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ARTÍCULOS

Thoughts on the cost-benefit and cost-effectiveness analysis in the Climate Change Laws of Chile and Colombia

Reflexiones sobre el análisis costo-beneficio y el análisis costo-efectividad en las normas de cambio climático en Chile y Colombia

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ABSTRACT The cost-benefit analysis is a process that allows the establishment of the relationship between the costs of an activity and the benefits it generates, that is, it allows us to determine whether it is economically efficient. However, its instrumental scope is inadequate when referring to the social effectiveness related to achieving a particular objective, which can be abstracted through the limitations that this type of analysis denotes to represent all the —potential— avoided damages, for example, by mitigating the negative effects of climate change. This aspect transcends if we consider that a more effective climate change mitigation measure in turn impacts economic costs, and thus affects social efficiency in the long run. In this order of ideas and from a legal-economic approach, in the light of Colombian and Chilean regulations, this contribution aims to reflect on the need to integrate a cost-benefit analysis and a cost-effectiveness analysis in the legal and multidisciplinary study of the fight against climate change, based on their incorporation into the legal framework that establishes the guidelines for the management of Climate Change in Colombia (Law 1931 of 2018, and Law 2169 of 2021) and the Framework Law on Climate Change in Chile (Law 21455 of 2022).

KEYWORDS Cost-benefit analysis, cost-effectiveness analysis, climate change, social efficiency, sustainability.

RESUMEN El análisis costo-beneficio es un proceso que permite establecer la relación que existe entre los costos de una actividad y los beneficios que esta genera, es decir, permite determinar si esta es económicamente eficiente. Sin embargo, su alcance instrumental resulta poco adecuado cuando se alude a la efectividad social relacionada con alcanzar un objetivo, lo que puede abstraerse a través de las limitaciones que

denota este tipo de análisis para representar todos los —potenciales— daños evitados, por ejemplo, al mitigar efectos negativos del cambio climático. Este aspecto trasciende si consideramos que, una medida de mitigación del cambio climático más efectiva, a su vez impacta en los costos económicos y, por ende, afecta la eficiencia social a largo plazo. En este orden de ideas y desde una aproximación jurídico-económica, a la luz de la normativa colombiana y chilena, este aporte tiene por objetivo reflexionar sobre la necesidad de integración del análisis costo-beneficio y del análisis costo-efectividad en el análisis jurídico y multidisciplinar de la lucha contra el cambio climático, a partir de su incorporación en el marco legal que establece las directrices para la gestión del cambio climático de Colombia (Ley 1.931 de 2018 y Ley 2.169 de 2021) y la Ley Marco de Cambio Climático de Chile (Ley 21.455 de 2022).

PALABRAS CLAVE Análisis costo-beneficio, análisis costo-efectividad, cambio climático, eficiencia social, sostenibilidad.

Introduction

Because of the development and generation of new knowledge to address public problems, the advancement of legislation and economic and social regulation with a tinge of modernity and humanism has posed a multi, inter, and trans-disciplinary challenge that has certainly transcended the academy and has ended up impacting ordinary citizens. These challenges have led to the emergence —or have been addressed through the creation— of research programs which, in turn, have led to intellectual traditions or movements that have also popularized the use of diverse methodologies and applied tools.

In the first part, this article covers a theoretical-conceptual approach to the cost-benefit analysis (CBA) and the cost-effectiveness analysis (CEA) in terms of its content and scope relevant, not only for the private sector or the State and collective action but also for a better understanding of the work of those who, within an open and democratic society, must act as social innovators or proactive agents of change.

In the second part, after differentiating and explaining the theoretical-conceptual implications of both concepts, we will review some of the pillar regulations to address climate change as a relevant issue for Colombia and Chile. It is from this context that we will briefly review some of these norms that establish the guidelines for the management of this issue in Colombia (Law 1931 of 2018 and Law 2169 of 2021) and in Chile (Law 21455 of 2022). These norms coincide in considering and/or projecting the transcendence of the CBA as a "principle", hence this article aims to reflect on the need to optimize coordination when applying the CBA and CEA in the legal implementation of the fight against climate change.

In this way, this article will argue that climate change has imposed itself on the international and national agenda in recent decades from the scientific information generated by the Intergovernmental Panel on Climate Change, which has confirmed that global warming arises from the burning of fossil fuels to generate energy, the engine of economic activity. As a result of this, greenhouse gases (GHG) are in the atmosphere which visibly impacts natural and human systems. The climate crisis is a challenge for all areas of science and it is at this intersection between law and economics that we will focus this article.

Likewise, the continued presence of climate change in the world's agenda has determined an international regime from which commitments are derived for States that, from different perspectives, have been generating measures, strategies, and framework laws on this issue. This legal instrument usually brings together national responses to these commitments and determines the tools necessary to implement a collective action strategy to address major public problems.

Therefore, the relevance of the proposed topic transcends the legality of the situation, insofar as climate change has been defined as a shift in climate statistics over several decades, with an increase in temperature being the first direct impact in addition to greenhouse gases in the atmosphere. However, this is not the only change, but also there is precipitation and a rising of the sea level, among the most obvious ones (Dessler, 2016). In other words, our Latin American region has maintained a participation in the international regime, adhering to the three conventional instruments that comprise it: the Framework Convention on Climate Change, the Kyoto Protocol, and the current Paris Agreement. From a domestic perspective, it has issued regulations that have been consolidating domestic policy to address the climate crisis.

Finally, the article begins by reviewing the concepts of "cost-benefit" and "cost-effectiveness", as well as the methodologies that have been established because of these concepts. It continues with a reflection on the cost-effectiveness analysis and its relevance for public problem-solving, followed by the presentation of some further considerations of this type of analysis. This contribution continues by exploring the intersection between economics and climate change and sharing an incisive legal analysis of the Colombian case and the Chilean case.

On cost-benefit and cost-effectiveness

The cost-benefit and cost-effectiveness methodologies

According to Arguello and others (2022), the cost-benefit methodology expressed through the cost-benefit analysis constitutes an extra-legal development that focuses on determining that the costs and benefits of projects contained in a plan, program, or (regulatory) policy of the State can be: a) identified, b) measured and c) valued

(Zárate, 2010: 95).[1] In turn, the cost-efficiency methodology, in addition to being a contribution whose origin lies in engineering and sociology, it can also be characterized as a methodological approach that determines that costs can be: a) identified, b) measured and c) valued. Although the benefits can be perceived, and sometimes even measured, they cannot —necessarily— be considered at the time of issuing the respective resolution that implements a plan, program, or (regulatory) policy of the State (Rivera and Mendoza, 2009: 8).[2]

Further ideas on cost-effectiveness methodology

On the other hand, the cost-effectiveness methodology compares the CUEs ("costs per unit of effect") of a particular project, program, or policy option with the CUEAs ("costs per unit of effect of alternatives"). It is guided by the premise that comparing costs and effectiveness will allow for: i) ranking alternatives; and/or ii) comparing them with other regulatory intervention options, policies, or even projects, plans, and/or programs established to address a public problem (Noveck, 2022: 31). It is necessary to underline that this methodology facilitates measurement and comparison in terms of (social) cost-effectiveness and thus allows for ranking regulatory interventions that —apparently— produce the same effect (Ministerio de Desarrollo y Planificación, 2006: 2).[3]

Furthermore, in using this type of methodological approach, it is argued that an indicator is "reliable" if it yields similar results when applied repeatedly to the same individuals or population groups. This is even more important given that most measures of effectiveness do not have completely reliable indicators. In this context, it is also intended that once expressed through the cost-effectiveness analysis, the cost-effectiveness methodology incorporates a reasonable range in its application, as international experience has shown that an indicator is valid if it closely matches the

1. The concept of valuation understood as a set of mechanisms to quantify (ex-ante and/or ex-post) is directly linked to public and private efforts for the establishment and practical implementation of rules of the game (order) on the environment. Let us remember that the various environmental impacts are always a latent possibility and that they, in turn, derive from a plan, program, or (regulatory) policy of the State that permits or prohibits them. Therefore, it is necessary to "quantify on people, ecosystems, plants, animals and inert materials" (MAVDS-CEDE, s.f.).

2. In Chile, the former Ministerio de Desarrollo y Planificación (2006: 1) argued that the "criterion of least cost of implementation" should prevail. Moreover, article 11 of Regulation number 975, for example, determined that the cost-efficiency approach should be used by the National Investment System to select publicly funded initiatives proposed to overcome or mitigate the gaps contained in a development plan.

3. Following Noveck (2022) and from a mainstream perspective, an activity, plan, program, or (regulatory) policy is defined as socially profitable when it generates greater benefits to society at large or satisfies —achieves— the general interest irrespective of its economic and/or financial profitability.

underlying impact it is trying to capture (Rivera and Mendoza, 2009: 6-7; Zárate, 2010: 96).[4]

In addition, when the analysis uses intermediate results that have limited validity, it is suggested that the analysis —and justification— of the selected indicator is based on empirical evidence from secondary sources (Ministerio de Desarrollo Social y Familia, 2022).

Theoretical considerations on the cost-effectiveness analysis

Given the above, it can be established that CEA allows a plan, program, (regulatory) policy, or even concrete activities (regulatory measures) to be evaluated and ranked according to their costs and effectiveness in achieving a specific social objective (for example, reduction of environmental impact when a river is polluted). Therefore, the combination of effectiveness and costs makes it possible to determine: which plan, program, (regulatory) policy, or even concrete activities (regulatory measures) generates a certain level of effectiveness at minimum cost; and which plan, program, (regulatory) policy, or even concrete activities (regulatory measures) provides the highest level of effectiveness for a given total cost.

Unlike the CBA, CEA expresses benefits in physical impacts (reduction of river pollution) and not *per se*, in monetary terms. To evaluate the effectiveness of a plan, program, or (regulatory) policy, or even concrete activities (regulatory measures), the objective of these must be defined beforehand. Likewise, the quantification of their success can be expressed through the reduction of their effect. Thus, the impacts on the predetermined objective need to be evaluated in physical terms, for example, quantity. Subsequently, the estimated total impact of a plan, program, (regulatory) policy, or even concrete activities (regulatory measures) are compared with the cost of implementation (Rivera and Mendoza, 2009: 7).[5]

Based on these previous considerations, it can be affirmed that the cost-effectiveness methodology and CEA constitute an opportunity to address public problems from an alternative approach, expressing greater breadth and flexibility at the methodological and (applied) analysis level than CEA if considerations built from the general interest are introduced. Furthermore, the type of methodology and analysis facilitate the work not only of social regulation as a central component of the formal institutional framework but also of the social innovator or change agent that seeks

4. Similarly, international experience has identified that when the CEA uses intermediate results that have limited validity, the indicators selected should be based on empirical evidence from secondary sources (Rivera and Mendoza, 2009: 6).

5. Total impacts should be expressed per unit of implementation cost, which makes it easier to compare benefits that are not expressed in monetary terms with monetary costs (Rivera and Mendoza, 2009: 6).

to address the resolution of public problems such as those addressed by the Climate Change Laws in Chile (Law 21.455 of 2022) and Colombia (Law 1.932 of 2018 and the Climate Action Bill).

Finally, the inclusion as "principles" of the cost-effectiveness methodology and CEA has also implied a positive evolution for both States. If we look at the review of mitigation and adaptation measures in force for both Chile and Colombia carried out by ECLAC in 2015, at that time we have few measures taken without the analyses we are studying (Sánchez and Reyes, 2015: 45-46).

Further ideas on cost-effectiveness analysis

The above is verified and consolidated if we consider that the resolution of public problems derived from the environmental impact, as Noveck (2022: 36-37) indicates, requires an approach, a methodology, and an applied (analytical) tool that fits and makes its assessment feasible to facilitate a complex process such as: the creation of projects, plans and/or programs that, in turn, involve identification and/or implementation by the demands of defining a public problem; analyzing data; designing people-centered proposals and incorporating a multidimensional vision; embrace collective intelligence; not neglecting the (expeditious) review of evidence; facilitate formalizing alliances and network collaboration; and finally, adjust to the concrete need to "measure" and/or "estimate" what does not work (MAVDS-CEDE, s.f.).

Furthermore, the cost-effectiveness analysis is a tool that allows a global characterization of what needs to be analyzed.[6] In other words, it is a key concept for a broader understanding of the relevance of other macro-concepts for the fullest possible comprehension of the social, legal, economic, and political significance of public environmental issues. An example is the concept of "total economic value", which is a central concept "transited" by the cost-effectiveness analysis, not restricted to the monetary but on the contrary:

> Focuses on the fact that any type of natural and/or environmental resource is characterized by values other than direct use value. If only use values are estimated, the true environmental benefits and/or costs are underestimated, and this would

6. As an example of the inclusion of this analytical perspective during the process of approving the framework law, we have the Long-Term Climate Strategy 2050. This instrument was approved by the Council of Ministers for Sustainability at its session on 21 October 2021, then approved by the President of the Republic and subsequently submitted during COP26 to the United Nations Framework Convention on Climate Change. It states that implementing the package of mitigation measures committed by Chile to achieve carbon neutrality by 2050 is not only cost-effective and cost-effective from the point of view of the direct net benefits already mentioned; it is also necessary to consider i) the benefit of the reduction of damages due to climate change, or social costs, as well as ii) the health benefits of the reduction of local pollutants associated with the reduction of greenhouse gas emissions.

> generate a large bias in environmental cost-benefit analysis studies of projects. The inclusion of these values would avoid underestimating the true value of the environment-resource system. This avoids inefficient patterns of resource use due to undervaluation problems (Geomática, 2019: 7).

Cost-benefit: Instrument for public policy and regional coordination for facing climate change in Latin America

Based on the above, it is justified that the cost-benefit analysis is timely and relevant to estimate, for example, the level of changes required in a decarbonization scenario in Colombia and Chile by 2050 (Arguello and others, 2022). It is through this analysis that the costs and benefits associated with sectors of the economy such as agriculture, mining-energy, transportation, and waste management, among others, can be evaluated or reviewed (MAVDS-CEDE, s.f.: 11; Benavides and others, 2021: 71).

Therefore, the cost-benefit analysis evaluates feasible interventions that contribute in a valuable way to meeting the demand for services in a trend scenario, at the same time as reducing greenhouse gas emissions (Arguello and others, 2022). Moreover, the cost-benefit analysis of the interventions also allows us to include aspects related to investments in new technologies, and of operation and maintenance for the alternatives that may be proposed that must also be evaluated (Benavides and others, 2021: 71).

Likewise, the monetary quantification of benefits allows us to include an estimate, among other variables, related to health benefits, greater efficiency in processes, reduction of negative impacts on ecosystems, and the generation of new businesses (Zárate, 2010: 93).

An application of the above is contained in the Final Report of CODS 2022 (Centro de los Objetivos de Desarrollo Sostenible para América Latina). Specifically from this report prepared for Colombia, the results show that it would be possible to achieve emissions which total net emissions were only 9 million tons of CO_2e in 2050, and that the sum of the economic costs and benefits at the national level during that period would be favorable, varying in magnitude between 50% and 220% of Gross Domestic Product (GDP) depending on the discount rate used.

Finally, as it has been shown by the report, another of the strengths of the cost-benefit analysis as a methodology lies in the fact that it can be *institutionally transplanted*.[7] Therefore, the cost-benefit analysis proved to be very useful if the objecti-

7. According to Jong, Lalenis, and Mamadouh (2002) and Mendez and Sumar (2020), institutionally transplanted refers to the action of institutional transplantation or to a conscious attempt to alter existing institutions (understood as a set of rules, processes, instruments, or other mechanisms to manage *collective action* and replace or complement it with new institutions).

ve (future) consists of developing a regional roadmap for Latin American countries (including Chile) and establishing common policies to address climate change. That said, the cost-benefit analysis constitutes a powerful proactive tool if we understand it in terms of social needs and solutions to public issues (Méndez and Sumar, 2020).

The intersection between economics and climate change

In general, economic ideas are used to address climate protection by examining costs and benefits. Such application can occur in the international regime to avoid individual states' actions and ensure their participation in the regime itself, and those that arise at the national level in framework laws.

Climate change obligates States to know how to act in the face of this crisis, which holds many possibilities (Ghaleigh, 2016). Among the complexities of the responses, we find the one that refers to the internalization of externalities that require State intervention and that focuses on the problem of social costs. The need to deepen the intersection between the environmental and economic dimension that considers costs and their benefits, along with environmental effectiveness with economic efficiency, is a huge regulatory challenge.

According to Condon and Sinha (2013), while adaptation seeks to reduce the negative impacts of climate change by increasing the ability of humans or ecosystems to cope with the changes, mitigation seeks to reduce the magnitude of climate change by decreasing gas emissions. The inter-relationship of the two measures is remarkable, but it is to be expected since the cost and benefit of adaptation are local while mitigation reaches global benefits.

It should be noted that mitigation measures have been more prominent in the international regime. For example, at the heart of the Kyoto Protocol developed countries made quantifiable commitments to limit GHG emissions, which entailed a long process from 1997 to 2005,[8] making this Protocol the least popular of the entire system. Nevertheless, mitigation is, for some, the centerpiece of long-term climate change policy (Dessler, 2016). The Paris Agreement, in a different way, balances the discussion and promotes, in importance, the adoption of both mitigation and adaptation measures (Lucas Garin, 2017).[9]

8. Along with these commitments, States also agreed in the Kyoto Protocol to economic instruments, such as the flexible mechanisms: the Clean Development Mechanism, Joint Implementation, and Emissions Trading. On the latter, Holzer (2014) notes that the multilateral emissions trading system was established under the Kyoto Protocol. It was shaped by the emission reduction targets adopted by developed countries and countries in transition (Annex B countries) and the emissions trading provision in article 17 that guides emissions trading among Annex B countries.

9. The Paris Agreement modifies the legal pillar, and the main commitment States submit to the Nationally Determined Contributions every five years which is the same for developed and developing countries.

Another point that could help distinguish these measures has to do with the fact that mitigation has long-term benefits, as opposed to adaptation which benefits are short and medium-term (Condon and Sinha, 2013). Moreover, states are not necessarily on their own, and we believe there may be scope for regional and international cooperation to develop mechanisms and strategies that address these intersections, including free trade agreements and other spaces where international trade has built bridges. No one doubts that the economic costs of climate change are very large which is why there must also be a connection with the investment regime.

Cases of Colombia and Chile: A brief description

Colombia

Law 1.931 of 2018 is concerned with establishing guidelines for climate change management. Following the same approach as the mainstream academia and experts in Colombia (MAVDS-CEDE, s.f.: 5), it determines a series of guiding principles for its implementation and regulation, including two principles of our interest: cost-benefit and cost-effectiveness (article 2). On the first, it is stated that:

> Priority will be given to the implementation of climate change adaptation options that bring the greatest benefit in terms of reduced impacts for the population at the lowest cost or effort invested, and with the greatest social, economic, or environmental benefits generated.

Regarding the cost-effectiveness principle**,** the standard states that:

> Priority will be given to the implementation of greenhouse gas mitigation options with lower costs per ton of greenhouse gasses reduced, avoided, or captured and higher reduction or sequestration potential, and with higher social, economic, or environmental benefits generated.

In article 3, devoted to definitions, point 10 mentions Economic Instruments and broadens the scope, as it is stated that:

> Economic instruments are considered to be the mechanisms that all levels of government design, develop and apply, within the scope of their competences, with the purpose that legal or natural persons, public or private, show changes in behavior and assume the benefits and costs related to the mitigation of greenhouse gasses and adaptation to climate change, thus contributing to the achievement of the purpose of this Law.

The normative distinction is that in the decision-making process for adaptation measures, cost-benefit analysis is applied; and for mitigation measures, the principle should be cost-effectiveness. The distinctions between the measures and how they

became more and more relevant within the international regime itself have been discussed above. This distinction in the Colombian standard probably reflected these differences in 2018, but in the analysis itself, the items to be considered are the same for mitigation and adaptation measures, that is, the social, economic, or environmental benefits generated must be measured.

The standard took mitigation and adaptation measures as the quintessential instruments of climate policy, hence the need to examine the applicability of cost-benefit analysis as a potential way to provide a more comprehensive response. This seems to have been the Colombian option (MAVDS-CEDE, s.f.: 6-11).

As an example of these analyses, we bring up the work entitled "Cost-benefit analysis of options for achieving zero net emissions in Colombia", which presents a scenario of sectoral transformations that would allow Colombia to achieve carbon neutrality by 2050 and quantifies the associated costs and economic benefits of implementing these transformations.[10]

Chile

Still recently approved, the Framework Law on Climate Change Number 21455 of June 2022, brings together the measures that were taken by the public scene to shape Chile's response to the climate phenomenon, in a comprehensive manner. Like all framework laws on this issue, article 2 defines the principles applicable to policies, plans, programs, standards, actions, and other instruments that are issued or implemented under this law. Moreover, this law also refers to the following principles: scientific, cost-effectiveness, ecosystem approach, equity and climate justice, no regression, participation citizenship, precautionary, preventive, progress, territoriality, climate urgency, transparency, transversality, coherence, and flexibility.[11] In particular, this law states:

10. This article on Colombia states: "The cost-benefit analysis was conducted using three different levels of discount rate, and in all cases, carbon neutrality is achieved with net economic benefits (outweighing the associated costs)" (Arguello and others, 2022b).

11. This set of actions and principles was built in line with the idea that Chile has to face climate change as a State Policy and maintain a proactive position on the international climate change agenda and negotiations, with a sustained increase in its importance in public policy and in the ambition of the commitments that the country has acquired. This is why Chile presented its Largo Plazo Climate Strategy at COP26 to consolidate the State's vision to face climate change and comply with what was established in article 4 (19) of the Paris Agreement that was signed, that the parties must formulate their strategies and take into account the temperature objective established in this regard "taking into consideration their common but differentiated responsibilities and their respective capabilities, in light of different national circumstances" (Ministerio del Medio Ambiente, 2021: 14).

> b) Cost-effectiveness: climate change management will prioritize those measures that, being effective for mitigation and adaptation, are those that represent the lowest economic, environmental, and social costs, considering the indirect costs of inaction for adaptation.

The previous thoughts and principles incorporated by Law 21.455 were directed to sustain a national objective for the country: Chile officially bid to be carbon neutral by 2050 (Benavides and others, 2021: 9; Ministerio del Medio Ambiente, 2021: 14-15). At the latest, the achievements will be reviewed every five years to determine whether to get close to institutional mid-targets. As has been stated by Benavides and others:

> This target is aligned with what scientists have determined needs to be achieved globally to meet the most ambitious goal of the Paris Agreement: limit temperature increase to as close to 1.5°C as possible (IPCC, 2018). In addition, international evidence suggests that moving towards net-zero emissions can bring economic and social benefits, such as increasing economic growth and job creation (2021: 18).

Then, being carbon neutral will mean deepening the decarbonization process and stopping burning fossil fuels in all activities so that winter greenhouse gas emissions —responsible for climate change— are equal to less than the absorptions of these gases by nature.[12] Accordingly, the final target for Chile is to be resilient to the climate and to decide how to respond to the effects of climate change in its territories (Benavides and others, 2021: 18).

Conclusions

Vis-à-vis the cost-benefit applied in Chile and Colombia has been argued in the evaluation of projects, governed by cost-benefit analysis, and there is a weak commensurability, preventing the measurement of the proportion of the different impacts since it only considers monetary valuation and no other valuation systems, and a strong comparability of values. That is to say, it considers only one form of valuation so that different alternatives can be easily compared within the evaluation of projects (Palma and Brain, 2019).

Based on the shared exploration, we consider that cost-effectiveness analysis facilitates a holistic vision for decision-making by constituting a tool that allows a global characterization of what needs to be analyzed in terms of public problems. Therefore,

12. According to Benavides and others (2021: 9): "This goal is set out in its Nationally Determined Contribution (NDC) which the country submitted to the international community under the Paris Agreement (Government of Chile, 2020). The target is aligned with the international efforts required to halt the global average temperature increase of between 1.5ºC and 2ºC".

CEA is a key concept to explore the incidence of other matrix concepts that have been forged around the analysis of public environmental issues.

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