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COMPLEXITY MEASURES FOR THE ANALYSIS OF SDG INTERLINKAGES: A METHODOLOGICAL APPROACH

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Abstract

The 2030 Agenda, with its 17 Sustainable Development Goals (SDGs), 169 targets and 232 indicators, has set an ambitious "plan of action for people, planet and prosperity"1 that must be achieved within 15 years (2015-2030). These first years of implementation of the SDGs by the 193 member states of the United Nations (UN) have served the international community to realize the complexity of the network of interactions (synergies and trade-off) between goals, targets and indicators, within a context where each country has set its priorities of development and those are not always aligned with the main objective of the 2030 Agenda (lack of policy coherence; policy vs politics). As a result of this situation, one of the main difficulties that the countries will need to overcome is to comprehend the nature and complexity of the intricate network of interlinkages between the SDGs, considering their universal and integrated nature. The purpose of this study is to improve the understanding of the level of sustainability complexity of each member state of the UN in the process of the implementation of the SDGs based on the Product-Space Theory and the Economic Complexity. Thus, we present a SDG priority-setting tool applied to the challenging and ambitious task of accomplishment of the 2030 Agenda, through the understanding of the SDG interlinkages network and its complexity. Our findings are significant for the on-going debate of policy coherence and alignment of national policies with the SDGs and the sustainability path countries should follow to progress towards an integral achievement of the 2030 Agenda.

Keywords: *Sustainable Development Goals (SDGs), Economic Complexity, Product-Space Theory, Revealed Comparative Advantage (RCA).*

Resumen

La Agenda 2030, con sus 17 Objetivos de Desarrollo Sostenible (ODS), 169 metas y 232 indicadores, ha fijado un ambicioso "plan de acción para las personas, el planeta y la prosperidad"1 que debe alcanzarse en un plazo de 15 años (2015-2030). Estos primeros años de implementación de los ODS por parte de los 193 estados miembros de la Organización de las Naciones Unidas (ONU) han servido a la comunidad internacional para darse cuenta de la complejidad de la red de interacciones (sinergias y trade-off) entre objetivos, metas e indicadores, dentro de un contexto donde cada país ha fijado sus prioridades de desarrollo y éstas no siempre están alineadas con el objetivo principal de la Agenda 2030 (falta de coherencia política; política vs política). Como resultado de esta situación, una de las principales dificultades que deberán superar los países es comprender la naturaleza y complejidad de la intrincada red de interrelaciones entre los ODS, considerando su carácter universal e integrado. El propósito de este estudio es mejorar la comprensión del nivel de complejidad de la sostenibilidad de cada estado miembro de la ONU en el proceso de implementación de los ODS con base en la Teoría del Producto-Espacio y la Complejidad Económica. Por lo tanto, presentamos una herramienta de establecimiento de prioridades de los ODS aplicada a la desafiante y ambiciosa tarea de lograr la Agenda 2030, a través de la comprensión de la red de interconexiones de los ODS y su complejidad. Nuestros hallazgos son significativos para el debate en curso sobre la coherencia de las políticas y la alineación de las políticas nacionales con los ODS y el camino de la sostenibilidad que los países deben seguir para avanzar hacia el logro integral de la Agenda 2030.

Palabras clave: *Objetivos de Desarrollo Sostenible (ODS), Complejidad Económica, Teoría del Producto-Espacio, Ventaja Comparativa Revelada (RCA).*

I. Introduction

The 2030 Agenda, with its 17 Sustainable Development Goals (SDGs), 169 targets and 232 indicators, has set an ambitious "plan of action for people, planet and prosperity" that must be achieved within 15 years (2015-2030) [UN, 2015]. These first years of implementation of the SDGs by the 193 member states of the United Nations (UN) have served the international community to realize the complexity of the network of interactions (synergies and trade-off) between goals, targets and indicators, within a context where each country has set its priorities of development and those are not always aligned with the main objective of the 2030 Agenda (lack of policy coherence; policy vs politics).

In this context, countries members have begun to send their Voluntary National Reviews (VNRs) to the High-Level Political Forum on Sustainable Development of the United Nations with their performances and experiences in the implementation of the SDGs at the national level [UN, 2016].

The main difficulties that countries, will need to overcome is to understand the nature and impact (synergies and trade-offs) of the interlinkages between the different targets at the national level, considering the universal and integrated nature of the SDGs and that the decisions made by the country in a specific goal will necessarily have an effect (positive, negative, or neutral) in the achievement of the other SDGs and in the probability as a country to accomplish the full 2030 Agenda.

As many experts have underlined, in this global scenario and facing the complexity and universality of the SDGs, a priority setting for the implementation of the 2030 Agenda is recommended [Allen et al., 2018; Allen et al., 2018a; Weitz et al., 2018; Zelinka & Amadei, 2019; McGowan et al., 2018], in order to: improve the qualitative and quantitative understanding on SDGs interactions; identify direct and indirect effects of SDGs interactions; detect patterns on SDGs interactions; identify critical goals and targets (central nodes) in the SDG network; and secondary analyses to increase synergies and avoid trade- off in the implementation of the 2030 Agenda and its alignment with the national plans of development [UN, 2014].

The aim of this study is to propose a new methodological approach for the analysis of the SDG interlinkages and the progress of the countries in the implementation of the 2030 Agenda, based on their accumulated sustainability capabilities measured by complexity measures and network theory.

II. Literature Review

Considering the universality, the diversity of sectors and stakeholders involved in the implementation of the 2030 Agenda, it becomes necessary for countries the identification of priorities within the SDGs [Allen et al, 2018; Weitz et al., 2018; McGowan et al., 2018; Alcamo, 2019; Nilsson et al., 2016; Scherer et al., 2018; Singh et al., 2018]. As stated by [McGowan et al., 2018], the selection of priorities reflects the strategy and policy criteria of each country (expressed by its policymakers) to evaluate the level of urgency in each sector.

The pioneer study in this field related to the SDGs was the one from [Le Blanc, 2015] that, even if it was criticized for the superficiality of the wording reference methodology implemented to analyze the interactions between SDG and mapping its interlinkages network. Then, [Vladimorova & Le Blanc, 2016] have presented and analysis of 37 official reports from the United Nations to evaluate the interactions between education and SDGs, based again on the wording reference methodology. In this case, the results have shown low levels of interactions between education and the SDGs related to energy, health and responsible consumption and production.

Applying the network approach and reinforcing the results presented by [Le Blanc, 2015] about the asymmetry of the interlinkages between the SDGs, [McGowan et al., 2018] highlight that those interlinkages are uneven, observing the lack of connections between critical SDGs as those related to gender equality, peace, and governance. These authors have based their analysis on the report from the [Griggs et al., 2017] and based on the interactions identified on it from a science-based perspective [ICSU, ISSC, 2015], they constructed a SDG network of interactions considering 4 main elements: degree (number of links per node), strength (total number of links from a node), closeness (distance with other nodes in the network and

centrality of a node in the network), betweeness (flow of information through the network).

Similarly, [Allen et al., 2018] and [Allen et al., 2018a] have implemented a network approach for the analysis of SDG targets interlinkages for 22 Arab countries, based on the methodology of [Nilsson et al., 2016] for the evaluation of the intensity of the interactions (from -3 to +3), through a cross-impact matrix to identify synergies, trade-off, and neutral interactions. The SDG network obtained as a result of the implementation of this methodology considers to 2 network metrics: outdegree and closeness centrality. Then, these results have been used as input for the evaluation of policy gaps and a multi-criteria analysis, to set priorities for the Arab region analyzed.

Similarly, based in the same methodology [Weitz et al., 2018] have evaluated the interactions between 34 SDG targets, obtaining results that reinforce the hypothesis that there are more synergies than trade-off in the SDG network, but in which the trade-off represents a serious threat for the accomplishment of the 2030 Agenda worldwide. Moreover, the SDG network obtained has a deeper level of analysis compared to the study from [Allen et al., 2018], showing the directionality of the interactions between SDG targets, type of interactions, intensity of the influence of targets in the SDG network, the clusters of SDG targets in the network, etc.

Finally, one of the most recent studies in the SDGs network system approach is the proposed by [Lusseau & Mancini, 2018], which analyzed how the main interactions of synergy and trade-off at the goal and target levels vary according to the level of income of countries, showing the existence of unstable networks composed by antagonistic subgroups, where the identification of development of priorities in each country is needed

III. Methodology

This research develops an analysis of the interlinkages among the Sustainable Development Goals, using the economic complexity and product space theory, offering a new approach to the study of SDG interlinkages.

Additionally, the methodology applied serves as a tool for policymakers to improve decision- making, facilitating the setting of priorities in the 2030 Agenda at the national level through the analysis of the interlinkages, synergies and trade-off existing in the structure of the SDGs and their impact in policy design and its implementation.

The implementation of the methodology is structured in 2 phases:

- Revealed Comparative Advantage: to identify the SDGs with RCA for each country under study. This information will serve as input for the complexity measures.
- Product-Space Analysis: to evaluate the SDG network and the interlinkages between goals. Then, to calculate and evaluate the Sustainability Complexity Index (SCI) and the Goal Complexity Index (GCI), and its implications in the prioritization of the SDGs.

IV. Results

The Sustainability Complexity Index (SCI) proposed in this study could be an interesting tool to improve the implementation of the 2030 Agenda, considering that it allows to measure the sustainability capabilities that each country has for the accomplishment of the SDGs.

Additionally, we observe that the SCI it is not only related to economic growth, but it is also strongly related to a wide and ambitious variety of critical indicators for the development of the countries, aligned with the integrated and indivisible nature of the SDGs.

Moreover, we can distinguish the different levels of correlation between the SCI and a diversity of development index as the SPI, GCI (World Economic Forum), HDI (United Nations) and the WHI (United Nations).

We can observe the first attempt of implementation of the methodological approach proposed in this study, showing the results of the SCI for the 156 countries with available data in [Sachs et al., 2018].

The biggest challenges for the accomplishment of the SDGs mainly remain in Africa and Southeast Asia. In South America, Bolivia and Venezuela present the lowest level of SCI.

Additionally, the Goal Complexity Index (GCI) has been measured, obtaining the results shown in Fig. 6. (Darker colors reflects higher levels of GCI).

From the GCI, we conclude that the top 3 of more complex goals in the 2030 Agenda, are the SDG12 (Responsible Production & Consumption), SDG13 (Climate Action) and SDG17 (Peace, Governance & Partnerships). In the other hand, the least complex goals are SDG9 (Industry, Innovation and Infrastructure), SDG3 (Health & Wellbeing) and SDG7 (Energy).

Finally, following studies should be oriented to analyze and to identify, with network theory and product-space theory, how the accomplishment of a specific SDGs could lead to the accomplishment (or not) of another SDG.

IV. Conclusions

The methodological approach proposed in this study shows strong evidence of its usefulness for the purposes of measuring the accomplishment of the SDGs, aligned with the 2030 Agenda. This complexity measures shows strong correlation with several development index that could explain the accomplishment of the SDGs in the different countries.

Now, the analysis of the SCI is limited to the availability of reliable data from the countries about their progress in the accomplishment of the different SDGs. It must be underlined, that the input data use in this methodology is based on SDG Report, published annually by the Sustainable Development Solution Network (SDSN) and the Bertelsmann Stiftung Foundation, that provides data that due to methodological limitations are not comparable year-by-year.

Nevertheless, we believe that the main contribution of this study is the innovative and interesting methodological approach to evaluate the progress in the accomplishment of the SDGs and the 2030 Agenda, offering a new tool to policymakers and decision-makers to set development priorities and to identify opportunities or synergies to accelerate the accomplishment of the

SDGs, based on complexity measures. Additionally, this index may provide a more synthetic summary to help predicting better adjustment policies.

Finally, considering that the methodology proposed in this study it is relatively new and the literature background of its implementation it is still relatively low, we suggest further studies to improve the experimentation and validation of the SCI and GCI for the analysis of the SDGs worldwide.

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