A Logical-Perequative Methodology to Define the Social Discount Rate for the Cost-Benefit Analysis Application

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Abstract. The need to define effective interventions for the urban sustainable development goals is always growing and recognized by the central governments. In the current economic situation, the adequate use of EU-funds for the investments to be carried out on the territory requires a targeted and valid implementation of the economic evaluations of the projects. In this framework, in the Cost- Benefit Analysis the Social Discount Rate (SDR) is ordinarily assessed by empirical approaches that neglect the main environmental, social and economic aspects of the nation in which the intervention will be realized. In this sense, in the present research an innovative logical-perequative methodology is proposed, able to take into account the specificities of the country through the detection of the main indicators related to the environmental, social and economic sustainability issues. The main advantage of the proposed methodology is the ability to determine the adequate corrective coefficient able to adjust the official SDR values, according to the real current sustainability levels of each country.

Keywords: Social Discount Rate · Cost-Benefit Analysis · sustainable development goals · equitable growth · multi-criteria assessment technique · composite indicator

1 Introduction

The awareness of the fundamental role played by the social cohesion for the achievement of the Sustainable Development Goals is growing, especially with reference to the key objective "to leave no one behind" expressed by the 2030 Agenda and to achieve a greater well-being for everyone [1].

The territorial disparities not only between regions and areas of each nation, but above all among the different European countries and between the European countries and the rest of the world, constitute the focus of the goal No.10 of the 2030 Agenda [1], which aims to reduce the inequalities within and between nations. In this sense, the access to essential services and infrastructures (transport, broadband, healthcare,

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schools, etc.) is unequally distributed among the collectivities, with remote, rural and disadvantaged regions that are increasingly late and missing basic facilities.

In theoretical terms, the accentuation and persistence of inequalities between the various growing territories undermines the economic strength of the European Union (EU), not allowing a fair and long-term sustainable development. The issue of the nations well-balanced growth is closely connected to the social inclusiveness target, which constitutes an important question debated in the recent decades by central and local governments. Therefore, the progressive achievement of a greater equality of and between nations should start from the adoption of fiscal, wage and social protection policies capable of highlighting the needs of disadvantaged and marginalized populations and of determining a countries economic growth that includes the quality of life improvement, in social, cultural and environmental terms.

According to the art. 174 of the consolidated versions of the treaty on the functioning of the European Union [2], the harmonious development of nations and the strength of economic, social and territorial cohesion are promoted, by paying particular attention to the rural areas, to the regions involved in industrial transition processes and to the zones with relevant and permanent natural or demographic minuses (e.g. the regions with very low population density as well as the island, cross-border and mountain regions) [3].

Within the urban transformation initiatives for the construction of new infrastructures and/or services and for the adaptation of existing ones, the need to increase the public investments is associated with the ever more pressing cogence to implement quality interventions. In the mentioned framework, it is essential to rationalize the entire planning, evaluating and monitoring public works process, in order to define urban initiatives that are able to lead to a balanced nations growth.

In the recent decades, the European programs (European Regional Development Fund (ERDF), European Social Fund Plus (ESF +), Cohesion Fund (CF), etc.) aimed at developing a structured set of strategies and reforms, that the Member States must follow for the robust recovery of the global economy and of each individual geographical context, include the reduction of gender, generational and territories inequalities among the priorities to be achieved [4–6].

In the current Italian context, the Mission No. 5 of the National Recovery and Resilience Plan (NRRP) [7] is in line with the main European purposes, as it is mainly focused on the cohesion goals to support the gender equality, the fight against discrimination, the increase in youth employment, the development of the South and inner areas. In particular, the component 2.2 of the Mission No. 5 – so-called M5C2.2 “urban regeneration and social housing” - defines a specific interventions cluster aimed at reducing marginalization and social degradation situations through the redevelopment of public areas and the promotion of cultural and sporting activities. Furthermore, the component 3 of the same Mission – named M5C3 “special interventions for territorial cohesion” - benefits from almost 2 billion euro for strengthening the national strategy in policies for the South and inner areas, with measures to improve the education, health and social services quality. Further interventions included in this target concern the economic and social enhancement of assets confiscated from the mafia and the improvement of the special economic zones service infrastructures, to increase the competitiveness and attractiveness of the existing activities. However, it should be pointed out that the social

inclusion strategic axis, defined primarily at European level, constitutes a cross-cutting goal in all components of the NRRP (in terms of essential public services provision, in the education and training sector, for the labor market, etc.). In fact, a complete social inclusion is fundamental i) to improve the territorial cohesion, ii) to help the economy growth and iii) to overcome the relevant gender and generational inequalities - often also accentuated by the Covid-19 pandemic.

In general terms, the NRRP aims to support the redevelopment of the most vulnerable urban tissues (suburbs, inner areas of the country) and to promote inclusion policies, mainly focused on the socially marginalized community groups, also through interventions to enhance the social housing, the temporary housing (such as the temporary reception facilities for the homeless or financially distressed individuals) and the subsidized housing to provide students or single-income families with accommodation at reduced rents.

At a wider European scale, the definition and execution of the social projects, in the same way, should be consistent with the six pillars of the Next Generation EU financial tool [8], on which each national reform and investment program up to 2026 is based. The social and territorial cohesions represent the fourth sector on which each national plan has been defined, after those related to the green transition, the digital transformation, the smart, sustainable and inclusive growth. Moreover, this sector is primary than the health and economic, social and institutional resilience and the policies for the next generation, including the education. Therefore, the social and territorial cohesion goal - at different scales (i. national, with reference to the gap between the different regions and macro-areas; ii. European, between the different EU Member States and iii. Global, between the different EU nations and the rest of the world) - is strongly connected to the homogeneous and equitable growth of nations scope, which intrinsically includes the sustainable development of countries issue. Within the framework of the CF (2014–2020 and 2021–2027) [9–11], established in order to strengthen the economic, social and territorial cohesion of the EU, the economic growth, the creation of jobs, the enterprises competitiveness and the environment protection represent the crucial measures to be promoted. Specifically, the allocation of the Union's funding for the cohesion policies is focused on two main purposes: the first is related to the investments for the employment for the labor market improvement; the second concerns the European territorial cooperation level in order to achieve a balanced development of each Member State.

2 The Economic Analysis for the Assessment of the Cohesion Policy-Funded Investments

In order to ensure the sustainable (in the three economic, environmental and social components), uniform and equitable growth for all EU Member States and, in a broader perspective, of Europe with respect to the rest of the world, the need to implement effective territorial investments, in line with the specificities of each geographical context and with the global goals of the inclusive development of the countries, is significant.

In this sense, the tools for assessing the projects feasibility should be able to provide reliable and appropriate results, according to the characteristics of the urban context in

which each initiative, is included. Thus, the evaluations should be flexible (as well as the techniques to be used) and carried out *ad hoc* according to the nature and size of the intervention and the surrounding urban area.

For the *ex-ante* verification of the economic feasibility of a project, the Cost-Benefit Analysis (CBA) is the main technique for evaluating the investments [12]. The core of the CBA concerns the determination of economic performance indicators (Net Present Value, Internal Rate of Return, Pay-back Period, etc.), starting from the results of a multi-year development of estimated costs and benefits associated with the analyzed investment (always considered compared to the alternative scenario referred to the *status quo*) [13, 14]. According to the art. 101(e) of Regulation No. 1303/2013 [15], the CBA – including an economic and financial analysis and a risk assessment – is mandatory in order to get the approval of large projects (i.e. whose construction costs is higher than 50 million euro) included within the EU Cohesion Fund 2014–2020. Depending on the investment type, sector, size and complexity, a set of economic appraisal methodologies could be considered for the assessment of projects included the EU 2021–2027 policy framework: the CBA is the preferred approach, even if, the Least-Cost Analysis (LCA) or the Cost-Effectiveness Analysis (CEA) are proposed for voluntary use and could be adopted as alternatives. A Multi-Criteria Analysis (MCA) could also be implemented, even though it is more often used as a complement to the other tools [16].

With reference to the input data to be included in the economic analysis carried out by using the CBA, the investment costs and, possibly, the operating costs (if the operativity phase regards the direct activity management) and the benefits deriving from the financial revenues appropriately turned by using the conversion factors, are estimated considering the prices charged on the local market. The Social Discount Rate (SDR) assumes a relevant role in the CBA context, since the determined costs and benefits - and subsequently attributed in the different years of the considered period of analysis - occur in different times and have to be homogenized, in order to be compared with each other. In theoretical terms, the SDR reflects the social point of view about the preference level of future costs and benefits compared to the present ones. Moreover, the value of the SDR is crucial for the analysis effectiveness, as it is strictly connected to the riskiness of the investment and it is defined taking into account the sacrifice that the community is willing to bear in order to renounce the current benefits for future ones (i.e. the cost/opportunity for the community principle) [17–19].

For the Cohesion Fund 2014–2020, the European States have ordinarily used the official SDR reported by the Guidelines for CBA implementation developed by local governments (5% for large projects promoted in the CF beneficiary countries and 3% for other Member States) [12]. For EU-funded projects in 2021–2027, Member States can independently establish and use their own country-specific SDR. In this sense, the Economic Appraisal Vademecum 2021–2027 sets that, in the absence of national values, 3% can be used [16]. In the reference literature, different approaches have been proposed to estimate the SDR, even if that generally recommended is the Social Rate of Time Preference (SRTP $= p + e \times g$, where p is the pure time preference, e is the elasticity of the marginal utility of consumption - i.e. the percentage change in individuals' marginal utility corresponding to each percentage change in consumption - and g is the expected growth rate of per capita consumption) [20]. The country-specific SDR

empirical determination should be carried out, by taking into account that i) the systemic risk and optimism bias should be reflected not in the SDR but in the risk assessment, ii) the SDR can decline over the reference period in projects with very long-term impacts, e.g. beyond 50 years, as they involve intergenerational equity considerations, iii) the SDR should not vary across sectors based on policy considerations [16].

Within the outlined framework, the differentiation of the SDR to be used according to the nation in which the initiative is to be implemented would allow a reduction of the risks associated with incorrect evaluations and a greater ability of the analysis to take into account the context specificities. In order to pursue the mentioned goals of inclusive and equitable sustainable growth of the European nations, the adoption of different rates would allow to reward projects characterized by positive long-term effects and to provide a lower coefficient for projects in countries in which higher need for interventions for the community is detected. In particular, the specificities of each nation could be summarized by a set of measurable indicators and reported by official sources, which allow to analyze the different characteristics of the countries to be compared in economic, environmental and social terms. The reference literature includes several contributions aimed at i) highlighting the role of indicators for the description of different contexts [21–23] and ii) identifying the main indicators able to measure the environmental, cultural, educational, social and economic level of the country [24–27].

It should be highlighted that the need to determine specific SDR according to the nations characteristics is also associated with the requirement of transparent methodological approaches to be used for this parameter estimation. Currently, the two issues assume a key role that is still poorly pointed out by governments, which rely on standard and often unique values for different countries, by neglecting, however, their different specificities. In addition, the cogence for constant updating of SDR to be used in the economic analysis is relevant, in order to avoid the use of obsolete and unreliable data, by remembering that too high SDR setting may mean that socially desirable projects are rejected and, conversely, too low SDR setting may result in resources being wasted on economically inefficient projects [28].

3 Aim

Within the economic evaluations implemented through the CBA, the current official SDR values totally neglect environmental aspects that assume a crucial role within the Sustainable Development Goals of the 2030 Agenda. Furthermore, the SRTP empirical approach - recommended by the Vademecum for the determination of SDR - is based on very often difficult computation processes aimed at calculating the different parameters included in its algebraic formula. Therefore, the aim of the present research is to define a logical-perequative methodology for the definition of the SDR that is able to take into account the environmental, social, economic specificities of the EU countries. In particular, the methodology is articulated in six ordered and sequential phases and involves the integration of the Analytic Hierarchy Process (AHP) and Data Envelopment Analysis (DEA).

Starting from the identification of a set of indicators that represent the existent environmental, social and economic issues at the time of the evaluation, the proposed methodology provides for a corrective coefficient of the SDR reference values to be used for

the "adjusted" SDR determination. This obtained SDR value can be adopted in the CBA applications aimed at the economic evaluation of the projects within each EU nation.

For an effective determination of the corrective coefficients or the "adjusted" SDR values, the identification of a "benchmark State" is necessary for the comparison among the nations, by considering the detected indicators data.

The developed methodology could be implemented in any territorial context that requires the CBA application for the economic evaluation of the investments to be carried out for the urban sustainable development goals. Due to this feature, it appears flexible and user-friendly and it constitutes a valid tool with reference to the assessment of effective interventions on each country.

The Sections contents included in the paper are described below: in Sect. 4 the proposed methodology is illustrated and the main steps that constitute the logical-perequative procedure to be implemented in order to determine the "adjusted" SDR value are described. In Sect. 5 the conclusions are introduced, and the further insights of the research are listed.

4 Methodology

The proposed methodology consists into six ordered and sequential phases by involving the integration of the AHP multi-criteria technique and the DEA for, respectively, firstly determining the level of the economic, social and environmental conditions, based on the existent disposable set of indicators that are collected as able to represent each aspect, and for secondly, defining the corrective coefficient of the SDR values officially used as references, according to the guidelines provided by the European Commission for the period under analysis.

In Fig. 1 the phases of the proposed methodology are shown.

It could be useful to highlight that the proposed methodology doesn't have limits of application related to the EU territorial context, because the sole required conditions of its adoption are: i) the use of the CBA requirement for the economic evaluation of the investment decisions; ii) there are known SDR values provided by official sources and iii) there is a sufficient number of States under analysis that allow to identify the features of the so-called "benchmark State".

4.1 Phase 1. Analysis of the Social, Environmental and Economic Issues Related to the CBA Field for Identifying the Sample of *n* Indicators that are Able to Represent Each Issue for the States

The analysis of the social, environmental and economic issues that characterize the economic evaluation of the CBA applications is important to identify the specific set of indicators that can represent the aspects for each of the State. This initial phase, in fact, is aimed at carefully defining the most influential socio-economic and environmental parameters that affect the CBA economic evaluation, according to the national and international literature on the matter and also by considering the main official guidelines. Therefore, in order to take into account the conditions of the States on the social, environmental and economic points of view, the identification of a unique set of *n* indicators

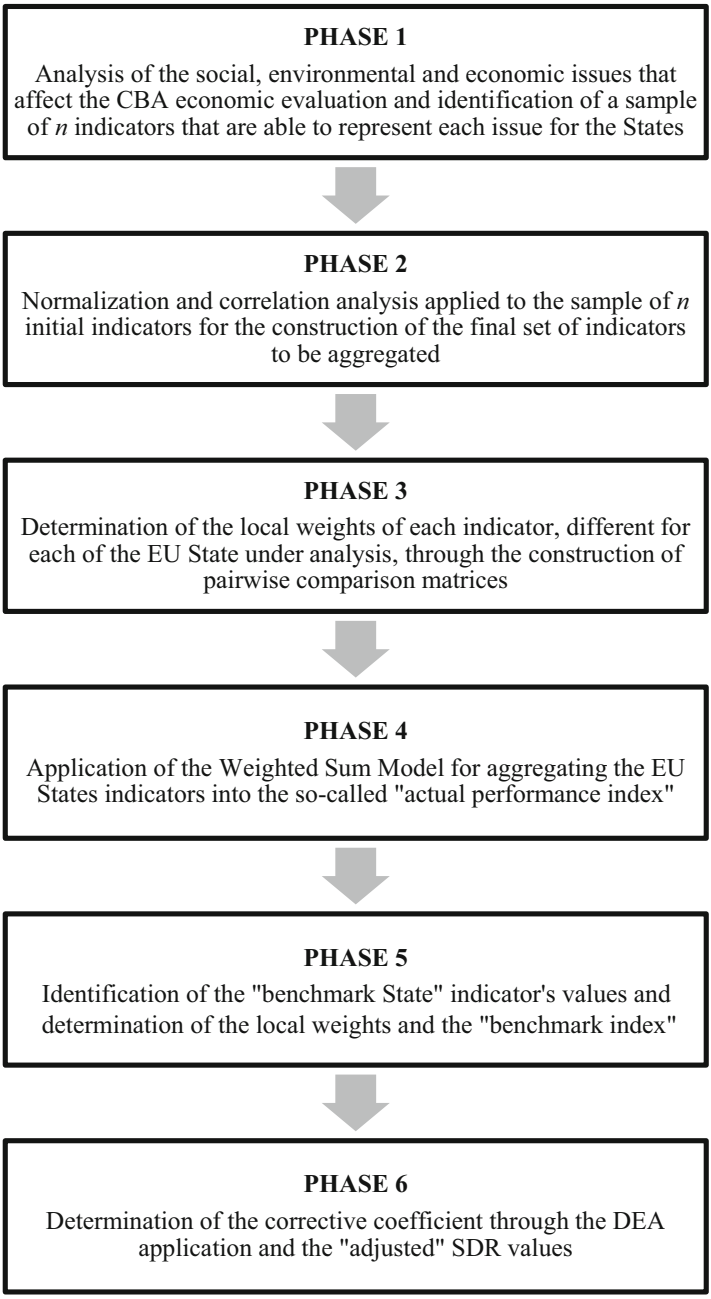

Fig. 1. Phases of the proposed methodology

for all the States is carried out. The indicators must be characterized by availability,

scientific robustness, readability and coherence with the related aspect that are intended to represent.

4.2 Phase 2. Normalization and Correlation Analysis Applied to the Sample of *n* Initial Indicators for the Construction of the Final Set of Indicators to be Aggregated

After having identified a sample of indicators that, in an adequate way and for all the EU States, allow to represent the social, environmental and economic conditions of each of them at the time of the reference year, in the case for which different unit of measure can be observed, the normalization is necessary to facilitate the comparison and the aggregation of the indicators. The normalization can be achieved through the use of different existent techniques such as the min-max technique or the z-score ones. It is a decision that can be affected by the purposes of highlighting the main critical values of the indicators or, differently, provide an average framework of them. Subsequently, the correlation analysis is aimed at removing the high-correlated indicators for the sample initially identified by carrying out a Pearson's matrix of order *n*, where *n* is equal to the number of the indicators.

At the end of this phase, the final sample of indicators from which the corrective coefficient of the SDR values officially used as references will be determined, is constituted.

4.3 Phase 3. Determination of the Local Weights of Each Indicator, Different for Each of the EU State Under Analysis, Through the Construction of Pairwise Comparison Matrices

In this phase the AHP is utilized for determining the relative importance that each indicator of the final sample has for each of the different EU State. It is important to note that the differentiation of the importance that each indicator can play for the States is related to the real role and relevance covered by each sector within the specific State: the environmental issues may be very important for some States, but for others they may be less important and the social or economic issues may prevail. For this reason, for each EU State a pairwise comparison matrix of order *n* is realized. In this case, a panel of experts that comprises professional and specialist profiles with a knowledge in the CBA economic evaluation field is involved. Pairwise comparisons tell how much more important one indicator is compared to the others by formulating the following question "how important is the indicator x to the indicator y?" to each member of the panel of experts. The collection of all the verbal judgments provides for the analysis of the transformed values through the use of the Saaty scale [29] and the subjectivity level analysis is given by the calculation of the Consistency Ratio (CR), as the ratio of the Consistency Index and the Random Index as shown in Eq. (1).

$$\text{Consistency Ratio} = \frac{Consistency\ Index}{Random\ Index} = \frac{[(\lambda_{max} - n)/(n-1)]}{Random\ Index} \tag{1}$$

where λ_{max} is the maximum eigenvalue of the matrix, *n* is the order of all the pairwise comparison matrices and the Random Index is chosen from the pre-established table of

values, according to the order *n* of all of them. If the Consistency Ratio is minor than 0.1, the consistency of the local weight's determination process is verified.

4.4 Phase 4. Application of the Weighted Sum Model for Aggregating the Indicators into the So-Called "Actual Performance Index"

A Weighted Sum Model (WSM) is applied in this phase for two reasons: the first one is the aggregation of the *n* social, environmental and economic indicators into a synthetic index, specifically called "actual performance index". The second one, is the verification of the presence of critical issues by comparing the performances index. This, in fact, represents the specific conditions of the States at the time of the evaluation and the reference years of the indicators.

4.5 Phase 5. Identification of the "Benchmark State" Indicator's Values and Determination of the Local Weights and the "Benchmark Index"

Once having analyzed the existent conditions of all the considered EU States, in Phase 5) the profile of the "benchmark State" is defined according to the optimal values that the *n* processed indicators could assume among the ones already detected for the States. In this way, the elementary indicators of the "benchmark State" have the maximum values if the indicator has a positive influence on the overall performance, otherwise minimum values are attributed to the "benchmark State" if elevated values of the indicators raise the criticalities of the related issues (e.g. occupational rate for the social sphere, public debt for the economic one and pollution level for the environmental one). The ranges of the collected indicators' values will guide the features' profile of the "benchmark State", in order to have the best possible combinations of the socio-economic and environmental conditions, ideally achievable by the EU States. The adoption of this "ideal" State is useful for comparing the obtained performances of the previous phase 4) and identify the State for which effective efforts are more or less required for an equitable growth. The determination of the local weights of the *n* indicators of the benchmark State is carried out in the same way as the other EU States, therefore by applying the AHP multi-criteria technique and with the support of the same panel of experts used in the Phase 3). A pairwise comparison matrix of order *n* is realized, and the CR of the judgments is verified with the Eq. (1) application. Subsequently, for determining the so-called "benchmark index" that refers to the "benchmark State" as the optimal target for all the EU States, a WSM is used, as in the Phase 4).

4.6 Phase 6. Determination of the Corrective Coefficient Through the DEA Application and the "Adjusted" SDR Values

The final step of the proposed logical-perequative methodology consists with the application of the DEA, in particular the Benefit of Doubt (BoD) approach that determines the corrective coefficients as the ratio between the i-th "actual performance index" associated to the European State - obtained in the Phase 4) – and the "benchmark one" or

the "benchmark State"- obtained in the Phase 5) – by applying the following Eq. (2):

$$\text{Corrective coefficient} = \frac{performance\ index\ of\ the\ i-th\ European\ State}{target\ performance\ of\ the\ benchmark\ State} = \frac{CI_i}{CI_{bs}} \quad (2)$$

After having obtained, by using the Eq. (2), the real corrective coefficients pertaining to each of the EU States under analysis, the "adjusted" SDR values are calculated as the product between the obtained corrective coefficient of the EU State and the SDR value officially used as reference in the period of analysis. In this way, an abacus where for each considered EU State corresponds the "official" SDR, the obtained corrective coefficient and the "adjusted" SDR can be provided.

5 Conclusions

The social and territorial cohesion goals - at different scales - are strongly connected to the scope of a homogeneous and equitable growth of nations, and they intrinsically include the issue of the sustainable development of countries [30–35]. For guaranteeing uniform economic, environmental and social growth, the need to define effective tool for supporting efficient territorial governance, consistent with the Sustainable Development Goals of the 2030 Agenda [1], is often central. Within the economic evaluations of the urban projects carried out through the adoption of the CBA, the SDR constitutes a fundamental parameter that reflects the social point of view about the preference level of future costs and benefits compared to the present ones and often is linked to the political targets set by each local and central government. The appropriate use of the SDR affects the results of the analysis, because a low SDR value may cause undesirable projects to be approved and public organizations to allocate a larger share of tax revenues to the long-term intergenerational projects, whereas a high SDR value can discriminate future generations and it may result in a possible rejection of desirable projects. For these reasons, the SDR to be used in the CBA for the decision-making process for selecting investments capable of ensuring sustainable and equitable development of all the States plays a fundamental role, in determining an adequate assessment of the aspects on which fair and inclusive growth depends.

This research is part of the framework outlined. The aim was to provide an innovative logical-perequative methodology for the assessment of the "adjusted" SDR according to the influencing socio-economic and environmental specificities on the sustainable development of each EU State. In specific terms, the proposed methodology differs from the generally used SRTP approach for the inclusion of the environmental issues, associated with the socio-economic aspects that characterize each nation. These parameters, in fact, are fundamental in the economic analysis of the projects, due to their capacity to affect the results, and therefore the investment decisions, in the CBA process.

The main advantages of the methodology regard:

i. the flexibility to be used in different territorial contexts;
ii. the simple structure and computational operative procedure;
iii. the possibility to take into account both qualitative and quantitative sustainability aspects;

iv. the ability to obtain a comprehensive framework for the current equitable growth of all the States.

However, it is necessary to highlight that, among the methodology limits, there is the cogence to detect valid, update and robust indicators for all the EU States that, at the same time, are consistent with the assessed sustainability's issues. For these reason, official sources or guidelines are required to be used.

Future developments of this research may concern the application to a real case study that regards the 27 EU States in order to test and verify the validity of the proposed logical-perequative methodology and to grasp the effects that the different environmental, social and economic conditions generate on the corrective coefficient and, therefore, on the reference SDR values of each State.

Note

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