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# To What Extent is Cost-Benefit Analysis Useful in Evaluating Climate Change Mitigation Policies?

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**Abstract**

Climate Change (CC) is evident due to rising sea levels, melting glaciers, and altered rainfall patterns. Increased global warming from infrared radiation and greenhouse gas emissions, with average temperatures forecasted to rise by 0.2°C every ten years, is negatively impacting the economy and the health of all living creatures. CC mitigation policies face unprecedented economic and political challenges due to their complexity and intricacy. Cost-Benefit Analysis (CBA) has been used to analyse the impact of these policies, but it has limitations such as inability to accurately evaluate benefits and costs to economy, society, and environment. Despite these limitations, CBA is often used to communicate benefits to decision-makers, determine the value of public investments, and create economic arguments for risk reduction.

**Keywords:** Cost benefit analysis, Climate, Climate change, Mitigation policies.

## 1 | Introduction

The increasing sea levels, melting glaciers, altered rainfall patterns, and a generally warmer world, lead to irrefutable evidence of Climate Change (CC) [1]–[3]. This is as a result of the increased level of global warming caused by infrared radiation, which is absorbed and reemitted by greenhouse gases [4]. Additionally, the average temperature is forecasted to grow by 0.2°C every ten years at the current rate of Greenhouse Gas (GHG) emissions, reaching 2°C by 2050, above unindustrialized periods [5] and around 66MT of $CO_2$ evaporate into the atmosphere yearlydue to human activities, caused by the burning of fossil fuels [2], [6], [7].

Due to this, global warming is having a significant negative impact on both the economy and the health of all living creatures [8], [9]. Hence, CC is a major challenge facing the world today. Its impact has been felt across different sectors of the economy, from agriculture to transportation and from energy to infrastructure [10].

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CC puts years of development work to fight poverty in peril [4]. Although everyone is impacted by CC, the poor and developing countries are the most severely affected [11]. Due to their dependence on environmental resources and inability to adapt to CC and instability, they seem to be more vulnerable [9], [12], [13].

Based on this, restoration and preservation activities will help communities and companies that depend on healthy ecosystems. To achieve this, the response to CC requires a comprehensive approach, including mitigation and adaptation strategies and policies [14]. However, the implementation of CC mitigation policies often involves significant costs that need to be carefully weighed against the benefits [15]. Cost-Benefit Analysis (CBA) is an instrument that can be utilized to evaluate the effectiveness of CC mitigation policies [16]. This study explores the extent to which CBA is useful in evaluating CC mitigation policies.

## 1.1 | The Concept of CBA

CBA is a technique for figuring out a project's long-term financial worth. It is a complex mathematical calculation that aids in assigning a monetary value to individuals' acts [17], [18]. As a technique and decision-making tool that assists in locating alternatives (such as infrastructure investments or policy proposals) for the efficient distribution of scarce financial resources, CBA has been identified as being helpful for policymakersin evaluating CC mitigation policies [19]. The analysis is used to determine whether it measures advantages are greater than its disadvantages in comparison to other options (i.e., it enables comparison of alternative measures based on their cost-benefit ratios) [20], [21].

Furthermore, businesses and governments frequently use CBA to determine whether a particular investment or action is desirable. The aim of CBA is to determine whether a policy is worth implementing based on its net benefits (net benefits are calculated by subtracting the cost of a policy from its benefits) [22], [23]. CBA involves a number of steps. First, the costs of implementing the policy or project are estimated [24] . These costs may include capital, operational, and maintenance costs. Once the costs have been estimated, the benefits of the policy or project are also estimated [25]. These benefits may include economic benefits, social benefits, and environmental benefits.

The benefits are then quantified and valued in monetary terms, so that they can be compared directly with the costs. As soon as the costs and benefits are estimated and quantified, a Net Present Value (NPV) is calculated. This involves calculating the Present Value (PV) of the benefits and subtracting the same of the costs [26]. If calculated NPV is positive, then the benefits of the policy are greater than its costs, and it is considered to be economically efficient [27]. In summary, CBA uses NPV, Internal Rate of Return, Percentage point and cost-benefit ratio ascriterion to guide decision-making.

Implementation is advised for every project or adaptation strategy with an NPV greater than 0. The project is abandoned in the absence of a positive NPV [4]. As a result, CBA can be extremely useful to decision-makers in determining how to best allocate their limited economic resources [9] for the most significant strategy for mitigating CC impacts including how to schedule and prioritize mitigation investments [16].

## 1.2 | The Use of CBA in Evaluating Climate Change Mitigation Policies

CC mitigation policies involve measures aimed at bringing down GHG emissions to ameliorate the challenges of CC [15]. These policies include energy efficiency measures or standards, renewable energy development or subsidies, reduced fossil fuel subsidies, carbon capture and storage, carbon pricing and taxes [28], financial support for clean energy sources, and emissions trading schemes [11], [29]. The implementation of these policies often involves significant costs, such as investment costs, operating costs, and transaction costs. However, they also have potential benefits, such as reduced GHG emissions, improved air quality, and enhanced energy security [20].

Scholars, have further noted that CC mitigation policies are crucial in order to reduce the negative cost implication on global GDP from 5% to 1% if steps are taken to ensure the policies are implementable [16]. Hence, to evaluate the effectiveness of CC mitigation policies, it is necessary to consider their costs and benefits. The scholarly analysis comparing the advantages of curbing GHG with those of ignoring the consequences was a major source of inspiration for CBA on CC policies [30]. Hence, scholars have argued that it is crucial to examine the veracity of assertions that CBA can support policy advocacy and implementation.

Hence, historically, making wise policy decisions at the federal level has relied on CBA. If the intended program's costs outweigh its advantages, and vice versa, it is usually cancelled [29]. Since CBA can be used to compare the net benefits of different policies and identify the most cost-effective options [31], one of its main uses is that it provides a framework for CC policymakers to evaluate the effectiveness of different mitigation policy options and identify the most cost-effective strategies for reducing GHG emissions [32]. For example, policymakers can use CBA to compare the costs and benefits of investing in renewable energy versus investing in carbon capture and storage [33].

Another use of CBA is that it allows CC policymakers to consider the trade-offs between different policy objectives. For example, policies aimed at reducing GHG emissions may have negative effects on economic growth. CBA can help these policymakers identify the trade-offs between these objectives and develop policies that balance them [4], [27], [33], [35]. Finally, it can also provide an objective and transparent way of evaluating policies, which can help build public support for these policies. For example, conducting a CBA should also necessitate the examination of non-financial factors, such as the financial advantages of raising employee happiness, which would help motivate the public [5], [10], [36]. Although this may make analysing the policy more challenging, but it does force the analyst to consider factors that could be more challenging to quantify [37].

## 1.3 | Criticisms of the CBA in Evaluating Climate Change Mitigation Policies

Although CBA may be able to assist with efficient material allocation and that policies are implemented in a way that maximizes their benefits and ensures GHG emissions are reduced, its use in the evaluation of CC mitigation policies has however been subject to criticism due to its limitations [37]. Scholars have, however, stated the CBA can mislead decision-makers when it comes to determining climate mitigation policies, as wealthier nations face fewer risks and farmers in the developing world are most at danger, but the latter pay far less for considerably bigger advantages [29]. For example, in spite of the UK producing relatively few greenhouse gases due to the relocation of its industry to developing countries like China and India [38], evaluation of the country's mitigation program, the country may actually be consuming more carbon than it produces when accounting for the GHG in its imports. This unequivocally shows that the carbon mitigation strategy is not yielding the anticipated results on a macro level.

Furthermore, one of the main limitations is the difficulty of valuing the benefits of these policies. For example, it is difficult to monetarily value the benefits of reducing emissions [22]. These benefits include reduced risks of CC challenges such as flooding, drought, rising sea level leading to food insecurity [39]. The difficulty of valuing these benefits makes it challenging to accurately assess the net benefits of CC mitigation policies [40], [41].

Another limitation of CBA is that it may not capture the full range of benefits and costs of CC mitigation policies. For example, CBA may not capture the non-market benefits of these policies, such as the value of biodiversity and cultural heritage. These non-market benefits are difficult to value and may not be fully captured [42], [43]. Also, there is often significant uncertainty associated with the estimated costs and benefits of CC reduction policies [43]. For example, the difficultyin predicting how the economy will respond to a particular policy or how quickly new technologies will be developed [26].

Furthermore, there are several other criticisms of the use of CBA in evaluating CC mitigation policies, especially as it relates to GHG reductions. One criticism is that "to date, cost-effectiveness of GHG reduction options, i.e. $/t$CO_2$ avoided, appears to be the single-most important decision criterion for policy makers in designing reduction programmes [25]. Another is that CBA tends to focus on momentary economic costs and benefits instead ofdeep-rootedecological and social impacts of policies because of the concerns that a long-term analysis may create bias for the future generation [24]. This can result in policies that are economically efficient in the interim, but have enduring fatal effectson the environment and society [23].

Another criticism is that CBA tends to undervalue environmental and social benefits because they are often difficult to quantify in monetary terms. For example, it can be difficult to put a monetary value on the health benefits that result from reducing air pollution [21]. Most of these limitations and challenges are evident in various cases, particularly in the US, where numerous assessments of the CBA of policymaking related to the implementation of the Montreal Protocol have been conducted. Since the U.S. EPA's completion of the regulatory impact analysis on the preservation of stratospheric ozone in 1988, the organization has encountered various contentious matters. These include the presence of inadequate data, the extended period of the analysis, the nearly irreversible nature of ozone depletion, the evaluation of mortality and illness fluctuations, and the selection of a discount rate [2].

# 2 | Alternative Methods for Evaluating Climate Change Policies

Other scholars have stated that there are better alternatives, such as "risk-opportunity analysis," which evaluates a variety of potential advantages and disadvantages, and "cost-effectiveness analysis," which identifies policy measures that minimize costs and are consistent with global warming and its effects from a long time ago [38]. Cost-effectiveness analysis is an efficient way to lessen all of CBA's restrictions on CC mitigation policies [22]. Cost-effectiveness analysis is a method that compares a program's expenses to its main benefits or outcomes.

In contrast to CBA, cost-effectiveness analysis focuses more on identifying the least expensive routes to a more stable climate than on maintaining the economic benefits of emitting GHG. Based on this, it was recommended that starting with what policymakers' temperature policy goals they intend achieving and then modifying the resulting emissions and economic activities to meet those goals instead of attempting to predict an 'efficient' GHG level based on insufficient assumptions on future harms [39]. For example, a specific objective designed to reduce atmospheric warming to 1.5°Ccould serve as a foundation for a climate policy [28], on the other hand, have criticized this method, arguing that it overlooks the advantages of averting climate-related impairments, yet it concentrates mostly on achieving a specific climate objective determined by political considerations.

# 3 | Conclusion

In conclusion, unprecedented economic and political challenges are brought on by the analysis of CC mitigation policies. Due to its enormous size and the intricacy of the economic and cost-benefit interactions, many flaws in the fundamental precepts of these fieldswhich had previously only gotten cursory examinationhave become known. Over the years, CBA has served as the basis ofanalysinghow viable the impact of CC reduction policies because it illuminates the physical and economic cost of the policies in the form of abatement costs and provides a simplified result that is used by stakeholders in making decisions. However, this essay further notes that there are limitations to CBA, which include its inability to accurately evaluate the benefits and costs of a policy to economy, society and environment.

Furthermore, even minor changes to some variables can have a big impact and affect how the stakeholders decide to proceed. But despite these shortcomings, CBA is frequently used to communicate benefits to decision-makers as it is crucial to determining the value for money of public investments since policymakers are concerned about the impact on the GDP or other similar measures, and it can be used to create economic arguments in favour of investing in risk reduction rather than coping with the aftereffects of a potential tragedy.

Hence, it was required for this essay to reassess these normative principles in order to guide policymakers in constructing a CBA that accurately reflects the full complexity of the problems in climate mitigation policies. With tools like cost-effectiveness evaluations and risk-opportunity analyses, economists have created new frameworks for considering CC mitigation policies. These extra tools and analyses fill in the gaps left by CBA. Based on this, CBA should be used in conjunction with other techniques that take into consideration its limitations because of its potential advantages in assessing CC mitigation plans. Policymakers should consider the ethical implications and distributional impacts of prospective mitigation strategies in order to ensure social justice and equityth properties of concrete. The combined use of pozzolanic materials and polypropylene fibers in concrete is to achieve high strength and measure the economic efficiency of this work.

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## Data Availability

The data used in this study are available upon reasonable request from the corresponding author. Any supporting materials that are not publicly accessible can be shared with interested researchers for academic and research purposes.

## Conflicts of Interest

The authors declare that there are no conflicts of interest related to this study.

## Reference

[1] Adeniran, A. O., Ilugbami, F. M., & & Oyeniran, G. T. (2024). The effect of plastic waste deposits on soil ecosystem. *Annals of ecology and environmental science*, *6*(1), 23–31. https://doi.org/10.22259/2637-5338.0601003

[2] Shreve, C. M., & Kelman, I. (2014). Does mitigation save? Reviewing cost-benefit analyses of disaster risk reduction. *International journal of disaster risk reduction*, *10*, 213–235. https://doi.org/10.1016/j.ijdrr.2014.08.004

[3] Willetts, E., Guadagno, L., & Ikkala, N. (2010). *Addressing climate change: issues and solutions from around the world*. IUCN.

[4] Familusi, O. B., Omoyeni, O. D., Samchuks, O. M., & Adeniran, A. O. (2024). Effect of renewable energy on co2 emission in Sub Saharan Africa. *Systemic analytics*, *2*(2), 304–314. https://doi.org/10.31181/sa22202431

[5] Change, I. P. on C. (2019). *IPCC special report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems,' summary for policymakers.* https://www.ipcc.ch/srccl/

[6] Adeniran, A. O., Oyeniran, G. T., Adeniran, A. A., & Mosunmola, M. J. (2024). Digitization in logistics and its effect on sustainability in Nigeria. *Discovery*, *60*, e15d1420. https://www.researchgate.net/profile/Adedayo-Adeniran/publication/379839886_Digitization_in_logistics_and_its_effect_on_sustainability_in_Nigeria/links/661e61d6f7d3fc287465bda8/Digitization-in-logistics-and-its-effect-on-sustainability-in-Nigeria.pdf

[7] Sussman, F., Grambsch, A., Li, J., & Weaver, C. P. (2014). Introduction to a special issue entitled perspectives on implementing benefit-cost analysis in climate assessment. *Journal of benefit-cost analysis*, *5*(3), 333–346. https://doi.org/10.1515/jbca-2014-9000

[8] Adedeji, O., Reuben, O., & Olatoye, O. (2014). Global climate change. *Journal of geoscience and environment protection*, *2*(2), 114–122. https://doi.org/10.4236/gep.2014.22016

[9] Adeniran, A. O., Muraina, M. J., & Ngonadi, J. C. (2023). Energy consumption for transportation in sub-saharan Africa. In *Achieving net zero* (Vol. 20, pp. 203–231). Emerald Publishing Limited. DOI: https://doi.org/10.1108/S2043-052320230000020009

[10] Change, I. panel on climate. (2022). *Summary for policy makers in Climate change 2022: mitigation of climate change. contribution of working group iii to the sixth assessment report of the intergovernmental panel on climate change*. https://www.ipcc.ch/report/ar6/wg3

[11] Bertram, C., Luderer, G., Popp, A., Minx, J. C., Lamb, W. F., Stevanović, M., … & Kriegler, E. (2018). Targeted policies can compensate most of the increased sustainability risks in 1.5 C mitigation scenarios. *Environmental research letters*, *13*(6), 64038. https://doi.org/10.1088/1748-9326/aac3ec

[12] Stern, N., Stiglitz, J., & Taylor, C. (2022). The economics of immense risk, urgent action and radical change: towards new approaches to the economics of climate change. *Journal of economic methodology*, *29*(3), 181–216. https://doi.org/10.1080/1350178X.2022.2040740

[13] Sussman, F., Weaver, C. P., & Grambsch, A. (2014). Challenges in applying the paradigm of welfare economics to climate change. *Journal of benefit-cost analysis*, *5*(3), 347–376. https://doi.org/10.1515/jbca-2014-9001

[14] Stern, N. (2008). The economics of climate change. *American economic review*, *98*(2), 1–37. https://doi.org/10.1257/aer.98.2.1

[15] Adeniran, A. O., Sidiq, O. Ben, Oyeniran, G. T., & Adenira, A. A. (2024). Sustainability impact of digital transformation in e-commerce logistics. *International journal of innovation in marketing elements*, *4*(1), 1–18. https://doi.org/10.59615/ijime.4.1.1

[16] Adapt, C. (2018). *Urban adaptation support tool - step 0 - 6*. https://climate-adapt.eea.europa.eu/en/metadata/tools/urban-adaptation-support-tool

[17] Mercure, J. F. (2019). Toward risk-opportunity assessment in climate-friendly finance. *One earth*, *1*(4), 395–398. https://www.cell.com/one-earth/fulltext/S2590-3322(19)30217-9

[18] Steiger, R. (2010). The impact of climate change on ski season length and snowmaking requirements in Tyrol, Austria. *Climate research*, *43*(3), 251–262. https://doi.org/10.3354/cr00941

[19] Smith, L. (2021). *Is cost-benefit analysis the right tool for federal climate policy? YALE Climate Connections*. https://yaleclimateconnections.org/2021/10/is-cost-benefit-analysis-the-right-tool-for-federal-climate-policy/

[20] Cahill, N., & O'Connell, L. (2018). Cost-benefit analysis, environment and climate change. national economic and social council. *Secretariat paper (national economic and social council). 15*. http://files.nesc.ie/nesc_secretariat_papers/No_15_CBA_Env_and_ClimateChange.pdf

[21] Spash, C. L. (2007). The economics of climate change impacts à la Stern: Novel and nuanced or rhetorically restricted? *Ecological economics*, *63*(4), 706–713. https://doi.org/10.1016/j.ecolecon.2007.05.017

[22] McKibbin, W. J., & Wilcoxen, P. J. (2002). The role of economics in climate change policy. *Journal of economic perspectives*, *16*(2), 107–129. https://doi.org/10.1257/0895330027283

[23] Saez, C. A., & Requena, J. C. (2007). Reconciling sustainability and discounting in Cost--Benefit Analysis: A methodological proposal. *Ecological economics*, *60*(4), 712–725. https://doi.org/10.1016/j.ecolecon.2006.05.002

[24] Ritchie, H., Roser, M., & &Rosado, P. (2020). *CO2 and Green house emission*. Our World In Data. https://ourworldindata.org/co2-and-greenhouse-gas-emissions

[25] Lind, R. C. (1995). Intergenerational equity, discounting, and the role of cost-benefit analysis in evaluating global climate policy. *Energy policy*, *23*(4–5), 379–389. https://doi.org/10.1016/0301-4215(95)90162-Z

[26] Ram, M., Bogdanov, D., Aghahosseini, A., Gulagi, A., Oyewo, A. S., & Child, M. (2019). *Global energy system based on 100% renewable energy – power, heat, transport and desalination sectors.* https://energypedia.info/wiki/Publication_-_Global_Energy_System_Based_on_100%25_Renewable_Energy:_Power,_Heat,_Transport_and_Desalination_Sectors

[27] Gramlich, E. M. (1990). *A guide to benefit-cost analysis*. Waveland Pr Inc. https://www.amazon.com/Guide-Benefit-Cost-Analysis-Edward-Gramlich/dp/0881339881

[28] Aldy, J. E., Kotchen, M. J., Stavins, R. N., & Stock, J. H. (2021). Keep climate policy focused on the social cost of carbon. *Science*, *373*(6557), 850–852. https://www.science.org/doi/abs/10.1126/science.abi7813

[29] Ber. (2020). *The cost-benefit analysis of climate change.* Berkeley Economic Review. https://econreview.studentorg.berkeley.edu/the-cost-benefit-analysis-of-climate-change/

[30] Dennig, F., Budolfson, M. B., Fleurbaey, M., Siebert, A., & Socolow, R. H. (2015). Inequality, climate impacts on the future poor, and carbon prices. *Proceedings of the national academy of sciences*, *112*(52), 15827–15832. https://doi.org/10.1073/pnas.1513967112

[31] Akinyi, D. P., Karanja Ng'ang'a, S., Ngigi, M., Mathenge, M., & Girvetz, E. (2022). Cost-benefit analysis of prioritized climate-smart agricultural practices among smallholder farmers: evidence from selected value chains across sub-Saharan Africa. *Heliyon*, *8*(4), 2–11. https://www.cell.com/heliyon/fulltext/S2405-8440(22)00516-3

[32] Helm, D. (2008). Climate-change policy: why has so little been achieved? *Oxford review of economic policy*, *24*(2), 211–238. https://doi.org/10.1093/oxrep/grn014

[33] Edenhofer, O. (2015). *Climate change 2014: mitigation of climate change* (Vol. 3). Cambridge University Press.

[34] Fankhauser, S., Tol, R. S. J., & Pearce, D. W. (1997). The aggregation of climate change damages: a welfare theoretic approach. *Environmental and resource economics*, *10*, 249–266. https://doi.org/10.1023/A:1026420425961

[35] GEMI. (1994). Finding cost-effective pollution prevention initiatives: Incorporating environmental costs into business decision making. *Global environmental management initiative, washington*, *202*(296). http://gemi.org/resources/COS_107.pdf

[36] Jansen, J. C., & Bakker, S. J. A. (2006). *Social cost-benefit analysis of climate change mitigation options in a European context*. Energy Research Centre of the Netherlands, The Hague. https://socialvalueuk.org/wp-content/uploads/2016/10/CBA-of-climate-change-mitigation-options-in-a-European-context-September-2006.pdf

[37] Kotchen, M. J., & Levinson, A. (2023). *When can benefit--cost analyses ignore secondary markets?* https://www.nber.org/system/files/working_papers/w29811/w29811.pdf

[38] McMichael, A. J., & & Githeko, A. (2001). *Impacts, adaptation, and vulnerability*. https://www.ipcc.ch/site/assets/uploads/2018/03/WGII_TAR_full_report-2.pdf

[39] Meade, J. E. (1972). Cost-benefit analysis. *The economic journal*, *82*(325), 244–246. https://doi.org/10.2307/2230232

[40] Mercure, J. F. (2019). Toward risk-opportunity assessment in climate-friendly finance. *One earth*, *1*(4), 395–398. https://ore.exeter.ac.uk/repository/handle/10871/40318?show=full

[41] Moore, J. (2019). *Cost-benefit analysis: Issues in its use in regulations, EPA environment and natural resources policy division*. https://www.oecd.org/en/publications/cost-benefit-analysis-and-the-environment_9789264085169-en.html

[42] Neumayer, E. (2007). A missed opportunity: the stern review on climate change fails to tackle the issue of non-substitutable loss of natural capital. *Global environmental change*, *17*(3–4), 297–301. https://doi.org/10.1016/j.gloenvcha.2007.04.001%0A

[43] Nordhaus, W. (1996). A general equilibrium model of policies to slow global warming. In: Economic models of energy and environment. *JSTOR*, *86*(4), 741–765. https://www.jstor.org/stable/2118303