MAKSWELL

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Report on multivariate analysis on MIP and well-being and SDGs indicators

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Report on multivariate analysis on MIP and well-being and SDGs indicators

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Summary

The MAKSWELL project aims to extend the actual set of measurement available for well-being and sustainability taking into account timeliness and geographical representation. The effort along this direction has been documented in different deliverables of the project (see for example Del. 2.1, 2.2 and 3.2).
However, since the economic crisis of 2009 has reinforced the need for set of indicators able to detect promptly the social and economic evolution of European countries, a framework devoted to this monitoring has been released such as the Macro Imbalance Procedure (MIP).
This work aims to explore, for the first time, how the analysis based on the MIP indicators provides different results compared to the ones based on the Sustainable Development Goals (SDG)
We propose an analysis based on a selection of 16 MIP indicators and 11 SDG indicators drawn from the social and economic Goals.
Using a multivariate analysis we compare the classification of the European countries according to the lastest available vintage of data for the two framework.
We observe that more than providing different representation, the analysis based on the two different set of data depict for a complementary picture. Even if the exercise is prone to some simple hypothesis concerning the selection of the indicators, the results seem to support the idea for an integrated dataset for policy analysis.
On a different prospective, we present an extension of the I-S-O framework that can be also adopted as an interpretative tool to understand more complex objects, like programs and plans. Its structure facilitates identification of connections and causal relationships by virtue of the *consequentiality\rationality* of stages based on physics-based principles allowing for an easy interpretation of the SDG's Goal.

1. Introduction

In the last decade, driven by the work of the Stiglitz-Sen-Fitoussi Commission Stiglitz et al. (2009), several institutions have developed new systems to measure well-being with the aim to provide useful information on climate change, poverty, resource depletion, health and quality of life.

At global level, important initiatives worth to mention are the Human Development Index UNDP (2010), the Happy Planet Index (HPI), and the OECD Better Life Index (OECD (2017)) while at national level the Canadian index of Well-being (CIW), the Italian Well-being (Istat (2019), Bacchini et al. (2020)) and the Gross national happiness index in Buthan could be considered[1]. According to the results of the project MAKSWELL (MAKing Sustainable development and WELLbeing framework work for policy analysis, (see Deliverable 1.1 and 1.2), funded by the European Commission, 19 of the 28 European Union countries[2] are currently involved in a well-being framework (11 of them use the framework for policy analysis) while 27 European Union countries are involved in the development of indicators to measure progress towards SDGs target (21 of them use these indicators for policy analysis).

Although all these initiatives share a common framework with similar aims, they are not fully integrated and it is generally difficult to compare and assess information at the different levels, from the local to the global one. As a consequence, the main international formulations, as for example the Human Development Index HDI, UNDP (2010), are based on a small set of indicators Neri et al. (2017) even when the aim is to investigate the relationship between economic growth and subjective well-being Stevenson and Wolfers (2008) and Bartolini and Sarracino (2014) or between economic growth, inequality and poverty Michálek and Vỳbošt'ok (2018).

In this context, the development of dashboards or scoreboards, as for SDGs, could represent a valid alternative. A scoreboard is a set of statistical indicators, possibly coupled with policy targets and\or thresholds aiming to give information on several aspects of a phenomenon without any synthesis. This approach has been adopted at European level for monitoring some European Union policies. For European Union countries a typical example of scoreboard is the Macroeconomic Imbalance Procedure one Ruggeri-Cannata et al. (2015), which is used in the context of the economic governance of countries at European level. The 2014 version of the MIP scoreboard included a set of eleven headline indicators, complemented by a set of auxiliary ones, intended to screen internal and external macroeconomic imbalances. In 2015, a subset of employment indicators were integrated in the scoreboard of the MIP for considering employment and social developments. The aim was to allow for a better understanding of the social consequences of imbalances, including during the correction of imbalances, and to help fine-tune the policy recommendations that fall under the scope of the MIP. The inclusion of these variables into the scoreboard shall not have legal implications nor change the focus of the MIP, which remains aimed at preventing the emergence of harmful macroeconomic imbalances and ensuring their

[1] In this regard it is important to remember the introduction, in 2015, of the seventeen Sustainable Development Goals (SDGs) and their related 169 targets

[2] This paper refers to data until 2014, when the EU was composed of 28 Member States

correction.

The actual set of MIP indicators can then be considered as a comprehensive set of indicators related both to economic growth and to at least two important well-being dimensions, namely economic well-being and social welfare. Moreover the MIP ensures that the selected indicators are standardised across European Union countries, based on European Union legislation and with a well established quality assurance framework. In spite of these important properties, MIP indicators have not yet been extensively analysed as a source for multivariate investigation on the relationship between economic growth and well-being.

Extending the previous results presented in Bacchini et al. (2020), the aim of this paper is to contribute to fill this gap by providing a multivariate analysis based on the MIP indicators and comparing it with one related to a selection of SDG indicators. In particular, we would like to investigate how the results drawn from the two seet of indicators might be related in terms of identified groups. Looking at the results of the comparsion we aim to answering on the usefulness of MIP as a source able to be considered also for measuring SDG.

On a different prospective, this deliverable proposes to investigate the multidimensional aspects of the relationships between human life and the context in which it develops (especially nature) that is of crucial importance. These relationships connect humans to both sources of vital flows and sinks for emissions and useless residues, expressed in terms of different units of measure: energy, matter, information, money, pollutants, waste, knowledge. This view has much to do with sustainability, enabling attribution of scientific and material consistency to this concept that is often elusive. Bastianoni et al. (2016) stated that to define in a qualitative-quantitative way the concept of sustainability, three key points can be determined: a) a shared (holistic) picture of the reality (i.e., what should be sustainable?), which demands a transdisciplinary approach in order to encompass the many dimensions of our life and behaviour; b) the purpose (i.e., why should we be sustainable?) is to create and maintain the conditions for durably living better and in harmony with the context in which we live (in particular with nature and other individuals); and 3) the critical assessment of how we can reach these conditions (i.e., how can we be sustainable?) requires new frameworks to evaluate and monitor progress towards the desired change.

2. Macroeconomic Imbalance Procedure as a source for well-being and sustainability analysis

2.1. Main characteristics of data: MIP

The Macroeconomic Imbalance Procedure (MIP), which is part of the so called European semester, is a surveillance framework that has been introduced in Europe, after the economic crisis in 2008, with the objective to detect, prevent, and correct problematic economic trends, in the form of internal and external imbalances, falling competitiveness, real estate bubbles or economic crises European Economy (2016)[1]. The MIP covers a number of sequential steps, having the Alert Mechanism Report (AMR) and its Statistical Annex (SA) as a starting point, with the AMR being an initial screening device providing an economic reading of the MIP Scoreboard. The MIP scoreboard refers to a set of fourteen headline indicators intended to screen internal and external macroeconomic imbalances, covering a time span of ten years for the European Union Member States (see Table 6.1).

The MIP scoreboard indicators are coupled with indicative thresholds sometimes varying between euro area and non euro area countries. Supplementing the MIP scoreboard indicators, a list of 28 auxiliary indicators provides additional information on aspects linked to the general macroeconomic situation, nominal and real convergence inside and outside the European Union and the euro area, detailed data on external liabilities, including foreign direct investment and net external debt, and social statistics (see Table 6.2). The strengthening of the social dimension in the framework of the European Semester surveillance for European Union countries and in particular in the MIP procedure has been implemented in two phases. In 2013 a set of eight social indicators related to the activity rate, long-term unemployment, youth unemployment and poverty were added to the set of auxiliary indicators. The aim was to allow a better understanding of the social dimension of risks implied by imbalances during economic adjustments and enhance the assessment of their social consequences. In 2015, a second step has been the inclusion in the scoreboard indicators of three of the (before auxiliary) social indicators related to the labour market. As stated in European Economy (2016), surveillance under MIP aims at fostering adjustment while addressing its social implications.[2]

The relationship between the MIP auxiliary indicators and well-being and SDG framework could be addressed into two ways. From a general point of view we observe that most European Union countries share a domain for economic well-being represented, among others, by the following indicators: People at risk of poverty, People living in absolute poverty, Severely materially deprived people, People living in households with very low work intensity. Focusing on the domain of labour and education, available information includes indicators on Employment rate, Unemployment, Youth unemployment rate, Young people neither in employment nor in education and training, and Long-term unemployment rate. All in all the MIP auxiliary indicators represent a sample of the common well-being indicators in the domains of economy, labour and education.

[1] This section of the report is drawn from the article Bacchini et al. (2020) as well the section on the methodology

[2] In fact, the adjustment process following the unwinding of imbalances is often associated with labour market distress and worsening social conditions linked to increased joblessness, inactivity, stagnating incomes.

Looking at the results, Bacchini et al. (2020) have explored the main characteristics of this set of information, looking separately at scoreboards, auxiliary and social indicators. They found that, despite the effort made in the coordination of European policies, dissimilarities increased amid countries in the periodo 2007-2014. This result holds with respect to different subsets of MIP indicators including the subset of social indicators, related to well-being. In particular, in 2014 the subset of social indicators showed the lowest degree of homogeneity across European Union countries.

To improve the use of the MIP indicators, the present analysis consider the last data available for the scoreboard comparing them with a subset of indicators drawn from the social and economic dimension of SDG.

2.2. Main characteristics of data: SDG

The 2030 Agenda for Sustainable Development, adopted by all United Nations Member States in 2015, provides a shared blueprint for peace and prosperity for people and the planet, now and into the future. At its heart are the 17 Sustainable Development Goals (SDGs), which are an urgent call for action by all countries - developed and developing - in a global partnership [3]. The 17 Goals are arranged into 169 targets. Finally targets are represented by indicators. For example the Italian framework on SDG presents 325 statistical measures (of which 296 different) for 130 UN-IAEG indicators (see Istat (2020)).

According to the results of the project MAKSWELL (Deliverable 1.1 and 1.2), 27 European Union countries are involved in the development of indicators to measure progress towards SDGs target (21 of them use these indicators for policy analysis)[4]. The SDG framework is then an important source for EU policy as confirmed by its inclusion in the related area in the Eurostat database.

Avoiding for the debate on the measurement of sustainability (see for example Costanza et al. (2016) and Miola and Schiltz (2019), for the selection of the indicators we refer to representation of the Goals along the 3 pillars, social, economic and environmente (Istat (2020), Figure 6.1 and Figure 6.2).

Considering the social and economic dimensions we select:

- Social indicators: GOAL 1: poverty risk (X1) and several deprivations (X2), GOAL 3 good health (X3), GOAL 4: early school leaving (X4), tertiary education (X5) and adult participation in learning (X6),

- Economic indicators: GOAL 7 employment gap (X7), GOAL8 GDP per capita (X8) and NEET (X9), GOAL 9 public investment (X10) and GOAL 10 income households (X11).

All indicators selected refers to different time span. For this first application we consider the last available vintage of data that is not the same for all indicators: for example, 2019 for the indicators based on the labour force survey and the immediately preceding years for the other economic indicators.

[3] see United Nations *https : //sdgs.un.org/goals*

[4] This paper refers to data until the EU was composed of 28 Member States

More important, the selection performed is just one of the possible sample that it can be drawn from al the SDG indicators. However your motivation is only to provide an example on the comparison with the MIP indicators while fine tuning in the selection, even in the number size, will be on the agenda for the next studies.

3. Multivariate methods:cluster analysis and principal components

Cluster analysis (see for example Everitt et al. (2011), Everitt and Hothorn (2011)) is a multivariate method which aims to classify a sample of heterogeneous statistical units, in our case European Union countries, on the basis of a set of measured variables, the MIP indicators, in a limited number of meaningful groups, each of which is internally homogeneous in terms of some form of similarity among its members. In order to perform cluster analysis, we need to define measures of distance, or similarity, among objects.

Many clustering methods have been developed and a large literature is available. According to Fraley and Raftery (1998), clustering methods can be classified into hierarchical and partitioning methods: hierarchical methods construct the clusters by recursively partitioning the units in either a top-down or bottom-up fashion; partitioning methods relocate units by moving them from one cluster to another, starting from an initial partitioning. Methods of the second kind require a pre-set number of clusters. To achieve global optimality in partitioned-based clustering, a relocation method iteratively relocates points among the already specified clusters. The homogeneity within the groups is maximized when the average distance of the reference object to all the other observations of the same cluster is minimized.

In this paper the cluster analysis will be performed by the k-median algorithm. For this purpose, the program PAM (Partitioning Around Medoids, Rousseeuw and Kaufman (1990)) within the package *cluster* of R software has been used. This algorithm is very similar to the well-known k-means algorithm, from which it differs mainly in clusters' representation. Each cluster is represented by the most centric object in the cluster, rather than by the implicit mean that may not belong to the cluster.

In order to empower our analysis, and although cluster analysis has been used as unique methodology in another study on economic convergence Artis and Zhang (2001), we complement results from the cluster analysis by a principal component analysis (PCA). PCA reorders the original multivariate data creating new variables, called principal components, that correspond to a linear combination of the original ones. The number of principal components is less than, or equal, to the number of original variables. Each principal component is estimated in a way to maximize the explained variance. A small number of principal components explains a large amount of the total variance of the original data. Variables and countries are then represented in the principal components framework improving the ability to interpret their similarity/dissimilarity.

The PCA representation complements the one provided by the cluster analysis and silhouette allowing for the interpretation of the movements of the indicators across time.

The proposed methodology is tested on the two different set of variables, the ones stems from MIP and the other stems from SDG searching for commonality or differences in the results. In this ways we provide evidences on the use of MIPS as an important source for SDG.

4. Main results

Applying multivariate analysis to the selected sample of 16 MIP and 11 SDG indicators we investigate along four different dimensions to argue on the (dis)similaity of the two framework for the 27 European countries (see Table **??** for the countries' abbreviation)

- distance matrix
- optimal number of clusters
- composition of the clusters
- PCA interpretation

The classification of observations into groups requires some methods for computing the distance or the (dis)similarity between each pair of observations. The result of this computation is known as a dissimilarity or distance matrix. Figure 6.3 presents the distance matrix for both MIP (6.3a) and SDG (6.3b: correlation across countries is higher using the SDG s indicators (the picture is characterized by a large zone of red-orange square).

Considering the optimal number of cluster the criteria based on the *Total within sum of square* is similar using MIP or SDG indicators: 3 or even 5 clusters might be considered as the optmal value. We fix 5 cluster to analyze the composition of the countries in the clusters (Figure 6.4).

Cluster analysis returns a first difference related to the use of the two different set of indicators confirming the evidence coming from (dis)similarity matrix: the first dimension is associated to 47.4% for SDG while 33.5% for MIP indicators (Figure 6.5a). According to the MIP indicators, two trivial clusters, composed by only 1 country, emerge: Greece and Ireland, both of them characterized by an high value of the *Total fi*

nancial sector liabilities, non-consolidated (X11) (Table 6.4). The other 3 cluster seem well characterized in term of geographical composition: cluster 2 much related to Eastern countries, cluster 3 to the Northern ones and cluster 5 to the Mediterranian. Labour market appears as one of the driver of this composition: the mean of the cluster for *Unemployment rate* (X10), *Long-term unemployment rate* (X13), *Youth unemployment rate* show a shape distance across the cluster as well as *General government gross debt.*

Results from PCA confirm these evidences adding relevance for *Current account balance* (X1), *Net international investment position* (X2) and *Private sector credit flow, consolidated* (X7) for Northern countries with *People at risk of poverty or social exclusion* (X16) and *Private sector debt, consolidated* (X8) more important for Finland and Sweden; Eastern countries are characterized more by *Real* *effective exchange rate* (X3), *Export market share* (X4), *Nominal unit labour cost index (2010=100)* (X5) and *House price index* (X6). Finally labour market is mainly driven the position of Italy and Spain (Figure 6.6a). All in all these results are in line with the ones presented in Bacchini et al. (2020) reinforcing the hypothesis that the convergence across European countries is far to be reached.

Interpretation from the cluster analysis based on SDG indicators return a similar picture adding some details (Figure 6.5b). Spain and Malta are considered as a single cluster, then there is a slight heterogeneity across Eastern countries, now included in three different cluster. The Northern cluster now includes France and Ireland. PCA helps to characaterize these differences. Labour market conditions *employment gap* (X7) together with *early school leaving* (X4) are one important driver for the position of Italy and Spain (Figure 6.6b). The position of these countries is also characterized by *several deprivations* (X2) and *NEET*(X9). *Tertiary education* (X5), *adult participation in learning* (X6) and *public investment* (X10) are instead associated with the position of Northern countries.

All in all the multivariate analysis applied to MIP and SDG indicators returns a complementary picture with some common drivers able to explain the (dis)similarity across European countries. Labour market, as well as education, appear one of the most important charateristics reinforced from one side from the public and private debt position and from the other for the external competitiveness.

5. The Input-State-Output (I-S-O) framework as a tool to investigate, interpret and manage system behaviour towards sustainability

5.1. The Input-State-Output (I-S-O) indicator framework

Pulselli et al. (2015) proposed a wider representation, rather than a further definition, of the concept of sustainability to acknowledge the urgent need of representing and investigating systems through appropriate tools and indicators. The result of this investigation emerged from the need a) to represent the environmental, economic and social aspects (i.e. the pillars) of sustainability together, and b) to solve the trade-off between juxtaposition of large number of indicators to define the three dimensions and computation of super-concentrated index given by extreme aggregation of information. The first point implies an evolution of one of the traditional representations of sustainability, that of a pyramid made for three sectors, namely the environment at the basis, the society in the middle and the economy on the top (Figure 6.7, A). The evolution consists in a clockwise rotation of the pyramid that recognizes a relational and physical order of environment, society, and economy. In particular, a system first needs resources, then it organizes and process them and, finally, produces an output (Figure 6.7, B).

As a consequence, to represent the functioning of a dynamic system and assess its behaviour in time, such a scheme may inspire a succession of steps that can be summarized in a so-called Input-State-Output (I-S-O) framework, directly derived from the environment-society-economic succession seen above (Figure 6.8)

The I-S-O framework can be used to investigate some aspects characterizing system dynamics by means of selected indicators referred to the three dimensions. The framework was introduced by Coscieme et al. (2013) to incorporate a limited number of systemic indicators to represent multidimensional aspects of the system under study: *this approach can represent and monitor sustainability with a trade-off that aims at maximizing information with the minimum numerosity of indicators: the information should be obtained by using indicators representative of the whole system; the numerosity is kept to the minimum to independently depict the three different dimensions of system sustainability, ensuring that every indicator maintains its identity, and complementary informative capacity. In addition, this approach allows for the relationships between different aspects of sustainability to be investigated by putting the environment, the society, and the economy in the proper relational order* (Pulselli et al. (2015), pag. 42).

5.2. The Input-State-Output (I-S-O) applications

With the aim of investigating ecosystem functioning, Coscieme et al, (2013) proposed the I-S-O framework to quantify ecosystem behaviour by means of input, state and output indicators, respectively, coming from the adoption and application of environmental accounting methods. In particular, an I-S-O scheme has been used to categorize ecosystems (in a socio-ecological context), whose characteristics can be described by the relationship among the three thermodynamics – or ecology-based orientors - emergy, eco-exergy, ecosystem services - making it clear that inputs are used up, directly or indirectly, to create and maintain a given systems *state/organization and/or* to produce (ecosystem) services in output[1]. The same scheme has been later proposed to study human-driven systems whose dynamics can be assimilated to those of ecosystems. In fact any dynamic system, including an economic system, needs a material input to survive and this vital input must be collected, organized, processed and metabolized for the system to survive and produce a useful output or achieve a goal. The first application of the I-S-O framework to human-driven systems was proposed to study almost 100 countries of the world (Pulselli et al. (2015)). The selected indicators to perform that study were: for the input dimension, the total emergy flow feeding each national economic system; for the state dimension, the Gini Index of income distribution; for the output dimension, the GDP per capita. The analysed countries have been categorized into 8 classes, especially highlighting diversity and inequality among nations, and the difficulty in dematerializing the economy and decoupling the economic result from material flows. In line with the proposal of adopting the I-S-O- framework to study national economies, a further study to identify changes in the performance of countries in two different years has been produced, in which a cluster analysis was made to corroborate the classification proposed before ((Neri et al., 2017)).

A further investigation was proposed to study more than 100 Italian provinces (Betti et al. (2017)). The indicators upon which the study was based were slightly different from those adopted for the application of the I-S-O- at the national and regional level. These are energy consumption (electricity and a set of fuel types, converted into CO2 to be aggregated and divided by the area of each province) (input indicator); the employment rate (state indicator); GDP per capita (output indicator). The result shows how a great diversity can be seen also among provinces within the same region, which suggests to consider, measure, investigate and take into account diversities at peripheral level to inspire policies also at the national, regional and sub-regional level. In order to refine and make the framework operative in an effective way two main points must be included in the research: a systematic medium-long time series analysis (5-10 years) in order to evaluate changes and transformative policies and measures; different sets of indicator in order to assess informative potential. For these reasons a project has been designed to examine the performance of countries by means of two complementary triads of indicators: for the input dimension, consumer vs. producer based CO_2 emission; for the state dimension, employment rate vs. life satisfaction, for the economic dimension, per capita GDP vs. median net income. The object of the study are European countries along a 15year time span (Sporchia et al. (2020)).

Classifyng and grouping
Children can work with classification systems from a very young age. The effort of classification and grouping helps children understand how the world is organised. Sorting objects, materials or living things helps children classify each unit as a member of a particular group and named accordingly. Growing up, this task is undertaken for different reasons. In fact, we organize and classify to be able to reason, plan and better address choices/decisions. Without classification systems, scientists would have to talk about individuals and not groups. Classification of objects is done based on similarities in characteristics/properties, so that systematic studies could be made about them. The

[1] Emergy is a physics-based measure of the flow of resources feeding a system, based on the amount of solar energy that has been directly or indirectly necessary to produce that flow, and it is thus a measure of the environmental cost of a given resource; eco-exergy is a thermodynamics-based entity representing the $organization/diversity/complexity$ of a system; the ecosystem services are goods and services directly derived from nature independently of a monetary counterpart.

Input-State-Output framework allows to accomplish the classification task of economies (countries, regions, etc.) very smoothly according to two different approach. The first one uses a graphical approach. In practical terms, a 3D representation, deriving from a three-axis diagram, in which the three dimensions are simultaneously, but separately, considered is adopted in order to identify points resulting from the combination of values. The indicator values (that represent the input, state and output dimension, respectively, and are expressed in different units) are distributed along three axes, occupying three segments equal in length, respectively, in which the median value is identified to separate low and high domains. The median values are forced in the middle of the segments, in such a way that 8 sub-cubes (different classes) can be determined to facilitate categorization of systems on the basis of different characteristics (Figure 6.9).

The values of the three indicators, related to each system (country or region or else) are placed along the three dimensions of the cube in Figure 6.9. The points, corresponding to each system, can be identified within the 8 sub-cubes, in line with the high or low domain of the indicator values (above or below the median value, respectively). Every point in the cube is not a single number, because it maintains the contribution of every single indicator of the triad. The proposed graphical approach, besides being a simple tool to classify system, could be also a good communication tool for example to encapsulate the *World in a Cube*.

The other classification approach, adopted in line with the rationality of the I-S-O framework, is based on the cluster analysis (Everitt et al. (2011)). In this case, the categorization is based on the concept of dissimilarity among different countries, instead of using a threshold in order to discriminate between high and low domains. Data clustering is recognized as a statistical technique for classifying data elements into different groups (known as clusters) in such a way that the elements within a group possess high similarity while they differ from the elements in a different group. The classification can be obtained by using the crisp cluster analysis or by using a soft clustering known as Fuzzy Cluster Analysis. Specifically a categorization of national economies through cluster analysis has been conducted (Pulselli et al. (2015), Neri et al. (2017)). We can finally state that the I-S-O is a rational solution for the study of a multidimensional concept like sustainability, providing a useful tool of communication and also allowing to categorize units like economies in order to reason, plan and better address policies and programmes.

The I-S-O as a medium

The I-S-O framework can be also adopted as an interpretative tool to understand more complex objects, like programs and plans. Its structure facilitates identification of connections and causal relationships by virtue of the *consequentiality/rationality* of stages based on physics-based principles. The input, state and output components of the framework, corresponding to the environmental, social and economic aspects of human driven systems, actions and project, enable obtainment of a complete representation of the multidimensional context in which we live. The 17 Sustainable Development Goals (SDGs) can be an interesting exercise to test the informative capacity of the framework and its ability to orient ideas to improve both the SDG scheme and its achievement by every single country.

Figure 6.10 shows a tentative allocation of the SDGs along the I-S-O framework, that highlights the preponderance of the social part over the environmental and economic ones. Much more information can be obtained from the 169 target articulation of the SDGs, but the majority of these refer to the social part and the influence of it to or from the other components. This result corroborates some critical approaches to SDGs, such as that by Wackernagel et al. (2017), who criticized the SDG index because the country rankings it generates *mimics the conventional development pattern that links higher development achievements with higher Footprints, rather than approaching the global sustainable development.* In this case, the I-S-O framework may help orient decisions for planning contents, specifying connections among goals and designing solutions.

6. Further steps

The MAKSWELL project aims to extend the actual set of measurement avaialble for well-being and SDS. The other deliverables present several analysis on the topic aiming to extend the timeliness and the territorial representation using also big data. This deliverable concentrate the attention on the extention of data and analysi along two directions. First, using an already exting framework such as the one related to the MIP. Second presenting an application of the I-S-O model together with its representation in terms of SDG.

Comparing to the other sources, MIP is a set of statistical indicators, possibly coupled with policy targets and\or thresholds aiming to give information on several aspects of a phenomenon without any synthesis. This approach has been adopted at European level for monitoring some European Union policies. MIP allows for the advantages: ciherence across the metadata definition and the real practice as a tool for policy analysis.

Against this scenario, MIP has not been fully employed in the policy analysis on well-being and SDG. Using the scoreboard, augmented by only two auxiliary indicators, Gross domestic expenditure on R&D and People at risk of poverty or social exclusion, a multivariate approach has been adopted to investigate the main drivers accounting for similarity across countries. The results are compared with the ones obtained using a selected subsample of SDG indicators.

Results suggest that the multivariate analysis applied to MIP and SDG indicators returns a complementary picture with some common drivers able to explain the (dis)similarity across European countries. Labour market, as well as education, appear one of the most important charateristics reinforced from one side from the public and private debt position and from the other for the external competitiveness.

Even if the exercise is prone to some simple hypothesis concerning the selection of the indicators, the results seem to support the idea for an integrated dataset for policy analysis.

On a different prospective, the I-S-O framework can be also adopted as an interpretative tool to understand more complex objects, like programs and plans. Its structure facilitates identification of connections and causal relationships by virtue of the *consequentiality\rationality* of stages based on physics-based principles.

Tables and Figures

Table 6.1: MIP scoreboard indicators (AMR 2018)

Indicator	Unit	code
Current account balance (% of GDP)	3 year average	X1
Net international investment position	% of GDP	X2
Real effective exchange rate (42 trading partners, HICP defl.)	3 years % change	X3
Export market share (% of world exports)	5 years % change	X4
Nominal unit labour cost index (2010=100)	3 years % change	X5
House price index (2010=100), deflated	1 year % change	X6
Private sector credit flow, consolidated	% of GDP	X7
Private sector debt, consolidated	% of GDP	X8
General government gross debt	% of GDP	X9
Unemployment rate	3 year average	X10
Total financial sector liabilities, non-consolidated	1 year % change	X11
Activity rate (% of total population aged 15-64)	3 years change in p.p.	X12
Long-term unemployment rate (% of active pop. aged 15-74)	3 years change in p.p.	X13
Youth unemployment rate (% of active pop. aged 15-24)	3 years change in p.p.	X14

Table 6.2: MIP auxiliary indicators (AMR 2018)

Indicator	Unit	Code
Real GDP	1 year % change	
Gross fixed capital formation	% of GDP	
Gross domestic expenditure on R&D	**% of GDP**	**X15**
Current plus capital account (Net lending-borrowing)	% of GDP	
Net external debt	% of GDP	
Foreign direct investment in the economy â€“ net inward flows	% of GDP	
Foreign direct investment in the economy â€“ stocks	% of GDP	
Net trade balance of energy products	% of GDP	
Real effective exchange rates â€“ euro area trading partners	3 years % change	
Export performance against advanced economies	5 years % change	
Terms of trade	5 years % change	
Export market share - in volume	1 year % change	
Labour productivity	1 year % change	
Nominal unit labour cost index (2010=100)	10 years % change	
Unit labour cost performance relative to euro area	10 years % change	
House price index (2010=100) â€“ nominal	3 years % change	
Residential construction	% of GDP	
Private sector debt, non-consolidated	% of GDP	
Financial sector leverage, non-consolidated	% debt to equity	
Employment growth rate	1 year % change	
Activity rate	% of total pop. 15-64	
Long term unemployment rate	% of active pop. 15-74	
Youth unemployment rate	% of active pop. aged 15-24	
Young people neither in employment nor in educ. and training	% of total pop. 15-24	
People at risk of poverty or social exclusion	**% of total pop.**	**X16**
People at risk of poverty after social transfers	% of total pop.	
Severely materially deprived people	% of total pop.	
People living in households with very low work intensity	% of total pop. 0-59	

Table 6.3: Legend for EU countries abbreviations

Abbreviation	Country
AT	Austria
BE	Belgium
BG	Bulgaria
CY	Cyprus
CZ	Czechia
DK	Denmark
DE	Germany
EE	Estonia
EL	Greece
ES	Spain
FI	Finland
FR	France
HR	Croatia
HU	Hungary
IE	Ireland
IT	Italy
LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SE	Sweden
SI	Slovenia
SK	Slovakia

Table 6.4: MIP indicators: mean of the variable for cluster

Cluster	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12	X13	X14	X15	X16
1.0	0.5	-172.0	-2.7	67.6	-4.4	127.6	-8.6	231.0	58.8	5.8	1,601.9	73.3	1.6	1.6	21.1	1.0
2.0	0.8	-36.7	-0.2	10.5	15.3	124.0	3.2	76.1	39.4	5.1	180.2	74.4	1.7	1.7	23.0	1.2
3.0	-2.0	-151.6	-2.0	3.6	3.0	104.7	-0.8	115.5	176.6	19.4	200.6	68.4	12.2	12.2	31.8	1.2
4.0	5.7	48.1	-1.5	2.1	6.3	116.7	4.9	180.7	46.5	5.2	3,938.0	78.2	1.1	1.1	18.2	2.4
5.0	0.2	-45.7	-1.7	4.7	4.2	112.7	3.7	157.6	101.9	9.5	709.6	71.2	3.4	3.4	23.0	1.5

Table 6.5: SDG indicators: mean of the variable for cluster

Cluster	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11
1	-2.0	-151.6	-2.0	3.6	3.0	104.7	-0.8	115.5	176.6	19.4	200.60
2	0.8	-36.7	-0.2	10.5	15.3	124.0	3.2	76.1	39.4	5.1	180.23
3	5.7	48.1	-1.5	2.1	6.3	116.7	4.9	180.7	46.5	5.2	3,938.01
4	0.5	-172.0	-2.7	67.6	-4.4	127.6	-8.6	231.0	58.8	5.8	1,601.90
5	0.2	-45.7	-1.7	4.7	4.2	112.7	3.7	157.6	101.9	9.5	709.63

Figure 6.1: Distribution of Goals by dimension

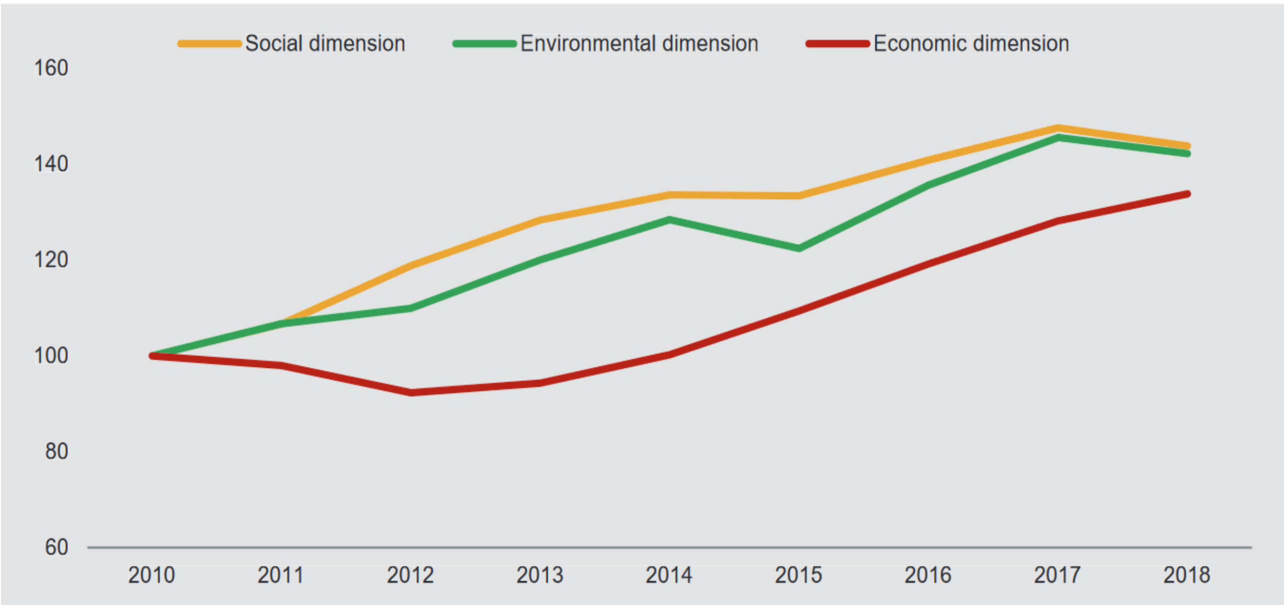
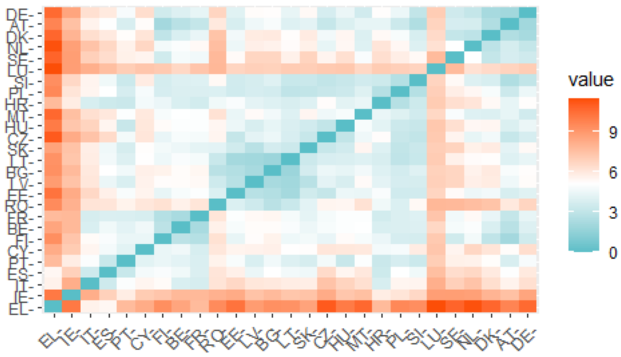
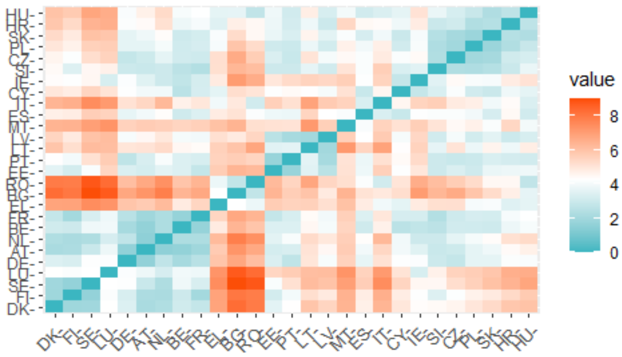


Figure 6.2: Composite indices for the social, economic and environmental dimensions. Italy, Years 2010-2018

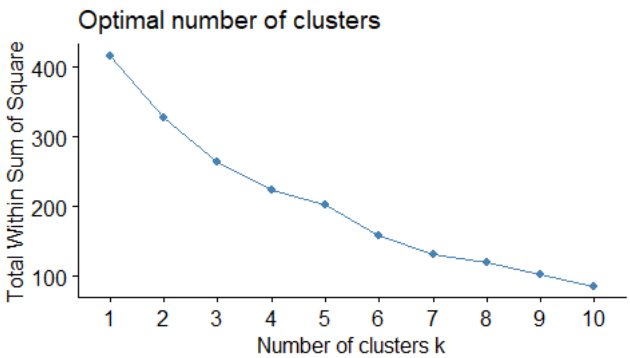


(a) MIP

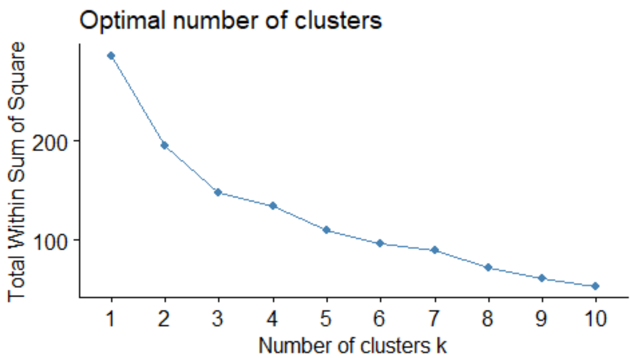


(b) SDG

Figure 6.3: Distance matrix

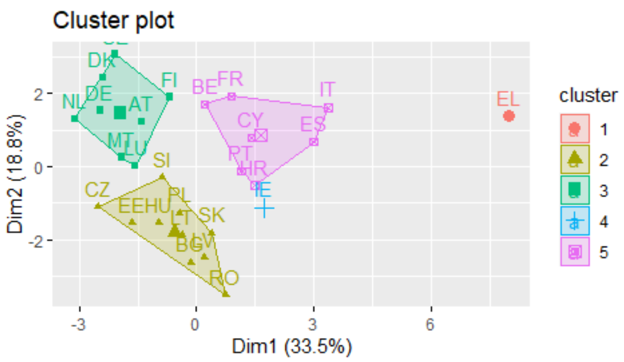


(a) MIP

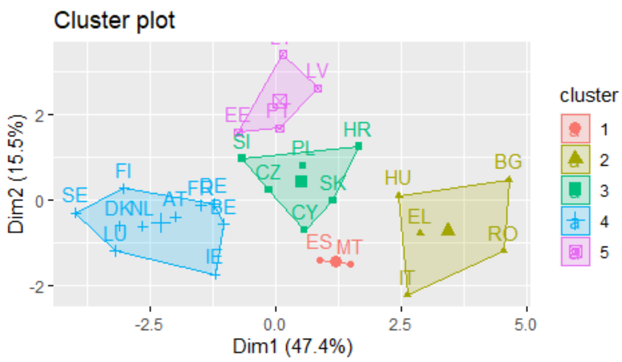


(b) SDG

Figure 6.4: Total within-cluster sum of square

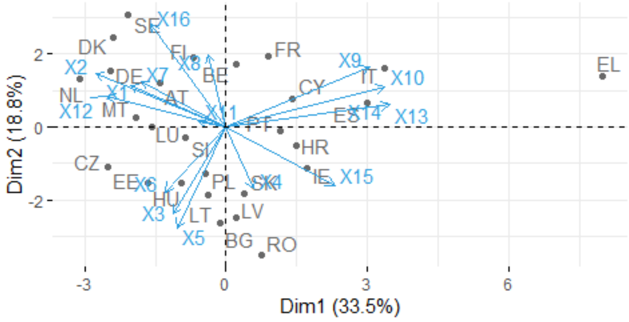


(a) MIP

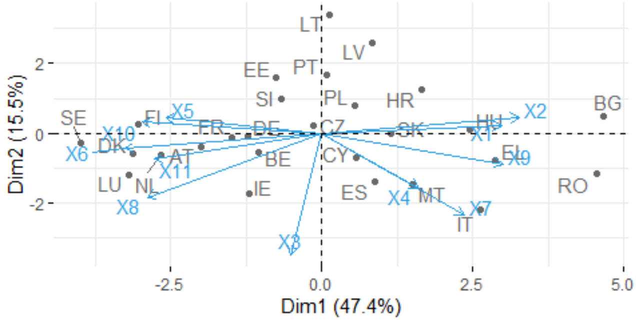


(b) SDG

Figure 6.5: Cluster plot n. cluster=5



(a) MIP



(b) SDG

Figure 6.6: Principal component analysis

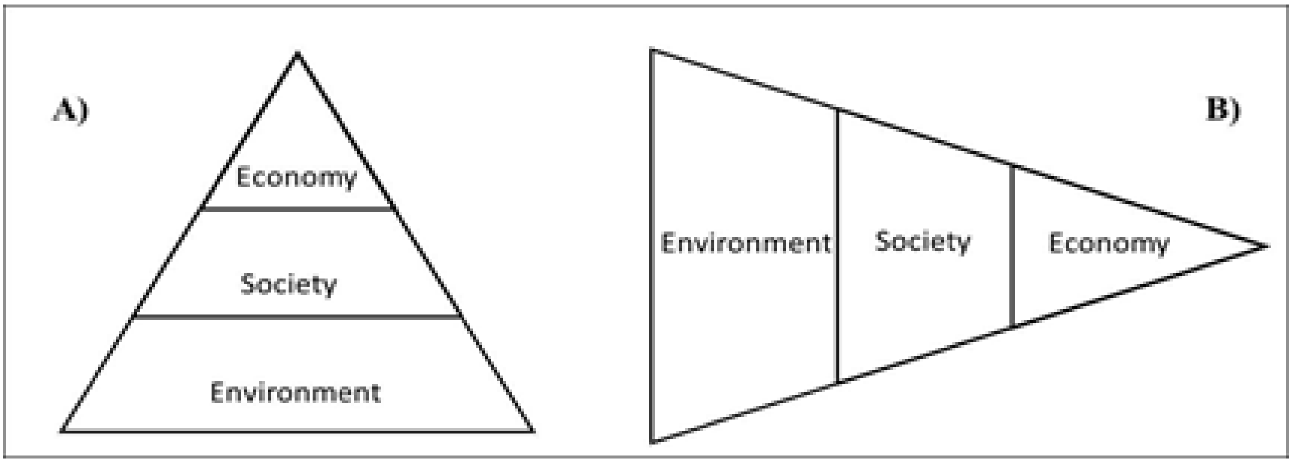


Figure 6.7: Three storey pyramid to represent sustainability

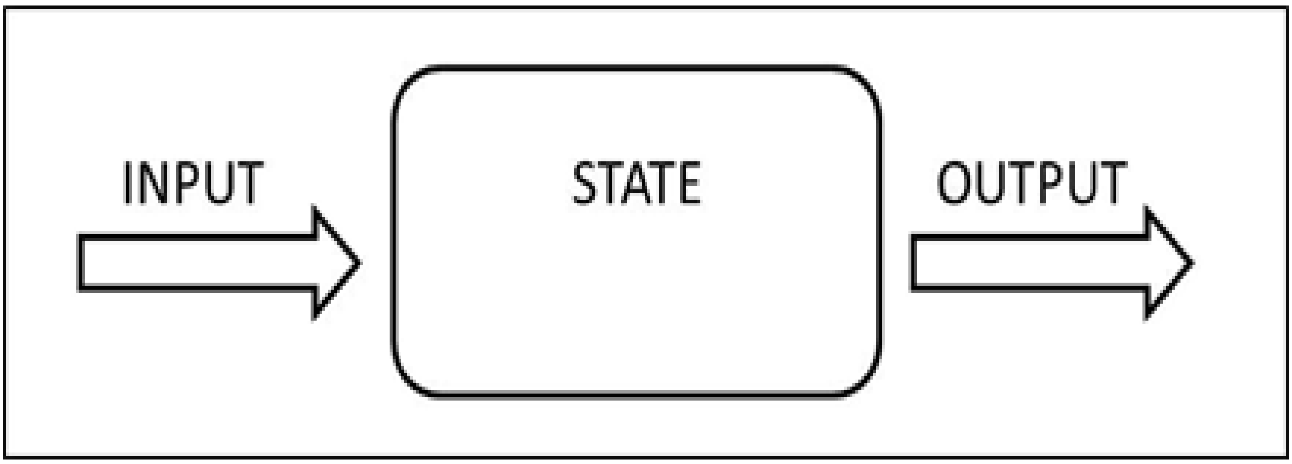


Figure 6.8: The Input-State-Output framework

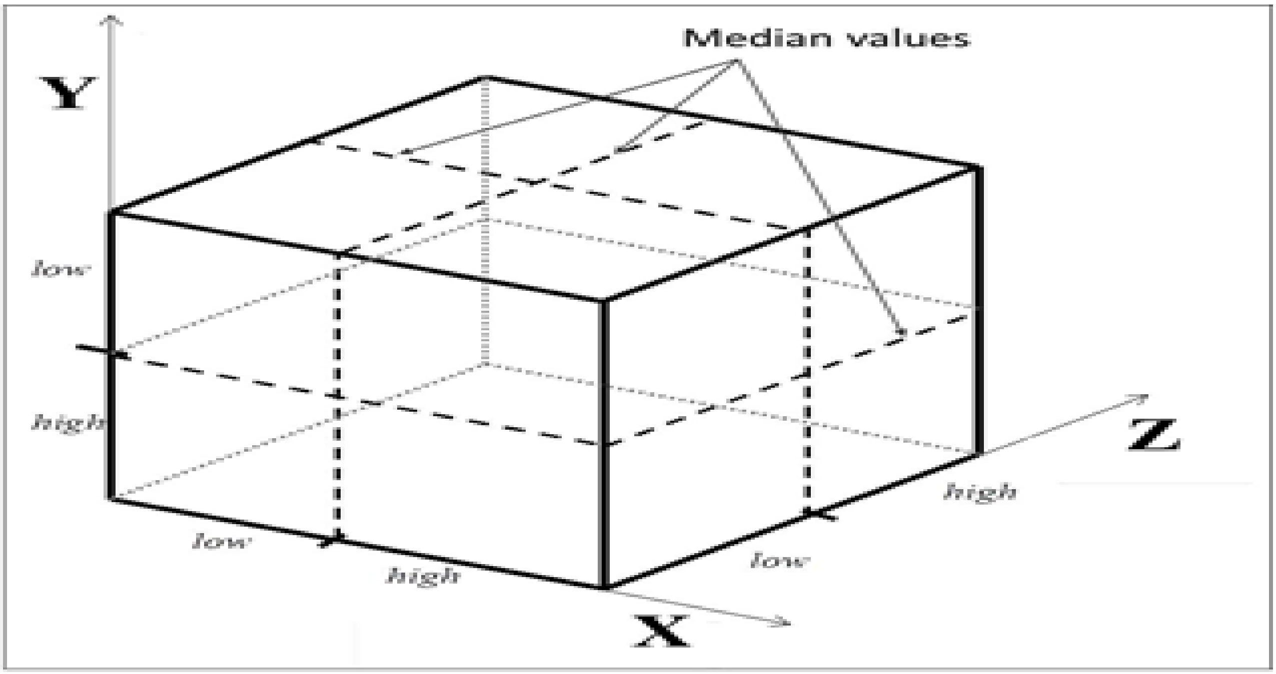


Figure 6.9: A cubic representation derives from a three-axis diagram. Median values of variables X, Y and Z are forced in the middle of the segments. In this way, 8 sub-cubes can be used to categorize different combinations of indicator values

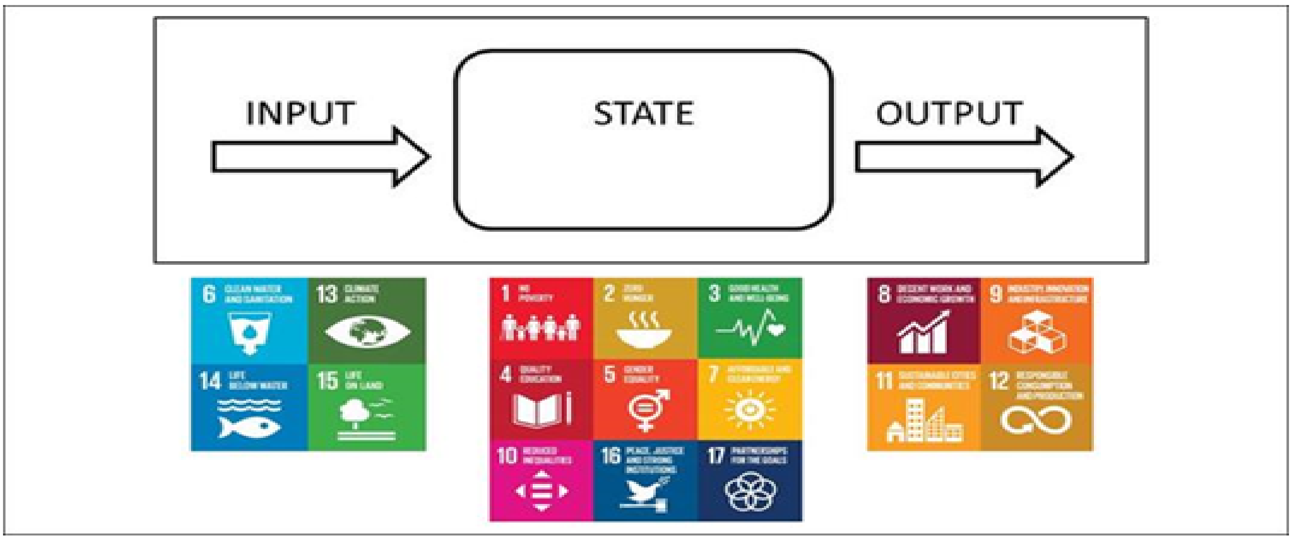


Figure 6.10: UN-SDG allocation within the I-S-O framework

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