par with the purchasing power of the two



countries' currencies. This concept allows to compare what one can buy with the same amount of money in different countries.



Executive summary

The analysis provided in this section should shed light on the MEDEAS Social module by assessing relevant social indicators which might be implemented in the MEDEAS framework. This section should identify the main drivers of social welfare that are key for transition to low-carbon economy. To address drivers of social welfare (or human well-being), we suggest to link it with two ways of addressing life satisfaction – based on one hand on “objective” indicators, and, on the other, on subjective (i.e. self-reported) level of happiness. Furthermore we propose to connect social welfare with (in)equality issues, and try to establish a link between social welfare and economic production. We propose to ask the following questions:

- What are suitable **indicators** to measure social welfare?
- What are the **factors** influencing social welfare, apart from levels of production (and consumption)?
- What role does **(in)equality** in terms of income **distribution** play?
- How much is social welfare linked with **economic production**?
- Up to which levels of consumption does human well-being rise?
- Etc.

Which indicators reflect drivers identified as key for social welfare and transition to a low-carbon economy? By asking the questions raised in the previous part, we have identified four indicators for the purpose of MEDEAS Social module:

- Gross Domestic Product (GDP) – one-dimensional;
- Human Development Index (HDI) – composite;
- Happiness index – composite;
- Gini index – one-dimensional.

GDP is included as probably the most popular socio-economic indicator showing the level of production and consumption of all final goods and services produced in a given period, although we are well aware of its limitations, described systematically e.g. by Van den Bergh (2009).

HDI is a composite indicator, focusing on broader aspects of socio-economic performance, not just those visible in a monetized economy. Beside per capita Gross National Income (GNI), it takes into account inflation, life expectancy and education.

Happiness index, based on World Happiness Reports, is also a composite indicator, based on ranking answers to life evaluation questions asked in a poll. The answers are weighted according to six factors: levels of GDP, life expectancy, generosity, social support, freedom, and corruption.

Gini index assesses (in)equality in a socio-economic unit, typically a state. Gini index measures deviation of the distribution of income within this socio-economic unit. A value of 0 represents absolute equality, a value of 1 absolute inequality.

These four indicators were selected because of their common use by international organizations, and thus also their credibility. Pragmatic reasons, i.e. data availability across time, also played a role, because of the need to correlate the datasets. Based on an evaluation of the suggested indicators, we are trying to investigate their mutual relations. The goal was to suggest possible links and interdependencies for the MEDEAS model structure. Specifically, we analysed correlations on the global aggregate level between:

- (1) **HDI and GDP** to see their mutual position (and, regarding the report about energy, emissions and social welfare, to see which of them should be linked with energy consumption per capita);
- (2) **HDI and Gini index** to see links between composite social welfare indicator and (in)equality;
- (3) **GDP and Gini index** to see the relation between economic production/consumption levels and (in)equality;
- (4) **GDP and Happiness index** to see the contribution of purely economic indicator to self-reported level of life-satisfaction;
- (5) **HDI and Happiness index** to see the link between broader “developmental” composite indicator and happiness perception;
- (6) **Happiness index and Gini index** to see the relation between (in)equality and self-reported level of life-satisfaction.

It should be noted that our datasets were (in case of Gini index and HDI) composed out of country level data. Hence, the correlations on a global level have been derived from weighted aggregates, and should therefore be taken with caution. The correlations only provide an indication. Further analyses can (and should) be made accordingly, depending on the MEDEAS model demand. Panel regressions for all countries will provide much stronger evidence, depending on the needs of MEDEAS model.

The strongest link has proved to be between GDP and HDI. The model should therefore take into account GDP as having impact on social welfare measured by HDI. However, GDP can contribute to, not explain social welfare. Even composite indicators such as HDI cannot themselves be seen as drivers of human well-being or social welfare. Happiness is probably a suitable complement to HDI or even GDP. These two or three (happiness and HDI/GDP) can provide a relatively good notion of social welfare within a given socio-economic unit.

To strengthen this basis of social welfare describing indicators, MEDEAS model should take into account (in)equality in terms of income (measured by Gini index). Albeit Gini index seems to be only relatively weakly linked with happiness, this might very likely be due to poor data basis, and the link between (in)equality and happiness/human development should be further studied and elaborated, e.g. with panel data for particular countries.

Introduction

Many policy decisions, cost-benefit analyses, international comparisons, measures of progress, as well as inequality analyses constantly refer to evaluations of individual and collective wellbeing. Hence, the importance of measuring social welfare should be considered in a tool such as MEDEAS. The fact that monetary measures still predominate is usually interpreted to be due to lack of a better index, rather than reflecting a positive consensus (Fleurbaey, 2009).

Maintaining social welfare is an important aspect of transition to low-carbon economy. Several studies (e.g. Easterlin, 1974, among the most famous ones) argue that human well-being cannot be measured simply by economic indicators such as GDP. Hence, there is a need to identify factors that influence social welfare by covering more aspects than only income levels. The main challenge is to discuss and select these drivers of human well-being and to find proper indicators that could serve for the assessment of social welfare for the modelling purposes.

The analysis provided in this report should shed light on the MEDEAS Social module by assessing relevant social indicators which might be implemented in the MEDEAS framework. Social welfare indicators are suggested to be influenced by variables from Economic module – population, GDP, and other indicators regarding economic production. They are also assumed to be connected to Climate module – see the link to climate change impacts in Figure 1. This section should identify the main drivers of social welfare that are key for transition to low-carbon economy.

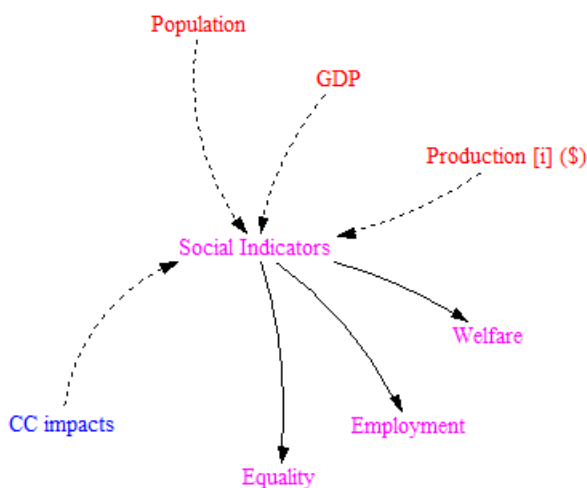


Figure 1 : Integration of social indicators to the MEDEAS model structure.

Note: Inputs and outputs in the Social module shown in the Figure above are just indicative.

The inputs to feed the Social module are still unclear, as well as the way of integrating data used in the Economy module. Social indicators are currently outputs that are not feed-backed to the rest of the model.

To address drivers of social welfare (or human well-being), we suggest to link it with two ways of addressing life satisfaction – based on one hand on “objective” indicators, and, on the other, on subjective (i.e. self-reported) level of happiness. Furthermore we propose to connect social welfare with (in)equality issues, and try to establish link between social welfare and economic production. Hence, our contribution should for example discuss the ability of economic indicators (such as GDP as probably the most popular) measuring production of the economy, to predict impact on social welfare and (in)equality, influencing then general human wellbeing. Specifically, we propose that the Social module should provide answers to the following questions:

- What are the **factors** influencing social welfare, apart from levels of production (and consumption)?
- What are the suitable **indicators** to measure social welfare?
- How much is social welfare linked with **economic production**?
- **Up to which levels of consumption** does the human well-being rise?
- What role does e.g. **(in)equality** in terms of income **distribution** play?
- What **other measurable aspects** can be taken into account (levels of education, health indicators, etc.)?

Employment is also suggested to be taken into account in the preliminary model structure. However, for the first steps of the analysis, we emphasized rather more all-embracing indicators to give us broader context than one-dimensional indicators. One-dimensional indicators (such as employment, level of education, life expectancy, etc.) provide very important information about various dimensions of social welfare, but cannot themselves successfully explain the level of well-being. The issue of composite versus one-dimensional indicators will be further discussed in the Methodology section.

In the “Methodology” part, we address mainly the first two questions from the list above. An overview (in the form of literature review) of the key factors/drivers of social welfare is provided. Whenever reasonable and possible, this overview tries to point out the most important drivers’ characteristics (strengths and weaknesses) that the MEDEAS model structure should take into account. We select social welfare indicators best reflecting the suggestions provided by the overview as a second step.

Answers to the other questions partly are also provided in the Methodology section. This applies especially for the last question, i.e. “What other measurable aspects can be taken into account?”. On the other hand, the main part of the answers is subject to interpretation in the part “Results”, where outcomes of our own analysis are presented.

In the section “Results”, we elaborate our own analysis of the necessary socioeconomic partially aggregated variables (PAVs) linked with human well-being, such as Human Development Index (HDI), Happiness index or Gini index, and we try to link these indicators with inequality measures (Gini index) and performance of the economy (Gross Domestic Product, GDP). We provide an analysis of links between these variables on the aggregated world level.

These data were gathered from (1) World Data Bank (GDP, Gini index) and (2) from United Nations Development Program (UNDP) database (HDI), World Happiness Report (Happiness index), or, respectively from the Our World in Data database, provided by Oxford University (for HDI).

Methodology

In this section, we describe the process of selecting key drivers and respective indicators to evaluate the level of social welfare. This requires answering some of the questions posed in the Introduction, i.e.:

- (1) Which **factors** influence social welfare, apart from economic drivers such as levels of production (and consumption)?
- (2) How do the **economic factors** exactly contribute to social welfare?
- (3) What are the suitable **indicators** to measure social welfare?
- (4) How much is social welfare linked with **economic production**?
- (5) **Up to which levels of consumption** does the human well-being rise?
- (6) What role does e.g. **(in)equality** in terms of income **distribution** play?
- (7) What **other measurable aspects** can be taken into account (levels of education, health indicators, etc.)?

It is, then, important to first identify (1), the drivers of social welfare. This will be based on literature review of various sources, varying from official surveys to academic studies. We separate economic from non-economic potential drivers. The economic drivers (2) are already suggested by the preliminary model structure (see Figure 1 above). However, the nature of their exact contribution will be discussed here as well.

As a second step, it is necessary to find (3) appropriate indicators that will address the drivers reflecting levels of social welfare.

Related to economic indicators' ability to indicate level of social welfare, questions (4) and (5) will be partly answered by literature review, and partly by our own analysis (section Results).

Concerning the role of particular areas of social welfare, such as (6) (in)equality issues, or (7) other aspects such as access to education or health care, these will be also partly discussed on the basis of review of relevant sources, and partly by our own analysis (part Results).

Apart from reviewing other relevant sources and analyses related to this report's topic, we provide a correlation analysis of the selected variables, based on our own analysis of selected variables.

Factors influencing social welfare

The meaning of “good life” and what is a desirable society has been discussed probably for millennia. In the last decades, several alternative approaches to defining and measuring quality of life were suggested. According to Diener and Suh (1997), these are (1) **social indicators** such as health, education, etc.; (2) **subjective well-being measures** (assessing people’s evaluative reactions to their lives and societies, such as self-reported happiness); and (3) **economic indices**. These indicators come from three approaches to well-being that are based, respectively, on normative ideals (the more education we have, the better), subjective experiences, and the ability to produce or purchase goods and services (measuring income or levels of production).

We provide a review and assessment of the strengths and weaknesses of these approaches further below. We argue that social indicators and subjective well-being measures are necessary to evaluate, respectively, the quality of life at the level of society, and at the individual level, and they should be evaluated as complements. Moreover, they should be taken into account whenever reasonable and possible together with the economic indicators that keep to be favoured by policy makers. Each approach contains information that is not contained in the other measures (Diener and Suh, 1997).

Economic approach to social welfare

The contribution of economic production/consumption levels to social welfare is being widely discussed among economists and social scientists. According to Diener and Suh (1997), the economic approach to defining good life is based on the **satisfaction of preferences**. Within the constraints of the resources they possess, people strive for things that will most improve their quality of life. The quality of life is based on whether the people can obtain the things they desire. This approach to **utility** is characteristic for neoclassical economic thinking.

In terms of indicators, we typically speak about GDP, GNI, GNP, etc. Fleurbaey (2009) suggests that even though so-called welfare economics has embraced new branches of life-satisfaction studies that are not utility-based, including theory of social choice (based on behavioural economics) or happiness studies, there are still several barriers to overcome. Nevertheless, national income, as a candidate for a measure of social welfare, is much less supported by economic theory than is commonly assumed (Fleurbaey, 2009; van den Bergh, 2009).

Diener and Suh (1997) suggest that policy makers currently weight choice utility most heavily because of the automatic assumption given by economists. It is nevertheless clear that progress in income increase cannot guarantee other important factors such as improved health care or absence of crime. In some cases, economic progress might even be inversely correlated with certain aspects of quality of life such as leisure time or a healthy environment. Another important criticism to the economic approach is that people’s choices may not make them always happy.

In addition, measuring utility based on people’s choices rests on a set of questionable assumptions about rationality and the transitivity of choices (Kahneman and Varey, 1991). Finally, to define a good life only in terms of market factors clearly omits important elements that influence the quality of life such as love, self-development, and possessing meaning in life. Thus, researchers have increasingly turned to different approaches to defining and measuring the quality of life (Diener and Suh, 1997). One of the concepts that turned the attention towards other than utility-based economic factors was the so-called **Easterlin paradox**.

Easterlin paradox

The **Easterlin paradox** is a concept in happiness economics. It states that a higher level of a country’s per capita GDP does not correlate with greater self-reported levels of happiness among citizens of a country (Easterlin, 1974). However, later research has questioned Easterlin’s conclusions (e.g. Veenhoven, 1991).

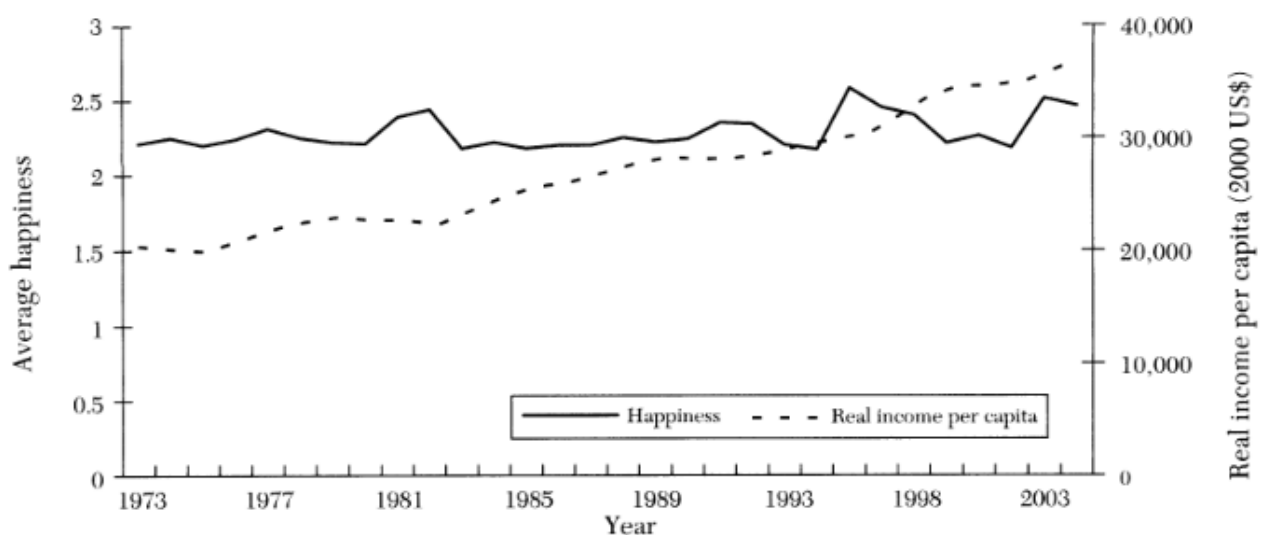


Figure 2 : Happiness and Real Income Per Capita in the United States, 1973-2004

(Source: “World Database of Happiness”, 2016)



Over the long-term (a period of 10 years or more) happiness does not increase as a country's income rises. Clark et al. (2008) suggest that even though there were found positive correlations between individual income and individual measures of subjective well-being, these findings are consistent with the Easterlin paradox. Income may be evaluated relative to others (**social comparison**) or to oneself in the past (**habituation**). This is confirmed by Easterlin et al. (2010), who show that only in the short-term in all types of countries, happiness and income go together, i.e. happiness tends to rise in economic expansions.

Fleurbaey (2009) confirms Clark's findings by stating that the Easterlin paradox can be understood in two different ways. For the so-called **welfarist approach**, the paradox reflects the fact that individual decisions are misguided. People strive for material achievements that have little impact on their subjective well-being. For the **liberal approach**, there is no paradox at all. People rationally want to improve their material conditions of life even if, in the long run, it does not increase their hedonic experiences nor does it improve their self-reported life satisfaction.

Non-economic drivers

There are two more approaches that allow to assess the level of social welfare or human well-being. Diener and Suh (1997) indicate that the first non-economic approach describes characteristics of a good life in terms of **normative ideals** based on religious, philosophical, or other types of beliefs. For example, we might believe that the good life must include high levels of education, because it helps our orientation in the world; or helping others because this is determined by our religion. These approaches to quality of life depend neither on the subjective experience of people nor on the fulfillment of their wishes (Diener and Suh, 1997). This approach to quality of life is most closely related to the social indicators tradition in the social sciences, although often combined with the economic indicators, which are, in fact, also matter of normative ideals (the more we have, the more utility we experience).

The last approach to quality of life is based on **individual experience**. If a person experiences her life as good and desirable, it is assumed to be so. In this approach, factors such as happiness, feelings of joy, pleasure, self-fulfillment, and life satisfaction are crucial (Diener and Suh, 1997). This approach to defining quality of life is mostly associated with the subjective well-being reporting tradition in the behavioural sciences, such as behavioural economics and its sub-field called happiness studies, among others, which will be discussed further below.

Non-economic normative approaches to social indicators

Among the drivers that are believed to improve our lives, levels of health care, life-expectancy, education, employment (which is also partly economic indicator), and many others are often reported as being the crucial factors (Diener and Suh, 1997). Fleurbaey (2009) argues that the weights of the various domain indicators in the general index are often imposed almost at random (which is why we include a section on the construction or assessment of composite indicators).

One problematic feature of these indicators is that they are focusing on the aggregate, societal level, thus avoiding asking individual experience (Veenhoven, 2002). They do not form an aggregate of individual indexes but add up social indicators for various domains of individual well-being instead (top-down approach). Adding up a social index of health (e.g. average life expectancy at birth) with a social index of income (e.g. GDP), as is done in the HDI together with an index of education, gives the same result for societies having the same value for both indexes, independently of the correlation between health and income at the individual level (Fleurbaey, 2009).

If such a correlation is important, it is not possible to rely solely on these summarizing indicators. It is of course possible to add the information about this correlation as an additional component of the composite indicator, but it “appears a much more satisfactory procedure to evaluate situations at the individual level before going up to social summaries” (Fleurbaey, 2009: 1034).

Subjective approaches: happiness studies and life-satisfaction

There is no doubt that the view that we have of our lives is of huge importance. For this reason perceptions of subjective well-being in measures of social welfare are being more and more frequently used – in particular to augment the usual measure of economic prosperity, such as GDP per capita (Sekulova and Van den Bergh, 2013). Well-being and life-satisfaction is concerned with rather long-term evaluation of one’s own life. Normative concepts of a good life thus matter more than actual emotions. Measurement of such experience is typically done by interviews and surveys (“Happiness and Life Satisfaction”, 2016).

The literature on happiness has surged in the last decades. The findings are well summarized in many surveys (e.g. Diener et al., 1999; Kahneman and Krueger, 2006; Layard, 2005). Measurement



of happiness instead of GDP was suggested e.g. by Di Tella and MacCulloch (2008) as a reaction to the Easterlin paradox. However, self-reported happiness levels also struggle with their explanatory potential for social welfare because of people's adaptability to new (higher) levels of well-being. When even relatively high well-being worsens suddenly, the perceived level of happiness is usually lower than it would be otherwise (Van den Bergh, 2009). Hence, the question that has to be examined here is how this approach can inform the evaluation of social welfare.

There seems to be a consensus on the idea that happiness studies suggest a shift of focus, in social evaluation, from purely materialistic ("economic") performances to a broader set of values – e.g. relative importance of income, health, social status and unemployment, marital status and family life, religions, rights and political freedom, and about the complexity of dynamic effects and comparisons to peer groups (Fleurbaey, 2009). In particular, the importance of social relations is highlighted by this literature while the role of consumption is weakened (Kahneman et al., 2004; Layard, 2005).

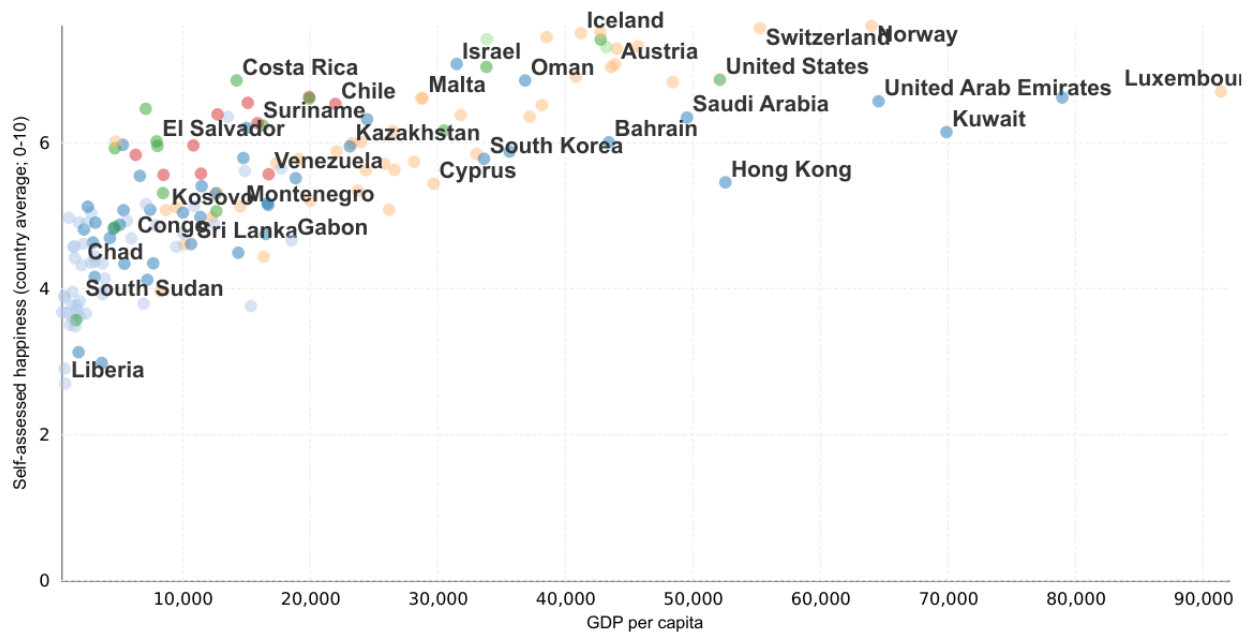
Doubts remain about whether the results coming from verbal statements and scaling questions can really be compared across individuals, especially across cultures (e.g. Krueger and Schkade, 2008). Self-reported happiness is based on subjective adaptation, and as such is also likely to hide objective inequalities. Subjective well-being therefore cannot serve as a metric for social evaluation without serious precaution and including other aspects and/or different types of measurements.

As a matter of fact, the differences with the standard economic utility model may be surprisingly less dramatic than it appears, if one reads the neoclassical utility model of consumer preference as describing what one wants for life, and take the object of preference to be a comprehensive vector of desires rather than a narrow vector of consumption, as the neoclassical utility theory assumes (Fleurbaey, 2009).

On the other hand, an important feature which is of big convenience of subjective well-being studies is its multidimensionality, and the individual approach to the measurement of a good life, unique among two other approaches presented here.

GDP per capita vs Happiness, 2011 to 2015

OurWorld
in Data



Data source: GDP per capita PPP 2011 – WDI, World Happiness Report 2016

OurWorldInData.org/happiness-and-life-satisfaction/ • CC BY-SA

Figure 3 : GDP per capita vs. happiness

(Source: "Happiness and Life Satisfaction", 2016)

Indicators of social welfare in MEDEAS

Which indicators reflect drivers identified as key for social welfare and transition to low-carbon economy? Based on the discussion above, in this part we explain and justify our choice of indicators suggested to represent the levels of social welfare in MEDEAS model structure. Even before that we briefly discuss opportunities and challenges related to using composite indicators. Then we discuss possible contributions of the proposed indicators to model development. Finally, we point out also criticisms of these indicators, in order to show their limitations (regarding their contribution to the MEDEAS model development).

Composite indicators as a tool of addressing drivers of social welfare

There are two types of indicators. **One-dimensional (simple) indicators** follow just one variable and its development over time. On the contrary, **composite indicators** are composed out of many simple indicators or follow several variables, often putting different weights to each. Regarding composite indicators, their methodology is crucial to understand, if we want to know what they can actually tell us about the developments which we are trying to measure. As we are going to propose two composite indicators for the purpose of MEDEAS as social welfare indicators, understanding the background of composite indicators can give much better insight into the way how these indicators can contribute to the MEDEAS model development, and what are their limitations.

Similar procedure for evaluating composite indicators was done by Environmental Pressure Index project aimed at creating a composite indicator to assess various aspects of environmental pressure (“Environmental Pressure Index”, 2012). According to that project, it is suggested to take into account the following steps when evaluating or creating composite indicators (Handbook on constructing composite indicators: Methodology and user guide, 2008; Nardo et al., 2005):

- **Theoretical framework** to provide a sound basis for the selection, combination and weights of variables (Saltelli, 2007). The philosophical groundings of each driver was discussed in the previous section on Factors influencing social welfare.
- **Selection of variables** according to their relevance (Handbook on constructing composite indicators: Methodology and user guide, 2008). This already involves implicit weighting process, as the inclusion of one parameter instead of another can significantly influence results.
- **Data selection** based on variables’ analytical soundness, measurability, country coverage and relationship to each other (Saltelli, 2007). The use of proxy variables should be considered when data are scarce.
- **Transformation, normalization and standardization**, which relate more to Deliverable 2.3 and to the model development itself.
- **Weighting and aggregation** – judging the relative importance of various components of an index. Sometimes the natural sciences provide guidelines (e.g. greenhouse gases and their relative importance for climate change), sometimes it can be determined empirically or elicited from empirical social science research (e.g. by asking experts or extended peer communities etc.) with established procedures (focus groups, stakeholder dialogues, citizens juries, etc.). Afterwards grouping of different variables into one index (Handbook on constructing composite indicators: Methodology and user guide, 2008).

- **Uncertainty and sensitivity analysis**
- **Links to other variables** – should be made to correlate the composite indicator with other published indicators as well as to identify linkages through regressions. We do this procedure for comparison between HDI (composite indicator) and GDP (simple indicators) – see section Results below.
- **Valuation** of the individual index scores with predetermined references which indicate what constitutes “good” or “poor” values (Nardo et al. 2005).

This list of procedures is a compiled suggestion for MEDEAS model development, in case it is decided to take composite indicators into account as part of the model structure. We provide assessment of the proposed indicators below, where we discuss their possible contributions and their limits. Later on, in the section Results, we try to assess the links of the selected indicators as well.

Description of indicators

Out of the literature review presented above, and by answering the questions raised in the Introduction, we selected few representative indicators that we propose to incorporate into the MEDEAS model structure. The selection process followed three criteria:

- (1) Representation of all three above mentioned approaches to measure/indicate levels of social welfare (utility based/economic; normative beliefs based/social; subjective perception based)
- (2) Credibility of data sources
- (3) Data availability for longer time series

The last point is probably worth explaining. Lot of social welfare indicators have available data only for last few years. This has excluded some otherwise very interesting candidates, such as Index of Sustainable Economic Welfare (ISEW), Genuine Progress Indicator (GPI), or Gross National Happiness Index, among others. Even for HDI there were data available only for nine points for the world level (in case of Our World in Data database). It should be noted that the data basis is then rather incomplete and serves only as a proxy for potential further analyses. The results should be treated accordingly – carefully with regards to data (un)availability.

In the end, we have identified four indicators for the purpose of MEDEAS Social module:

- Gross Domestic Product (GDP) – one-dimensional;



- Human Development Index (HDI) – composite;
- Happiness index – composite;
- Gini index – one-dimensional.

GDP is included as probably the most popular socio-economic indicator showing the level of production and consumption of all final goods and services produced in a given period, although we are well aware of its limitations, described systematically e.g. by Van den Bergh (2009). GDP represents a “purely economic” approach to measure social welfare, based on utility maximization. As it reports amount of production within a given economy (in our case the world economy), it shows indirectly also to income levels. However, use of GNI could be also taken into account by MEDEAS, especially when combined with GINI index measuring income disparities.

HDI is a composite indicator, focusing on broader aspects of the socio-economic performance, not just those visible in monetized economy. Except from per capita Gross National Income (GNI), it takes into account life expectancy and education – see subsection on HDI below. Opposite to GDP, HDI represents a composite indicator based on GNI, education levels and life expectancy (as described below). Hence, its approach is exactly to combine utility-based indicator (GNI per capita, measuring levels of income) with two normative indicators selected out of the beliefs of modern society about what improves the conditions of our lives.

Happiness index, based on World Happiness Reports, is also a composite indicator, based on ranking answers to life evaluation questions asked in a poll. The respondents are asked to rate their own current lives on 0 to 10 scale, ranking their own self-perceived happiness. The answers are weighted according to six factors: levels of GDP, life expectancy, generosity, social support, freedom, and corruption (“World Happiness Report”, 2016). Happiness index represents the third approach – it emphasizes the importance of subjective self-reported degree of one’s life-satisfaction.

Gini index assesses (in)equality in a socio-economic unit, typically a state. Gini index measures deviation of the distribution of income within this socio-economic unit. A value of 0 represents absolute equality, a value of 1 absolute inequality. Compared to the others, Gini index is not directly aspiring to measure the level of social welfare. It “only” adds one of possible aspects to it – the level of income distribution (in)equality. As such, it can be argued that Gini also represents some normative beliefs, e.g. that equality is better than inequality. However, to prove causality between income disparity and levels of pollution or energy use is beyond the scope of this report. We just recommend to keep such indicators in mind. We chose Gini as an example of other possible ways to assess well-being by additional one-dimensional indicators.



Last but not least, all these four indicators were selected because of their common use by international organizations, and thus also their trustfulness. Finally, pragmatic reasons, i.e. data availability across time, also played a role, because of the need to correlate the datasets. HDI is collected by the United Nations (UN). World Happiness Report has its roots in UN as well. Gini index is collected by the World Bank in its World Development Indicators database; the same applies for global GDP data.

We start the description of these indicators and discuss their potential contributions to the development of MEDEAS model from GDP as the most commonly used indicator measuring performance of the economy, and we point out why it cannot be taken itself as a measure of social welfare. Then we move to other indicators that we suggest as more suitable – HDI and Happiness index. Last but not least, we provide an explanation of theoretical basis of Gini coefficient, which brings a very important dimension to the debate over social welfare, i.e. the issue of inequality.

Key features as well as pros and cons (regarding their contributions to MEDEAS model) of each suggested indicator are discussed in the sections below.

GDP

Gross domestic product (GDP) at market prices is the **expenditure on final goods and services minus imports** – final consumption expenditures, gross capital formation, and exports minus imports (“Gross domestic product (GDP)”, 2016). Domestic means that it is production by the resident institutional units of the country (typically companies). GDP can be determined in three ways: **production** (or output, reps. value added) **approach** by summing the outputs of enterprises; **income approach** assuming that the value of the total product must be equal to total people’s expenditures; and **expenditure approach**, which supposes that the productive factors must be equal to the value of their product, and determines GDP by finding the sum of all producers’ incomes (“Gross domestic product (GDP)”, 2016).

Nominal GDP per capita does not, however, reflect differences in the cost of living, neither the inflation rates of the countries. Using a GDP PPP per capita is, then, probably more useful when comparing differences between countries.

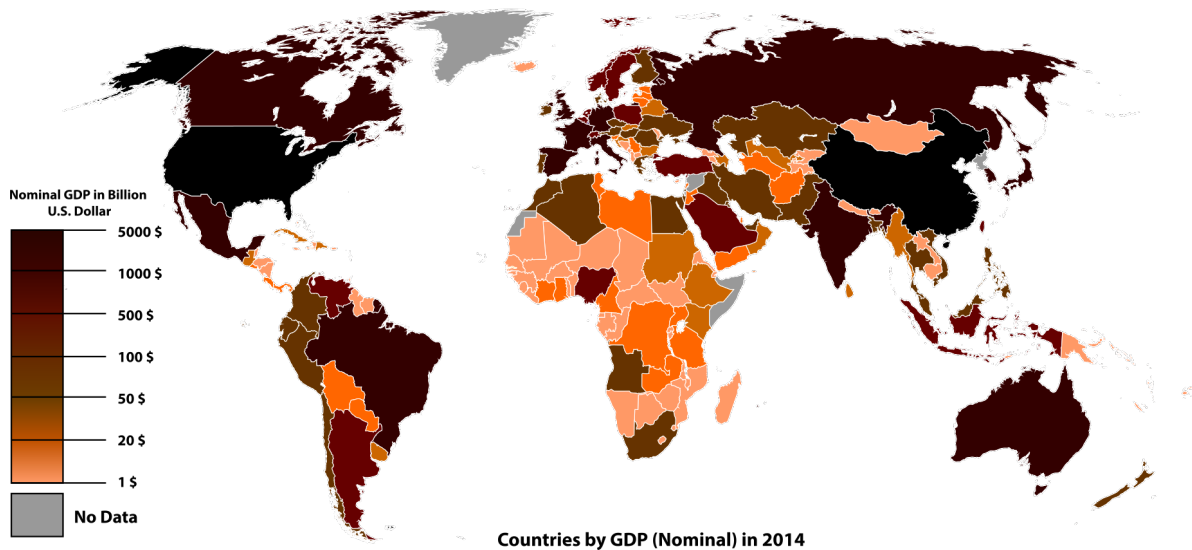


Figure 4 : GDP in particular countries

(Source: "Gross domestic product", 2016)

Hence, GDP counts for what is produced in the formal (monetized) economy – it measures current economic activity accountable with money. Nevertheless, as an indicator, GDP suffers from serious pitfalls, talking about its contribution to describe level of social welfare. Some activities counted in GDP can in fact even contribute to worsening of human well-being – as argued by happiness studies (e.g. Griffin, 2007).

The use and implicit interpretation of GDP per capita as a proxy of social welfare (and therefore treating increase in GDP as progress) has been receiving growing criticism (e.g. Mishan, 1967; Easterlin, 1974; Sen, 1976; Dasgupta, 2001; Kahneman et al., 2004). The reasons are several, but all tend to emphasize a narrow focus of GDP on measuring the “monetary throughput” of the economy. GDP statistics ignore income distribution, international income flows, household production of services, destruction of the natural environment, and many determinants of well-being such as the quality of social relations, economic security and personal safety, or health (Fleurbaey, 2009). Even worse, GDP increases when e.g. convivial reciprocity is replaced by market relations (O’Neill, 2014).

A very useful summary of GDP criticisms provides Van den Bergh (2009):

- (1) GDP is an **estimate of the costs instead of the benefits**. In addition, GDP does not capture all social and environmental costs as it omits external costs.

- (2) Even neoclassical **economic theory does not support GDP as a measure of social welfare**. A positive correlation between GDP growth in certain periods with perceived progress should not be confused with the idea that GDP (growth) is a good measure of social welfare (progress).
- (3) **GDP per capita growth and the associated rise in material consumption is an imperfect compensation for a lack of satisfaction of basic needs**, like serenity, clean air and direct access to nature.
- (4) Subjective well-being studies show that **individual income is not a suitable proxy of individual welfare**. Relative income and various income-independent factors influence individual welfare or happiness significantly instead. This is confirmed by the **Eurobarometer surveys**, the half-yearly opinion polls of the inhabitants of the EU Member States. Moreover, people may get used to changed circumstances: well-being may temporarily change but then returns to its baseline level. Since people do not realize this adaptation, they keep striving for more.
- (5) **GDP per capita neglects (changes in) the income distribution. Uneven distribution implies unequal opportunities** for personal development and well-being. (Which supports the idea to include Gini index in the analysis.)
- (6) The presence of (negative environmental and social) externalities means that the current market prices insufficiently reflect the total costs, which makes these prices an incorrect basis for a social welfare indicator. Moreover, **if air, water, or natural areas are being polluted, the resulting damage does not enter GDP. But when pollution is being cleaned up this will increase GDP**. GDP suggests we are richer than we really are.

According to Van den Bergh (2009), there are four alternative indicators available. A first type is based on rather pragmatic accounting adjustments to GDP by repairing important deficiencies through adding or subtracting certain partially-calculated money amounts to/from GDP. The most influential example is the Index of Sustainable Economic Welfare (Daly and Cobb, 1989). Applications of ISEW show that, whereas GDP follows a rising trend, the ISEW shows a constant or even decreasing pattern after a certain time (Van den Bergh, 2009).

However, level of income still provides one of the preconditions (though criticizable and imperfect) for social welfare. As the whole input-output tables structure is based on monetary flows through the economy, we suggest that it is useful to work with GDP in the MEDEAS model, when we treat this indicator carefully, and when we are fully aware of the above mentioned problems.

HDI

Human Development Index was created by the United Nations to emphasize that **people and their capabilities should be the ultimate goal of evaluating the development of a country** instead of purely economic criteria such as economic growth measured by GDP (“Human Development Index (HDI)”, 2016). HDI is a composite indicator, summarizing achievements in selected key dimensions of human development. Its normative goals are “long and healthy life, being knowledgeable and have a decent standard of living” (“Human Development Index (HDI)”, 2016), as can be seen on Figure 5 below. HDI consists of a geometric mean of normalized indices for each of these three dimensions, aggregated into a composite index.

The **health dimension** is represented by **life expectancy at birth**, **education** is measured by **mean of years of schooling** for adults aged 25 years and more and expected years of schooling for children of school entering age (“Human Development Index (HDI)”, 2016). The economic aspect is measured by **gross national income per capita**. In addition, HDI uses logarithm of income, to reflect the diminishing importance of income with increasing GNI.

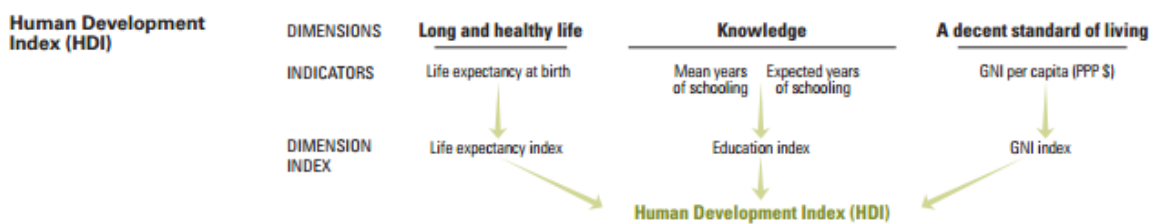


Figure 5 : HDI components

(Source: “Human Development Index (HDI)”, 2016)

Conceptually similar procedure of merging various variables into one composite indicator is followed by World Happiness Reports. The difference is that the latter are based on subjective self-perception of wellbeing in five categories, rather than data collected by a central authority.

However, HDI does not reflect for instance on inequalities, poverty, human security, empowerment, gender disparity, etc. Therefore we decided to include also Gini index as a possible complement to HDI and other indicators of social welfare. Even though HDI has much broader focus than GDP, it shares also some of its shortages. The most striking one is probably that neither of these three dimensions covered by HDI do not themselves contribute to a better life – they “only” create preconditions for it. This is the reason why we decided to include also level of happiness.

According to Fleurbaey (2009), HDI represents the “**capability approach**” proposed by Amartya Sen. This approach has inspired a variety of applications, HDI among a few ones that composed a widely used synthetic composite index. A key aspect of the “capability approach” is its aggregate

nature – it tends to take rather summarized data for the whole population, rather than individual valuations of the relevant dimensions.

Fleurbaey (2009) argues that the “synthetic indicators” such as HDI (that are constructed as weighted averages of summary measures of social performance in various domains) are ill-equipped to take account of the distribution of well-being and advantage among the members of society. This is also the reason why we argue that it is important to take Gini index into account as probably the most reliable indicator of income distribution within a given socio-economic unit.

Happiness index

“Overall happiness is the degree to which an individual judges the overall quality of his/her own life-as-a-whole favorably. In other words: how much one likes the life one leads” (“World Happiness Report”, 2016). The World Happiness Index surveys numerous people from various countries in search of which country has the happiest population. Happiness index is also a composite indicator. The Happiness Index looks at more than just economic factors, like most other world polls measuring social welfare do (“World Happiness Report”, 2016).

The rankings in the Happiness index are based on answers to the main life evaluation question asked in the poll. This is called the Cantril ladder: it asks respondents to think of a ladder, with the best possible life for them being a 10, and the worst possible life being a 0. They are then asked to rate their own current lives on that 0 to 10 scale (“World Happiness Report”, 2016).

The researchers ask people to rank their own feeling of happiness. The answers are then weighted based on six factors:

- **levels of GDP**
- **life expectancy**
- **generosity**
- **social support**
- **freedom**
- **corruption**

Then, the results are compared to Dystopia, an imaginary place where everyone is miserable. This fictional, sad realm allows all of the countries to remain positive in the six factors listed above. In other words, Dystopia is a benchmark that every country passes.

The surveys are done on a rather small sample size, with only 2,000 to 3,000 people per country. A sample size of 2,000 to 3,000 is large enough to give a fairly good estimate at the national level. This is confirmed by the 95 percent confidence intervals shown at the right-hand end of each country bar (“World Happiness Report”, 2016).

In 2016, Denmark is the world happiest country, according to the report. It is followed by Switzerland (2015’s “winner”), Iceland, Norway, Finland, Canada, the Netherlands, New Zealand, Australia, and Sweden among the top 10. For instance, the US ranks 13th, Germany 16th, and the UK 23rd. The world unhappiest countries are typically countries where a long-lasting conflicts persist, such as Afghanistan at 154th position, followed by Togo and Syria. Burundi comes last as 157th country with reported level of happiness (“World Happiness Report”, 2016).

Happiness Index has origins in happiness studies, a field of behavioral economics, which suggests that people strive not only for utility maximization, but that their aspirations are broader and richer. Happiness is supposed to mean the ability to connect with others, to have meaningful relationships, to have a community, the opportunity to self-realize, the propensity to feel positive emotions, the capacity to recover from negative emotions, and holding a sense of purpose (e.g. Kahneman et al., 2006).

For problematic aspects of happiness measurements and happiness studies in general, see the section on Subjective approaches above. Basically, according to the authors of the Happiness and Life Satisfaction study from Our World in Data project (“Happiness and Life Satisfaction”, 2016), there are two main problems:

- (1) **Cultural differences across countries** – the same questions are perceived differently by people from different cultural backgrounds and depending on the language (e.g. post-soviet countries typically scoring much less than Latin American countries. although the “objective” social welfare indicators are more or less the same).
- (2) **Comparisons of happiness measures across time** has been almost impossible so far, as the questions has been changing. Thus, the changes over time might reflect changes of the assesment rather than changes in happiness.

Additional very interesting analyses about happiness and its relation to other various indicators of social welfare can be also found on the webpage of the Our World in Data project: <https://ourworldindata.org/happiness-and-life-satisfaction/> (“Happiness and Life Satisfaction”, 2016).

Gini index

The **Gini index** (also referred to as a **Gini ratio** or a **Gini coefficient**), proposed by Italian statistician and sociologist Corrado Gini in the beginning of 20th century, is a measure of statistical dispersion representing the distribution of a given value typically among socio-economic unit's residents. It is the most commonly used measure of (in)equality ("Income Gini coefficient", 2016).

The Gini index measures the inequality among values of a frequency distribution (most commonly levels of income). A Gini coefficient of 0 means perfect equality, where all values are the same (e.g. everyone has the same income). A Gini coefficient of 1 (or 100%) stands for maximal inequality (e.g. where only one person has all the income or consumption, and all others have none) – see Figure 7 below.

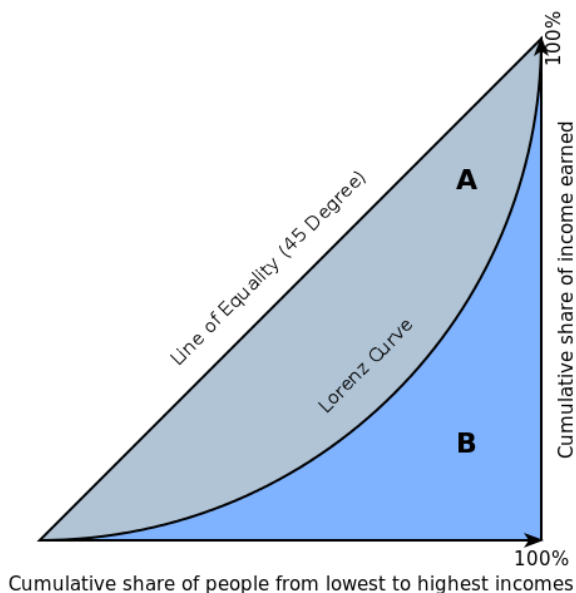


Figure 6 : Gini index illustration

(Source: "Gini coefficient", 2016)

The income Gini index for OECD countries ranged between 0,24 and 0,49 in the late 20th century, with Slovenia the lowest and Chile the highest. The global income Gini coefficient in 2005 has been estimated to be between 0,61 and 0,68 by various sources (*The real wealth of nations: Pathways to human development*, 2010). However, our calculations for the aggregate world level confirm slow decrease of Gini index since 1995. However, those are not data for all countries, often missing the poorest ones, where Gini index is usually among the highest.

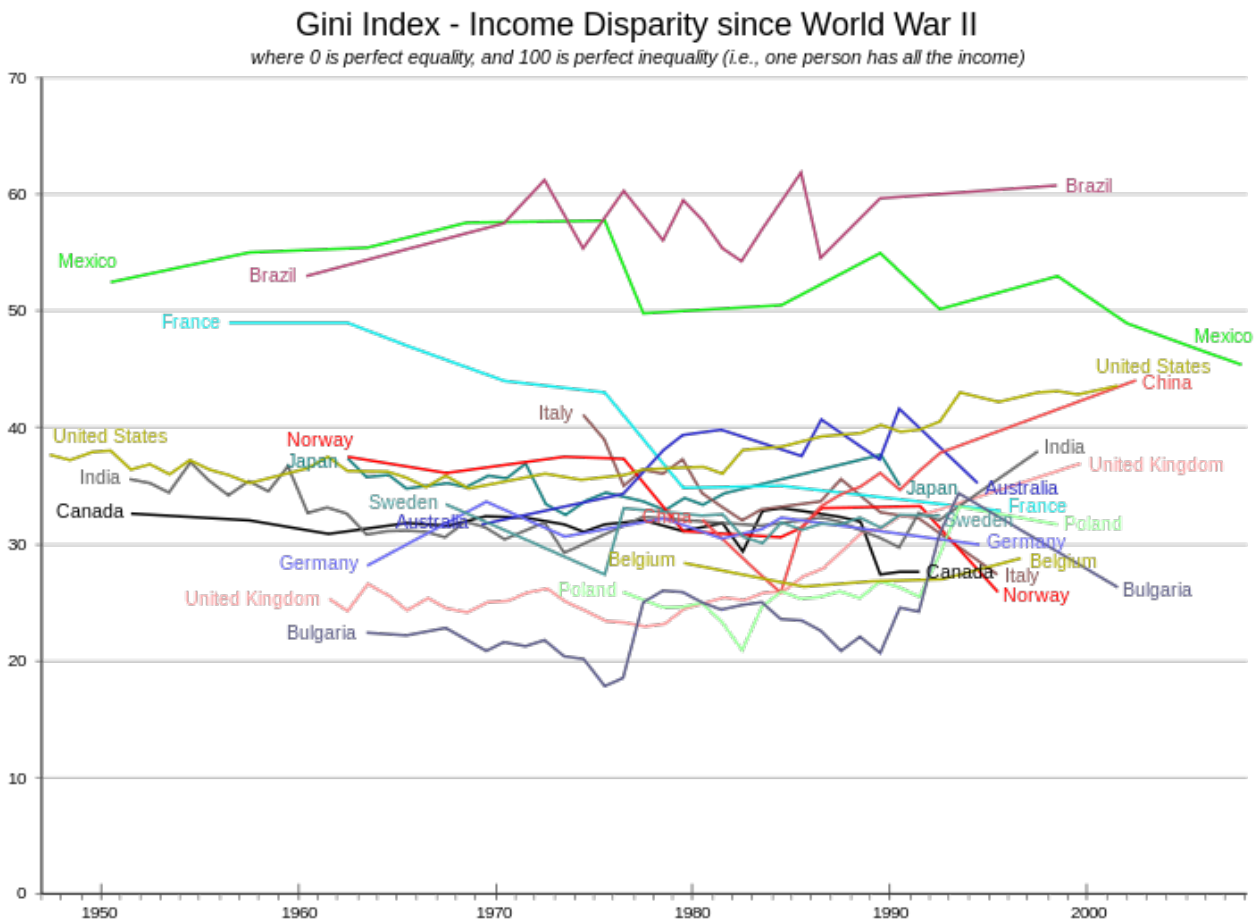


Figure 7 : Gini index development of selected countries since WWII

(Source: "Gini coefficient", 2016)

There are some issues in interpreting a Gini coefficient. The same value may result from many different distribution curves. When interpreting Gini coefficient, the demographic structure should be taken into account. Countries with an aging population, or with a baby boom, experience an increasing Gini index even if real income distribution for working adults remains constant.

Hence, Gini index gives an important insight into the distribution of wealth within a society/socio-economic unit. On the other hand, again, it cannot by itself explain the level of well-being, nor the "distribution" of well-being, as it describes only the distribution of income. However, if happiness measurements would have taken into account also income distribution issues, it would be possible to say how strong the factor of (in)equality is in terms of providing explanation to social welfare.

Suggested analyses

Based on evaluation of the suggested indicators, we were trying to investigate their relations. The goal was to suggest possible links and interdependencies for the MEDEAS model structure. Specifically, we analysed correlations on the global aggregate level between:

- (1) **HDI and GDP** to see their mutual position (and, regarding the report about energy, emissions and social welfare, to see which of them should be linked with energy consumption per capita);
- (2) **HDI and Gini index** to see links between composite social welfare indicator and (in)equality;
- (3) **GDP and Gini index** to see the relation between economic production/consumption levels and (in)equality;
- (4) **GDP and Happiness index** to see the contribution of purely economic indicator to self-reported level of life-satisfaction;
- (5) **HDI and Happiness index** to see the link between broader “developmental” composite indicator and happiness perception;
- (6) **Happiness index and Gini index** to see the relation between (in)equality and self-reported level of life-satisfaction.

It should be noted that our datasets were (in case of Gini index and HDI) composed out of country level data. Hence, the correlations on a global level have been derived from weighted aggregates, and should therefore be taken with caution. The correlations only provide an indication. Further analyses can (and should) be made accordingly, depending on the MEDEAS model demand. Panel regressions for all countries will provide much stronger evidence, depending on the needs of MEDEAS model.

Results

We analysed links between HDI, GDP, Gini index, and final energy consumption per capita. This was done by running a linear regression analysis for the global level. For Gini coefficient and HDI, the number for the global level must have been composed out of the country level.

Composing data for the global level

The procedure for composing the global level data for HDI and Gini was the following. For every year and for every country, where the number (i.e. Gini coefficient or HDI) was available, we calculated a proportion (ratio) of the country's population to total world (respectively, only for those countries where the indicator numbers were available at that year) population for the respective year. Then, we multiplied this ratio by the index number, and summed up these numbers to give us a "world" Gini index/HDI. The same procedure was applied for calculating weighted global Happiness index.

It should be noted, however, that the overall results for the world level depend heavily on the number of countries that were taken into account for each year. We used only those years where a majority of countries provided their data. Nevertheless, the results for the global level can still vary more than if all countries provided the data.

We are aware of the limitations of such process. However, we tried to compare the results at least for HDI, for which we found data at the Oxford University's website called "Our World in Data". As can be seen, the results do not vary so widely.

Outcomes

We calculated six types of correlations:

- (1) Human development index with GDP;
- (2) Human development index with Gini coefficient;
- (3) GDP with Gini coefficient;
- (4) GDP with Happiness;



- (5) Human development index with Happiness;
- (6) Happiness with Gini coefficient.

Historical developments of the considered indicators are shown in the Appendix.

HDI-GDP relations

Figure 9 shows a correlation between HDI (calculated out of UNDP database, weighted by countries) and GDP. The Pearson’s product-moment correlation is 0.9922398, which shows a very strong correlation.

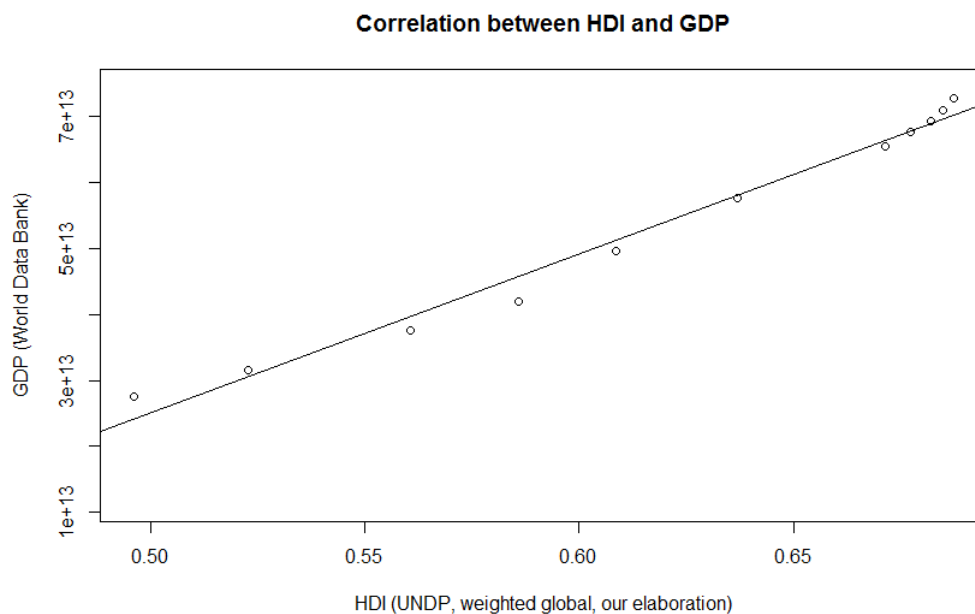


Figure 8 : Correlation between HDI and GDP

(Source: UNDP, our elaboration; World Data Bank)

Figure 10 shows a correlation between HDI (from Our World in Data database) and GDP. The results are very similar with our own elaboration, concerning the use of HDI data. The Pearson’s product-moment correlation is 0.9958104, which again shows a very strong correlation.

Correlation between HDI and GDP

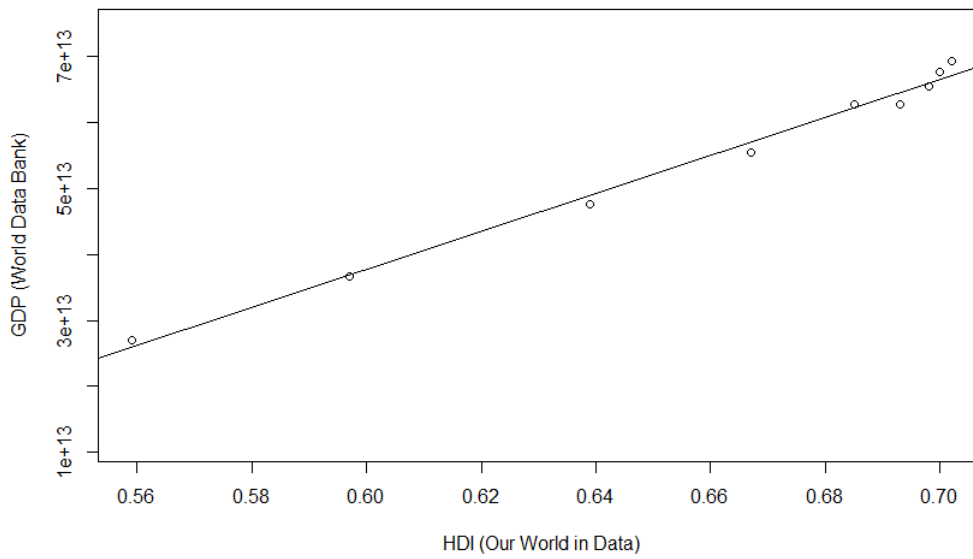


Figure 9 : Correlation between HDI and GDP

(Source: Our World in Data; World Data Bank)

HDI-Gini relations

Figure 11 shows relation between HDI and Gini index. The Pearson’s product-moment correlation is -0.4843451 , which shows a weak negative correlation. Figure 12 shows again correlation between HDI and Gini index, now with different data for HDI. The Pearson’s product-moment correlation is -0.7049428 , which shows a relatively strong negative correlation.



Correlation between HDI and Gini coefficient

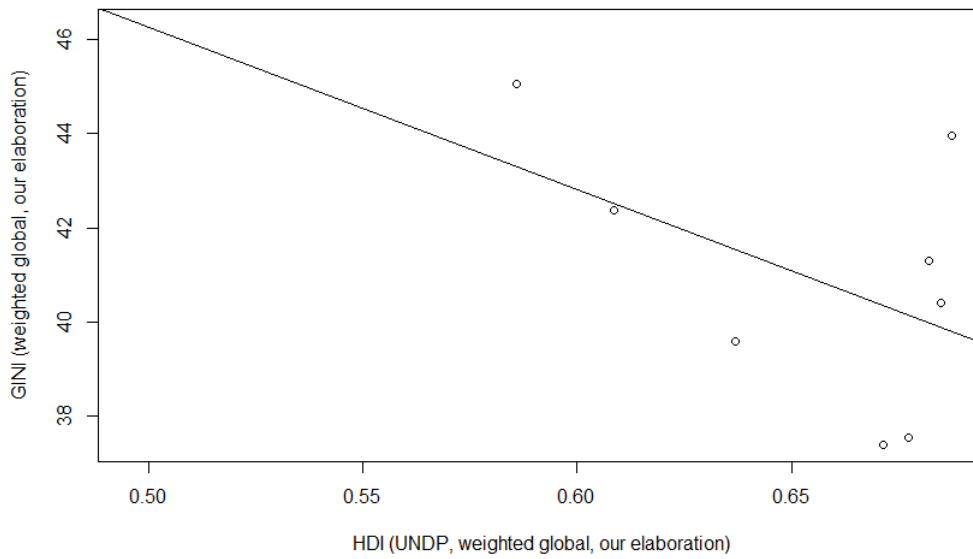


Figure 10 : Correlation between HDI and Gini coefficient

(Source: UNDP, our elaboration; World Data Bank, our elaboration)

Correlation between HDI and Gini coefficient

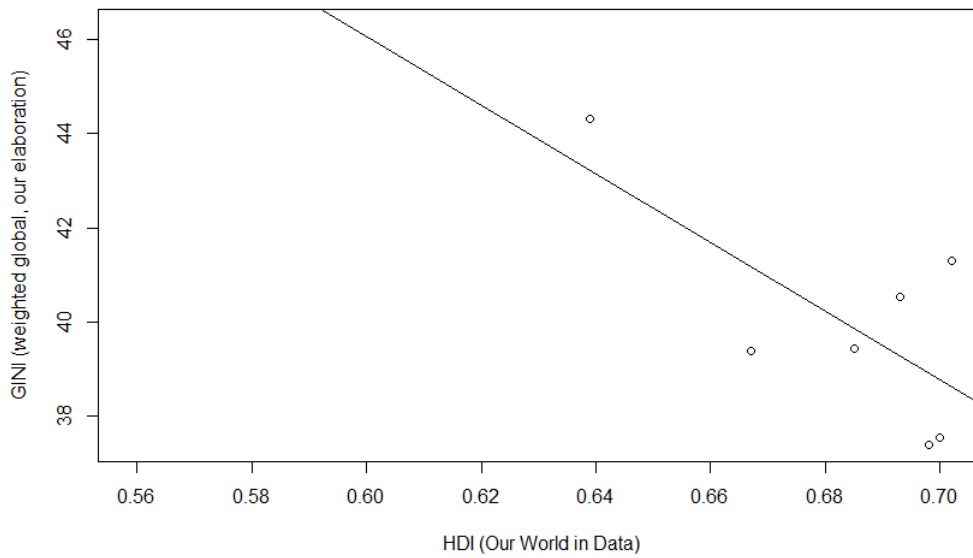


Figure 11 : Correlation between HDI and Gini coefficient

(Source: Our World in Data; World Data Bank, our elaboration)



GDP-Gini relation

Figure 13 shows correlation between GDP and Gini index. The Pearson's product-moment correlation is -0.6829759 , which shows a relatively strong negative correlation. Figure 14 shows the same relation, but in the form of panel regression at a country level.

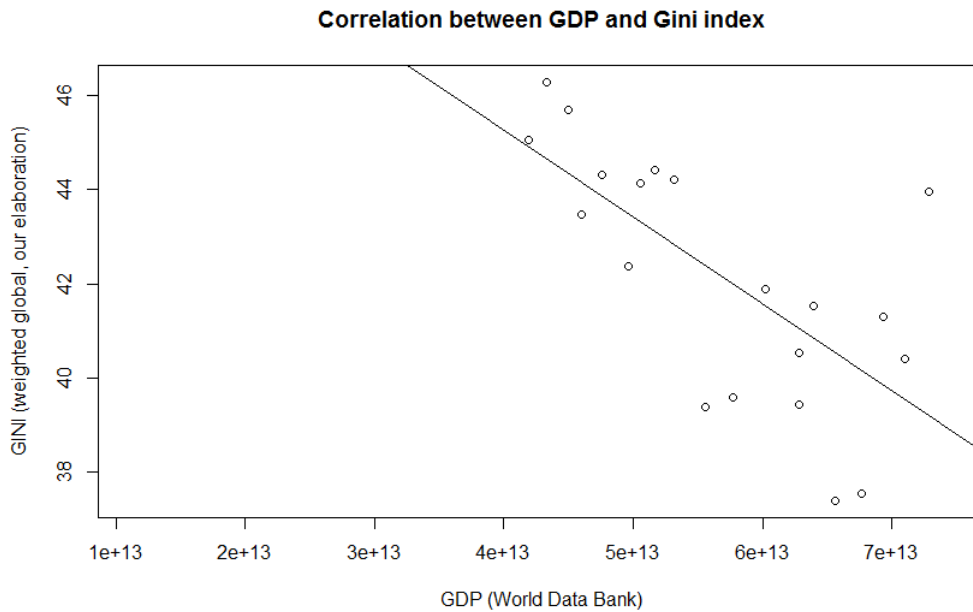


Figure 12 : Correlation between GDP and Gini coefficient

(Source: World Data Bank; World Data Bank, our elaboration)

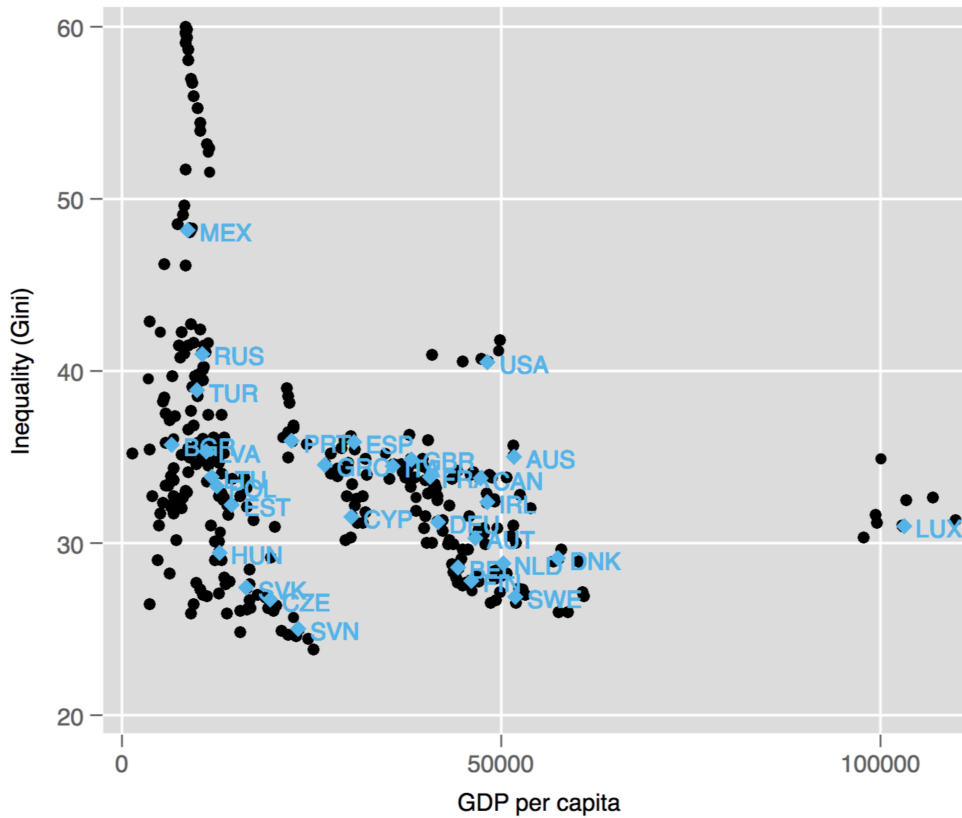


Figure 13 : Correlation between GDP and Gini coefficient for the country levels

(Source: World Input-Output Database, our elaboration)

GDP-happiness relation

Figure 15 shows correlation between GDP and Happiness index. The Pearson’s product-moment correlation is -0.4705644, which shows a relatively weak negative correlation.



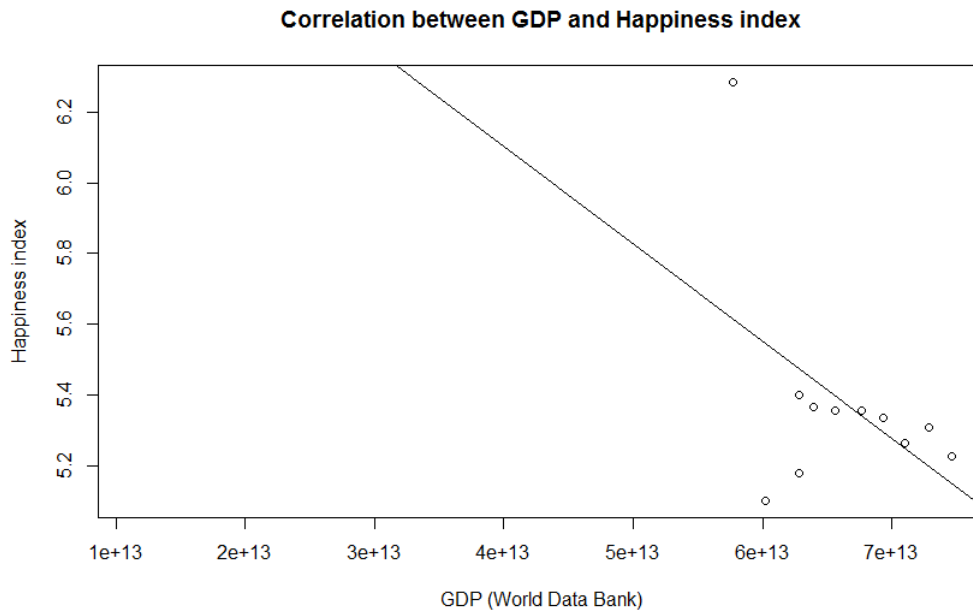


Figure 14 : Correlation between GDP and Happiness index

(Source: World Data Bank, World Happiness Report 2016, our elaboration)

HDI-happiness relations

Figures 16 and 17 show the relation between HDI and Happiness index (both calculated for the world level). The Pearson's product-moment correlation for Figure 16 is -0.9694675, which shows a very strong negative correlation. The Pearson's product-moment correlation for Figure 17 is -0.05941154, which shows a very weak (or almost no) negative correlation.

Obviously the results vary widely. However, we should point out that the HDI-Happiness seems to take only 6 data points. This may be because HDI was taken in years when Happiness was not recorded, and then the program obviously drops those years. The basis for the correlation analysis is thus quite poor. Nevertheless, we give just a brief first overview. A panel for all countries would provide a much stronger evidence. Further analyses can be made accordingly depending on the model demand.

Correlation between HDI and Happiness index

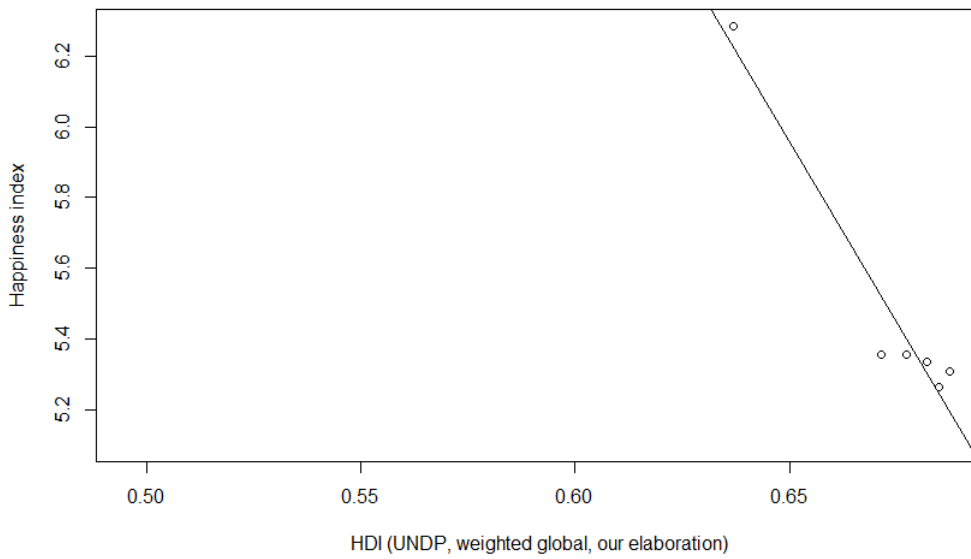


Figure 15 : Correlation between HDI and Happiness index

(Source: World Data Bank, our elaboration; World Happiness Report 2016, our elaboration)

Correlation between HDI and Happiness index

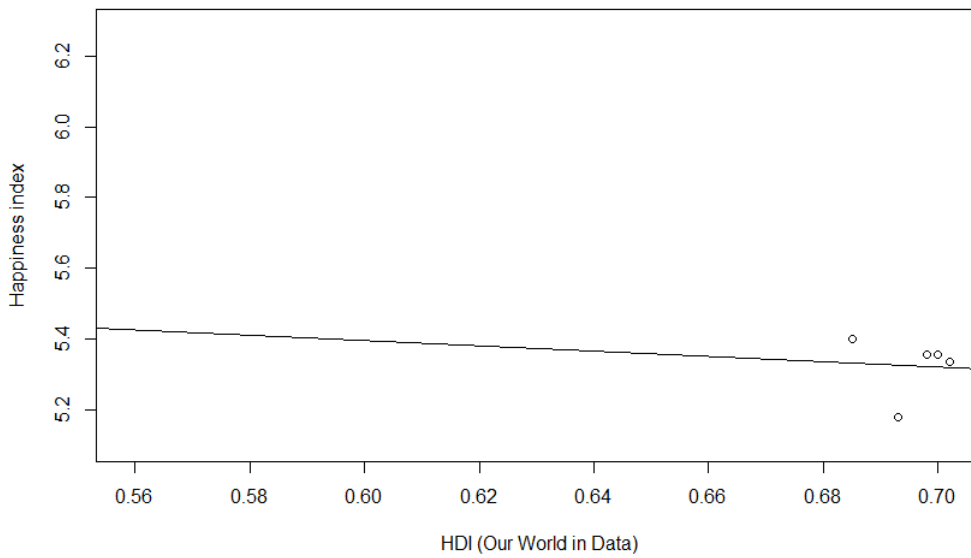


Figure 16 : Correlation between HDI and Happiness index

(Source: World Data Bank, our elaboration; World Happiness Report 2016, our elaboration)

Happiness-Gini relation

Finally, figure 18 shows the relation between Happiness index and Gini index. The Pearson's product-moment correlation is -0.2318222, which shows a very weak negative correlation.



Figure 17 : Correlation between Happiness index and Gini index

(Source: World Happiness Report 2016, our elaboration; World Data Bank, our elaboration)

Discussion

To answer which drivers and variables concerning social welfare should receive highest priority, given relevance, required analyses, and potential data constraints, we discuss the results of our analysis.

Regarding the relation between GDP and HDI, i.e. between production/consumption levels in the economy and “human development” (life expectancy, level of education, and GNI per capita) which is subject to correlation no. (1):

- There is a strong positive link between GDP and HDI, Pearson's correlation being more than 0,99. This is by far the strongest link that has emerged out of our analysis.

In (2) and (3) we were comparing whether it is GDP or HDI which has stronger links to Gini index:

- For (2), i.e. HDI-Gini correlation, Pearson's coefficient is -0.48, respectively -0.70 (depending on which HDI dataset we used), which shows a negative, albeit not so strong (especially in the first case, when data of the aggregated world level from our own elaboration were used) correlation.
- The level of "human development" can, but does not necessarily have to, imply bigger equality (the closer Gini index is to zero, the higher level of equality there is).

Compared to (3), where we focused on correlation between GDP and Gini index:

- Pearson's coefficient of GDP-Gini correlation is -0.68. This again shows a relatively strong negative correlation, i.e. the higher GDP, the higher equality.
- GDP growth may cause equality, but also inequality may cause GDP not to grow anymore.
- When we compare (2) and (3), the results somehow confirm what was found in (1), that HDI (containing GNI, education levels and life expectancy) and GDP are strongly correlated, at least for the selected period (years 1980, 1985, 1990, 1995, 2000, 2005, and 2010-2014; resp. 1979, 1989, 1999, 2004, 2007, and 2009-2012 – which is of course a non-exhaustive analysis) and for the aggregate world level (HDI calculated as a weighted average out of each country's HDI for which there were data available for the respective years).

In (4) and (5), we wanted to see which indicator (GDP or HDI) has a stronger link with reported happiness:

- Pearson's coefficient for (4), i.e. GDP-Happiness relation is -0.47, which shows a relatively weak, albeit still some negative correlation. This seems to in some sense support critiques of GDP as an indicator which does not cover some crucial aspects of human well-being.
- In comparison, (5) shows a rather confusing result. While for one HDI dataset (our elaboration of world aggregate data out of UNDP data for particular countries), the correlation is -0.97, for the other (from Our World in Data results) the correlation is -0.06.
- However, we should point out that the HDI-Happiness relation seems to take only 6 data points. This may be because HDI was taken in years when happiness polls were not realized, and then the analysis obviously drops those. The confusing results can thus be assigned to the weak data basis.

Finally, regarding (6), the correlation between (in)equality (Gini index) and happiness (Happiness index) is not very strong:



- Pearson's coefficient is -0.23, showing that happiness rises not so significantly when Gini index decreases.

To sum up, the strongest link has proved to be between GDP and HDI. The model should therefore take into account GDP as having impact on social welfare measured by HDI. However, GDP can contribute to, not explain social welfare. Even composite indicators such as HDI cannot themselves be seen as drivers of human well-being or social welfare. Happiness is probably a suitable complement to HDI or even GDP. These two or three (happiness and HDI/GDP) can provide a relatively good notion of social welfare within a given socio-economic unit.

To strengthen this basis of social welfare describing indicators, MEDEAS model should take into account (in)equality in terms of income (measured by Gini index). Albeit Gini index seems to be only relatively weakly linked with happiness, this might very likely be due to poor data basis, and the link between (in)equality and happiness/human development should be further studied and elaborated, e.g. with panel data for particular countries.

Conclusions

This document has analysed options of social welfare measurement, its various aspects, and its links to economic variables and (in)equality issues. Three types of drivers of social welfare were considered: utility-based economic variables (such as GDP per capita); objective social welfare indicators based on normative beliefs (represented by HDI as a composite indicator consisting of levels of education, life expectancy and GNI); and subjective perceptions of life fulfillment, such as Happiness Index, reported repeatedly by World Happiness Reports.

Four variables were selected: GDP, HDI, Happiness Index and Gini index. Concerning the links between the variables considered, the strongest link has proved to be between GDP and HDI, thus the model should take into account GDP as having impact on social welfare measured by HDI. However, GDP can contribute to, not explain social welfare.

On the other hand, even composite indicators such as HDI cannot themselves be seen as proxy of human well-being or social welfare. Happiness issues instead of HDI or even GDP are a better proxy of the social welfare itself (depending on the definition and interpretations, as described above), even though happiness seems not to be so strongly linked to the economic variables, here represented by GDP. This might be due to the self-reporting nature of happiness reports that were used in the analysis, and that have several limitations if they are used as a single measure (proxy) of social welfare.

Hence, only Happiness Index together with HDI and GDP provide a broad enough basis to define the level of social welfare. Other new indicators such as Gross National Happiness Index could also be taken into account, once they dispose longer time series. Moreover, MEDEAS model should take into account inequality in terms of consumption issues (provided by Gini index data). Albeit Gini index seems to be only relatively weakly linked with happiness, it provides an interesting third dimension to the social welfare assessment, which impact on happiness is not included in any of the other composite indicators. The link between inequality and happiness/human development should be further studied and elaborated, e.g. with panel data for particular countries.

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Appendix

Historical development of respective PAVs

Below we present a table with development of PAVs that were considered for our analysis. These are HDI, taken from Our World in Data database; HDI data from UNDP database, calculated for global level as described above; Gini coefficient (from World Data Bank, again weighted global, as described above); GDP (from World Data Bank); and Happiness index (from World Happiness Index).

Year	HDI (Our World in Data)	HDI (UNDP, weighted global, our elaboration)	Gini coefficient (World Data Bank, weighted global, our elaboration)	GDP in millions of \$ (World Data Bank)	Happiness (World Happiness Report, weighted global, our elaboration)
1960				11181685	
1961				11662672	
1962				12308285	
1963				12946281	
1964				13806690	
1965				14574318	
1966				15415911	
1967				16093406	
1968				17084361	
1969				18126257	
1970				18903690	
1971				19707473	
1972				20826514	
1973				22173308	
1974				22613829	
1975				22818406	
1976				24021801	
1977				24983852	
1978				26009442	
1979	0,559			27077117	
1980		0,496		27607575	
1981				28143449	
1982				28288444	
1983				29002724	
1984				30325395	

1985		0,523		31509934	
1986				32533918	
1987				33711230	
1988				35270228	
1989	0,597			36598161	
1990		0,561		37675251	
1991				38186993	
1992				38868198	
1993				39512786	
1994				40708010	
1995		0,586	45,059	41912228	
1996			46,287	43310626	
1997			45,703	44936607	
1998			43,48	46035176	
1999	0,639		44,313	47555809	
2000		0,609	42,363	49617598	
2001			44,128	50593866	
2002			44,421	51699181	
2003			44,226	53195808	
2004	0,667		39,371	55568184	
2005		0,637	39,588	57691303	6,284
2006			41,889	60218379	5,1
2007	0,685		39,424	62814127	5,398
2008			41,523	63975980	5,366
2009	0,693		40,526	62876799	5,179
2010	0,698	0,672	37,386	65612000	5,354
2011	0,7	0,677	37,541	67653907	5,356
2012	0,702	0,682	41,294	69321696	5,334
2013		0,685	40,403	70980531	5,263
2014		0,687	43,958	72834635	5,307
2015				74631031	5,226

Table 1 : Development of considered PAVs