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The Delta of Sustainable, Inclusive and Resilient Infrastructure Investment:

Evidence from Cost-Benefit Appraisal

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Table of Contents

ABSTRACT	4
1. INTRODUCTION	5
2. LITERATURE REVIEW	6
3. DATA	10
4. EMPIRICAL STRATEGY	16
5. RESULTS	18
6. CONCLUDING REMARKS	23
REFERENCES	25
APPENDIX	28

Abstract

This paper examines whether infrastructure projects that incorporate sustainability, inclusion, and resilience (SIR) components differ from traditional investments in economic appraisal outcomes. Using a harmonized dataset of World Bank and Inter-American Development Bank projects across energy, transport, and water sectors in Latin America and the Caribbean, we identify SIR-oriented operations through text-mining and compare them with non-SIR projects using a propensity score matching approach. Results show no statistically significant differences in standard cost–benefit indicators – such as internal rates of return, benefit–cost ratios, or total economic costs – between SIR and non-SIR projects. However, SIR projects exhibit a distinct cost structure: a higher share of discounted capital expenditures and relatively lower operating and maintenance costs, suggesting more investment-intensive designs and better long-term adaptation. This difference has important policy implications: by concentrating costs upfront and reducing recurrent expenses, SIR projects improve cost predictability, enhance resource allocation efficiency, and strengthen fiscal responsibility. At the same time, current appraisal methods fail to capture the broader benefits of SIR investments, underscoring the need for improved data and valuation frameworks to measure resilience and inclusion gains. This study provides one of the first empirical assessments of SIR considerations in economic appraisal and highlights the priority of advancing methodologies to reflect their true value.

JEL Codes: D6; D63; H43; H54; O18; Q56.

Keywords: Infrastructure investment; sustainability; resilient infrastructure; inclusive infrastructure; project evaluation; cost-benefit analysis.

1. Introduction

Latin America and the Caribbean face a persistent and significant infrastructure gap that limits access to essential services, constrains productivity and inclusion, and poses long-term challenges for development. Most current estimates suggest that the Region needs to invest close to USD 2.2 trillion in infrastructure to be able to reach the sustainable development goals in infrastructure (Brichetti et al, 2021). While closing this gap remains a priority, an additional dimension of the investment challenge has emerged: expanding access alone is no longer sufficient. To address growing risks associated with climate shocks, vulnerability, and inequality, the concept of adequate infrastructure has evolved to incorporate resilience, sustainability, and inclusion (SIR) as fundamental priorities (Bagnoli, et al., 2025). These dimensions also contribute to improving infrastructure quality by strengthening durability, reliability, and long-term performance, particularly in the context of increasing exposure to extreme weather events, rapid urbanization, and persistent social disparities, which together heighten the fragility of conventional infrastructure and exacerbate existing gaps.

SIR¹ infrastructure aims not only to deliver essential services but also to mitigate damage during shocks, reduce environmental impacts, and improve access for vulnerable populations. Although sustainability, inclusion, and resilience have become central themes in policy debates, their practical implications for infrastructure design, management, and economic appraisal remain largely unexplored. Understanding these implications is critical for several reasons. First, promoting investment in sustainable infrastructure requires clarity on its cost implications—specifically, the additionality or “delta” associated with incorporating SIR components. Second, it is essential to assess how these features affect benefits, including potential gains from enhanced resilience, reduced vulnerability, and greater social inclusion. Finally, these cost and benefit dynamics fundamentally shape the economic rationale for investment, influencing key appraisal metrics such as cost–benefit ratios and internal rates of return. Advancing research in this area is therefore indispensable to refine valuation frameworks, inform public policy, and ensure that infrastructure investments effectively support long-term resilience and inclusive development.

To address this knowledge gap, this paper examines how the integration of SIR elements is reflected in cost–benefit analysis (CBA) outcomes, assessing whether projects that incorporate sustainability, inclusion, and resilience differ from traditional investments in key appraisal indicators. We construct a harmonized dataset of infrastructure projects in the energy, transport, and water and sanitation sectors across Latin America and the Caribbean, drawing on digitized information from World Bank and Inter-American Development Bank project documents. Using text-mining techniques, we identify SIR-oriented projects and link them to project-level valuation metrics, enabling a systematic comparison of cost structures and expected economic performance. To strengthen causal inference and address endogeneity concerns arising from the non-random adoption of SIR components, we implement a propensity score matching approach. This method estimates the likelihood of incorporating SIR elements based on observable characteristics and

¹ For this study, SIR refers to the integration of Sustainability, Inclusion, and Resilience as defined by the Inter-American Development Bank’s IDBImpact+ Strategy. Sustainability encompasses economic, environmental, and social dimensions to ensure long-term viability and development outcomes. Inclusion emphasizes equitable access and participation for historically underrepresented groups in both the design and benefits of infrastructure projects. Resilience denotes the capacity of infrastructure systems to withstand and recover from natural disasters, climate shocks, and systemic disruptions, in alignment with the Bank’s mandate to enhance disaster preparedness, response, and recovery across Latin America and the Caribbean. For more information, see <https://www.iadb.org/en/home/idbimpact>.

matches similar projects to compute the average treatment effect of SIR adoption on CBA outcomes. This integrated strategy provides robust evidence on whether SIR considerations translate into systematic differences in economic appraisal and cost composition.

Our results indicate no statistically significant differences between SIR-oriented and traditional projects in terms of economic rates of return, benefit–cost ratios, or total discounted costs. However, we find a notable distinction in cost composition: SIR projects allocate a larger share of total discounted net flows to costs,² with an estimated increase of approximately 0.13 relative to non-SIR operations. This effect is primarily driven by a substantial reduction in operating and maintenance costs rather than disproportionately higher capital investments. In other words, SIR-related design features—such as the use of more durable materials, risk-mitigating components, and systems that lower long-term maintenance needs—appear to reconfigure the cost structure toward upfront investment while reducing recurrent costs over the project lifecycle. This pattern aligns with the economic rationale behind SIR interventions, which emphasize resilience and sustainability through lower long-term vulnerability and reduced exposure to operational disruptions.

At the same time, results indicate how current appraisal methods fail to capture the broader benefits of SIR investments, underscoring the need for improved data and valuation frameworks to integrate sustainability, inclusion, and resilience into project evaluation. While our findings highlight a clear change in cost structures toward upfront investment and reduced recurrent costs, they also reveal a critical gap: the economic benefits associated with enhanced resilience, lower vulnerability, and greater social inclusion remain largely unaccounted for in conventional appraisal metrics, likely reflecting limited understanding and measurement of their underlying benefits. These may differ substantially across dimensions, for instance, resilience can generate avoided future losses and lower maintenance needs, while inclusion yields distributional and welfare gains, making them harder to capture within standard appraisal frameworks.

2. Literature Review

This paper sits at the intersection of two major research streams: (1) the traditional use of cost–benefit analysis (CBA) for infrastructure appraisal and (2) the emerging focus on sustainable, inclusive, and resilient (SIR) infrastructure. A third, nascent area explores how these dimensions can be integrated within CBA frameworks – a space where empirical evidence remains scarce and where this paper contributes.

CBA is widely recognized as a core instrument for the economic evaluation of infrastructure projects. Its theoretical foundations provide a well-established framework to assess changes in social welfare associated with alternative policy or investment decisions. Canonical studies formalize CBA within a welfare-economic model, emphasizing consumer surplus, shadow pricing, and the valuation of marginal changes in resource allocation (De Rus, 2021; De Rus, 2025). While this framework remains central to appraisal procedures, the growing complexity of infrastructure projects and the increasing relevance of

² Total discounted net costs are defined as the sum of discounted capital investment and operating and maintenance cost net flows.

environmental, social, and risk-related dimensions have motivated methodological extensions. Contemporary developments aim to incorporate a broader range of impacts not captured in conventional settings.

A first body of this literature focuses on how environmental sustainability can be incorporated into economic appraisal. Recent research has increasingly expanded the conventional CBA framework to account for environmental impacts such as greenhouse gas emissions, local air pollution, biodiversity loss, resource depletion, and changes in ecosystem services (Moldan et al., 2012). A substantial set of studies has developed methods to measure and value climate-related impacts, particularly through the estimation of the social cost of carbon and related approaches that enable greenhouse gas emissions and emission reductions to be incorporated into economic appraisal. At the same time, growing attention has been devoted to ecosystem services, including carbon sequestration, flood protection, water regulation, pollination, recreational opportunities, and habitat provision, as these benefits are often affected by infrastructure investments but are not reflected in market prices (Freeman et al., 2014; Atkinson et al., 2014).

To incorporate these environmental impacts into project appraisal, the literature has developed a relevant set of quantitative methods, including contingent valuation, stated preference methods, travel cost models, hedonic pricing, and benefit-transfer approaches (Johansson, 1993; Atkinson & Mourato, 2015). These methods allow environmental benefits and costs to be expressed in welfare terms and compared with conventional project costs and benefits. Nevertheless, many sustainability impacts remain difficult to monetize, particularly those involving long-term ecological change, biodiversity loss, non-marginal environmental effects, or uncertain climate-related outcomes (Ekins, 2011; Ekins & Zenghelis, 2021).

A related fact is that the economic evaluation of infrastructure projects should carefully consider costs and benefits over the entire project life cycle. Projects with sustainability components may involve higher upfront costs but generate benefits through lower level of emissions, improved environmental quality, or avoided future damages. Studies on life-cycle costing and green infrastructure emphasize that focusing only on construction costs may lead to biased project selection, particularly when long-term environmental performance is relevant (Baker & Ruting, 2014; Alaloul et al., 2021). More recent applications show that nature-based solutions and green infrastructure can produce substantial social and environmental benefits when broader impacts, such as carbon sequestration, recreational value, and local environmental improvements, are included in the appraisal (Reyes et al., 2024). Overall, this literature shows that sustainability can be incorporated into CBA through complementary indicators, non-market valuation techniques, and longer evaluation horizons. At the same time, it highlights that many sustainability-related impacts remain difficult to quantify or monetize, suggesting that conventional appraisal may still overlook important dimensions of project performance and reinforcing the need for continued methodological and empirical development.

The second aspect of this analysis focuses on the integration of social inclusion into the economic appraisal of infrastructure projects. In general, equity-oriented research critiques standard CBA, however, often aggregates benefits and costs across individuals, which may lead to an underestimation of differences in access, affordability, exposure to externalities, and service quality across income groups, geographic

locations, and vulnerable populations (Hahn & Metcalfe, 2019; Martens, 2011). Extended approaches therefore demonstrate the importance of including distributional weights, impact tables, accessibility indicators, and spatial measures of vulnerability into appraisal frameworks (Hahn, 2021; Markanday et al., 2021). These tools help understanding how infrastructure projects affect different groups.

In line with these concerns, recent empirical evidence emphasizes that equity assessment requires identifying the relevant benefits and burdens, the groups across which they are distributed, and the normative criteria used to evaluate the distribution (Martens et al., 2019). Empirical studies also show that infrastructure improvements can reinforce existing inequalities if benefits accrue mainly to already well-served areas, while disadvantaged communities continue to face lower access or higher environmental burdens (Managh & El-Geneidy, 2010; Gandy, 2024). Thus, one of the central implications from this literature is that the appraisal of inclusive infrastructure requires moving beyond aggregate measures of project performance to explicitly account for the distributional and spatial allocation of project costs and benefits.

Recent studies have increasingly emphasized the importance of identifying disadvantaged groups, recognizing heterogeneous needs across populations, and distinguishing between horizontal and vertical equity objectives in infrastructure project design and economic appraisal (Litman, 2022; LeClair et al., 2023; Gandy, 2024). While horizontal equity focuses on ensuring equal treatment and access for individuals or communities with similar needs and circumstances, vertical equity recognizes that disadvantaged groups may require differentiated treatment or targeted interventions to achieve equitable outcomes. At the same time, related research has highlighted a lack of tools for assessing long-term distributional effects, particularly those arising from the interaction between infrastructure investments and broader social contexts (Sierra et al., 2016; Sierra et al., 2017).

Overall, the literature on inclusion and equity has been advancing on novel scopes to move beyond aggregate measures of project performance to evaluate the distribution of costs and benefits across population groups and geographic areas when an infrastructure project is developed. Recent contributions have showed innovative conceptual frameworks, indicators, and appraisal tools to operationalize these dimensions, particularly in the transport and urban infrastructure sectors. Nevertheless, important challenges remain in developing comparable and operational evaluation frameworks across sectors and project types. Existing approaches continue to face limitations in capturing long-term distributional effects, incorporating procedural dimensions of equity, and linking project-level outcomes to the broader social and institutional contexts in which infrastructure investments are implemented.

On the other hand, resilience-focused studies emphasize the need to incorporate risk and uncertainty into infrastructure appraisal and CBA frameworks by quantifying hazard-related losses and evaluating risk-reduction measures (Mechler, 2005; Proag & Proag, 2014). Recent contributions extend this approach by developing methodologies to value avoided losses, comparing adaptation strategies, and assess system performance under stress (Rose, 2022). In parallel, complementary frameworks integrate hazard exposure, system reliability, and long-term risk management into project design, shifting the focus from reactive responses toward preventive, resilience-oriented planning (Bagnoli et al., 2025).

Building on these advances, the literature increasingly recognizes resilience as the capacity of infrastructure systems to absorb shocks, maintain functionality, and adapt over time, particularly under non-linear risks and potential threshold effects. However, conventional appraisal frameworks remain limited in capturing these dynamics, as they tend to focus on expected outcomes ignoring possible irreversible changes in system performance (Walker et al., 2010). This limitation implies that resilience should be evaluated not only in terms of expected performance, but also in relation to the risk of large welfare losses, reinforcing the need for appraisal approaches that explicitly incorporate uncertainty and probabilistic assessments of disruption.

From a relatively static perspective, the more traditional resilience literature has focused on the ability of infrastructure investments to reduce expected losses from adverse events and improve system reliability under predefined risk scenarios. In this view, resilience is often incorporated into economic appraisal through the valuation of risk-reduction measures, avoided damages, and adaptation investments, allowing analysts to compare the costs of resilience-enhancing interventions with the benefits derived from lower vulnerability to shocks (Mechler, 2005; Proag & Proag, 2014). Recent studies have strengthened this approach by developing methods to quantify hazard-related losses, estimate the economic value of adaptation strategies, and incorporate resilience considerations into project appraisal and design (Bagnoli et al., 2025). The central implication is that resilient infrastructure creates economic value by reducing the likelihood and consequences of future disruptions, even when such disruptions do not ultimately occur.

Emerging literature has considered also a dynamic understanding of resilience that emphasizes how infrastructure systems perform before, during, and after disruptive events. Rather than focusing on expected losses, in this approach resilience is interpreted as the capacity of systems to absorb shocks, maintain critical functions, recover functionality, and adapt to changing conditions over time (Walker et al., 2010). In line with this approach, recent studies have proposed resilience metrics based on deviations from normal service provision, recovery trajectories, and adaptation capacity, linking physical system performance to economic outcomes (Hallegatte et al., 2019; Martani et al., 2021; Francis & Bekera, 2014). Other contributions have included uncertainty, system interdependencies, and evolving risk conditions through scenario analysis, probabilistic methods, and dynamic modeling into CBA (Baley, 2016; Zhu & Leibowicz, 2022; Singh et al., 2023). Under this perspective, resilience is understood not as a fixed characteristic of an infrastructure asset, but as a dynamic process that determines how effectively systems respond to and recover from disturbances over their life cycle.

In summary, this literature shows that incorporating resilience into infrastructure appraisal requires considering key features of this dimension, such as expected losses, risk, uncertainty, and system performance over time. Resilience is generally measured by how well systems handle disruptions, limit losses, and recover, using metrics that capture both the size and duration of impacts. However, its integration into standard appraisal practices remains limited, leaving open questions about how resilience-oriented investments are reflected in traditional economic indicators.

Lastly, similar to the approach adopted in this paper, only a limited number of studies have analyzed cost-benefit appraisal outcomes across large portfolios of infrastructure projects. Among the pioneering contributions in this area have used databases of projects financed by the European Union, the World Bank,

and the European Bank for Reconstruction and Development to examine the variation in key appraisal indicators, including economic rates of return, financial rates of return, and co-financing rates across projects (Florio and Vignetti, 2025 & Del Bo and Florio, 2010). These studies explore whether systematic differences in appraisal outcomes emerge across sectors, countries, financing institutions, and time. Their findings suggest that a substantial share of the observed variation in project returns is associated with structural project characteristics, while also highlighting the value of standardized project-level appraisal databases for understanding patterns in infrastructure investment and evaluation.

More recently, Florio, Morretta, and Willak (2018) use a dataset of approximately 1,000 major infrastructure projects financed under the European Union Cohesion Policy to compare financial and economic rates of return across sectors. A core finding from this paper is that economic returns systematically exceed financial returns, reflecting the significant share of externalities, shadow prices, and other social benefits in explaining welfare changes provoked by these infrastructure projects. More broadly, these studies demonstrate the value of project-level appraisal databases for understanding how infrastructure evaluation is implemented in practice and how economic outcomes differ across investments. This literature is particularly relevant for the present paper because it treats appraisal indicators not merely as decision-making tools, but as empirical outcomes that can be analyzed to identify how specific project characteristics shape the results of economic evaluation.

Despite the substantial literature devoted to developing methods for incorporating sustainability, inclusion, and resilience into infrastructure appraisal, there is still limited empirical evidence on how these dimensions affect cost-benefit analysis outcomes in practice. Similarly, while there has been a significant expansion of valuation techniques and appraisal frameworks, much less is known about whether projects that incorporate these objectives differ systematically from traditional investments in terms of costs, benefits, and overall economic performance. As a result, an important gap remains between methodological advances and the evidence available from project-level evaluations. This paper contributes to filling that gap by examining how sustainability, inclusion, and resilience components are reflected in the economic appraisal outcomes of infrastructure projects.

3. Data

This paper relies on a unique, purpose-built dataset that compiles detailed information on cost-benefit analysis (CBA) outcomes, in particular: economic internal rates of return (IRR); benefit-cost ratios; total discounted capital investment; net operation and maintenance costs over the life cycle and total discounted costs, and project characteristics for infrastructure operations financed by the Inter-American Development Bank (IDB) and the World Bank (WB) in Latin America and the Caribbean from 1996 to 2025.³ Constructing this dataset required an extensive review of all publicly available appraisal and evaluation documents in the energy, transport, water, and sanitation sectors, including annexes containing economic analyses. From these sources, we extracted project-level data on net present values of investment costs, operating and maintenance costs, expected benefits, internal rates of return (IRR), and design attributes related to sustainability, inclusion, and resilience. The result is a novel harmonized database of economic

³ The information was gathered from the following websites: <https://projects.worldbank.org/en/projects-operations/projects-list?os=0> and <https://www.iadb.org/en/project-search>.

evaluations for infrastructure projects in the region, developed specifically for this study through a time-intensive process of document digitization and variable identification. Appendix A provides a detailed description of the documents and procedures used to build the final dataset.

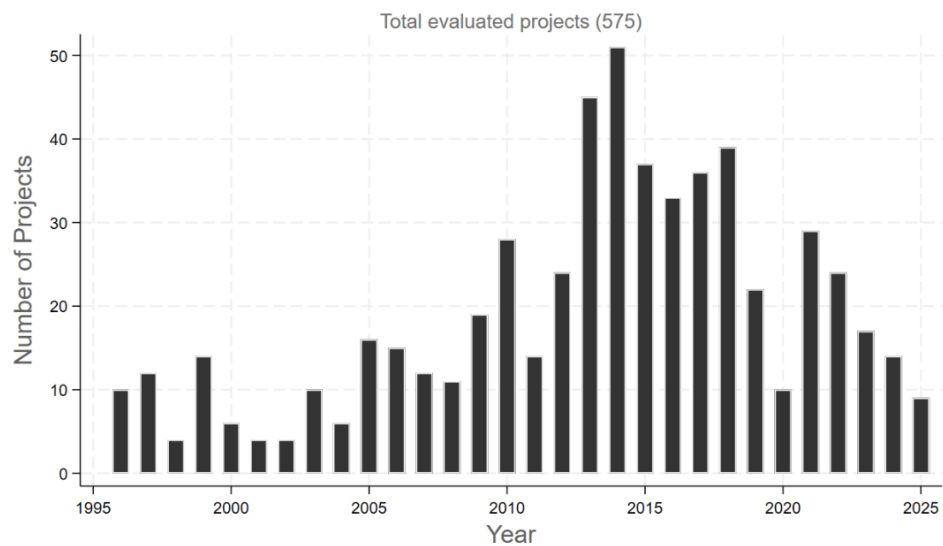
Recent region-wide analyses indicate that information on sustainable, inclusive, and resilient infrastructure remains limited, partly due to the absence of standardized criteria to identify or classify resilience-related investments. Limited data and the absence of clear accounting guidelines for resilient investments make it hard to monitor investment trends and assess project performance over time (Bagnoli, et al., 2025). The harmonized dataset assembled for this paper contributes to filling this gap by collecting project-level CBA information across sectors and years, providing a consistent comparison of investment trends on SIR-oriented infrastructure developments.

The dataset includes 575 infrastructure projects approved between 1996 and 2025 for which information on at least one CBA outcome is available. As shown in Figure 1, the number of projects with accessible appraisal data varies considerably over time. Coverage is relatively limited in the late 1990s and early 2000s, when few project evaluation reports were publicly disclosed,⁴ but rises markedly after 2005 and again after 2015. These two surges correspond, respectively, to the regional expansion of infrastructure investment programs and to the growing emphasis on sustainability and resilience within multilateral operations (Cavallo, Powell, & Serebrisky, 2020) (Calderón & Servén, 2009) (Serebrisky, 2014).

In addition, Figures A1 and A2 in the Appendix illustrate the consistency of our sample relative to the total number of infrastructure projects financed by Multilateral Development Banks in LAC, and relative to their total approval amounts. Figure A1 shows that the number of projects with any available CBA outcome included in our sample follows a trend that closely mirrors the total number of projects recorded by the Multilateral Development Banks in their publicly available repositories. The gap between the total number of projects and those with CBA information decreases notably from 2013 onward. Figure A2 presents a complementary comparison between the total amount approved for infrastructure projects and the total amount approved for the projects in our sample. The two series exhibit similar behavior over time, with a wider gap between them in the period 2005–2010 but otherwise following comparable paths. Together, these figures indicate that our sample reflects the trends of the broader universe of MDB-financed infrastructure projects in Latin America and therefore reduces concerns about potential selection bias related to project availability or loan size.

⁴ In multilateral development banks such as the IDB and World Bank, infrastructure project cycles systematically integrate both ex-ante and ex-post economic evaluations. At the outset, loan approval documents -including Project Profiles and Project Appraisal Documents - contain comprehensive economic analyses such as economic rate of return assessments, benefit-cost evaluations, and sector-specific cost estimates. These documents are rigorously vetted through successive internal reviews, including Quality and Risk Reviews and Board submissions. Following project completion, Project Completion Reports provide ex-post economic data. These reports reassess actual returns, costs, and lessons learned to evaluate performance and inform future operations. This dual-phase approach ensures that infrastructure investments are first justified on economic grounds and later evaluated against realized outcomes, reinforcing both accountability and institutional learning in the financing of development projects.

Figure 1. Number of Projects by Year



Given the growing focus on sustainable, inclusive, and resilient infrastructure, and in line with the motivation of this paper, we use public available information on each project’s main objective to determine whether it explicitly incorporates elements of sustainability, inclusion, or resilience (SIR). To construct this classification, we implement a text-mining procedure that searches for relevant terms within the narrative sections of each appraisal document (in English, Spanish, and Portuguese). After normalizing the text, we apply regular-expression patterns to identify terminology associated with each SIR category. Specifically, references to resilience, adaptation, risk, mitigation, climate, hazard, disaster, emergency, and preparedness indicate resilience-related content; expressions such as inclusion, equity, gender, poverty, participation, and social cohesion capture social inclusion; and words like environment, biodiversity, conservation, pollution, renewable, ecosystem, and deforestation denote environmental sustainability. Projects whose objectives include at least one of these terms are classified accordingly.⁵

Considering this, Table 1 reports the share of projects that explicitly reference each category across the three main infrastructure sectors. In addition to the individual indicators for sustainability, inclusion, and resilience, the table also presents the share of projects classified under the SR category, defined as those that mention sustainability, resilience, or both. This category includes all operations that include at least one of these two elements, capturing the conceptual linkages that exist between them, particularly in projects addressing climate adaptation, environmental protection, and long-term infrastructure durability. Similarly, the broader SIR indicator identifies projects that reference at least one of the three categories (sustainability, inclusion, or resilience), providing a more comprehensive measure of the extent to which these objectives are incorporated into project design.

⁵ It is important to note, however, that our approach does not allow us to measure the intensity with which SIR dimensions are incorporated into each project. The text-mining procedure identifies the presence of SIR-related elements based on the occurrence of relevant terms in the projects’ main objectives, regardless of the extent to which these themes are emphasized, operationalized, or integrated into project design and implementation. As a result, the classification captures whether a project references sustainability, inclusion, or resilience, but not the degree or robustness of these components. This limitation should be considered when interpreting the results, as projects identified as SIR-oriented may differ in their strength or scope.

Table 1. Share of Projects with SIR Components by Sector

Sector	Resilience	Inclusion	Sustainability	SIR	SR
Energy	6.72%	15.97%	23.53%	33.61%	26.05%
Transport	7.14%	13.84%	8.93%	21.43%	11.16%
Water	20.26%	10.34%	32.33%	43.53%	39.66%
Total	12.35%	12.87%	21.39%	32.87%	25.74%

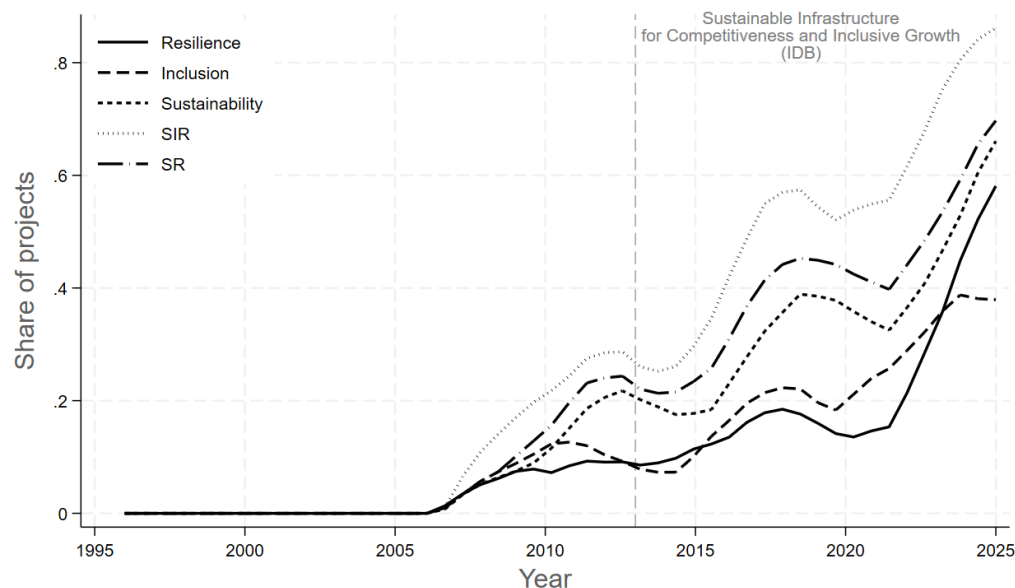
Overall, about 33 percent of projects in the sample include at least one sustainability, inclusion, or resilience (SIR) component, while 26 percent explicitly incorporate sustainability, resilience, or both (SR). The prevalence of these elements varies across sectors. Water and sanitation projects exhibit the highest rate of SIR integration — 44 percent, include at least one reference — with environmental sustainability (32 percent) and resilience (20 percent) as the dominant components. Energy projects also exhibit strong engagement with sustainability (24 percent) and inclusion (16 percent), reflecting the sector’s focus on renewable energy, efficiency, and access. Finally, transport projects display lower overall incidence, with only 21 percent referencing any SIR component and about 11 percent combining sustainability and resilience.

More interestingly, we observe important changes in the evolution of these dimensions over time. Figure 2 shows that projects incorporating objectives related to sustainability, inclusion, or resilience have become increasingly prevalent. The share of projects mentioning at least one of these aspects (SIR) has grown steadily, particularly after 2010, reaching almost 80 percent in recent years.

This trend coincides with important changes in the strategic priorities of multilateral development banks, particularly the Inter-American Development Bank (IDB). One notable milestone was the growing emphasis on sustainable infrastructure, reflected in the Bank's efforts to promote projects that integrate environmental and social considerations into infrastructure planning, construction, and maintenance. This orientation was reinforced through flagship initiatives such as *Sustainable Infrastructure for Competitiveness and Inclusive Growth*, which emphasized the role of infrastructure in delivering high-quality services while supporting sustainable and inclusive development. More recently, the IDB Impact Framework and Strategy (2024-2030) explicitly reaffirmed the institution's commitment to sustainability, resilience, and inclusion as central pillars of its development agenda. Overall, the increasing prevalence of SIR-related objectives is consistent with the broader shift among multilateral development institutions toward sustainability and climate resilience.⁶

⁶ This evolution is illustrated by the IDB's publication of key strategic documents, such as *Sustainable Infrastructure for Competitiveness and Inclusive Growth* (2013) and the *Impact Framework 2024–2030: Executive Summary* (Inter-American Development Bank, IDB Invest, & IDB Lab, 2024).

Figure 2. Evolution of Sustainability, Inclusion, and Resilience (SIR) Components in Infrastructure Projects, 1996–2025



Note: This graph shows the polynomial-smoothed trend in the share of projects that include SIR components over time.

Among the individual categories, sustainability has shown the fastest and most consistent growth, reflecting the importance of environmental considerations into infrastructure design nowadays, as shown in Figure 2. Resilience has also gained relevance, particularly after 2015, in parallel with the global policy agenda on climate adaptation and disaster risk management (UNISDR, 2015). The share of projects with inclusion objectives has increased more gradually but remains a key dimension in recent years. The SR series, which captures projects referencing sustainability or resilience, or both, closely mirrors the overall pattern of SIR, highlighting the strong presence of these two aspects within modern infrastructure operations.

A complementary perspective on the integration of SIR objectives within the portfolio is presented in Figure 3, which reports the annual share of approved loan amounts allocated to projects that include sustainability, inclusion, or resilience within the sample. This measure focuses on the composition of lending rather than on the number of operations, offering a clearer view of how financing priorities have shifted over time. The results show a steady increase in the share of lending directed toward sustainability- and resilience-related objectives, while inclusion exhibits a more stable trend.

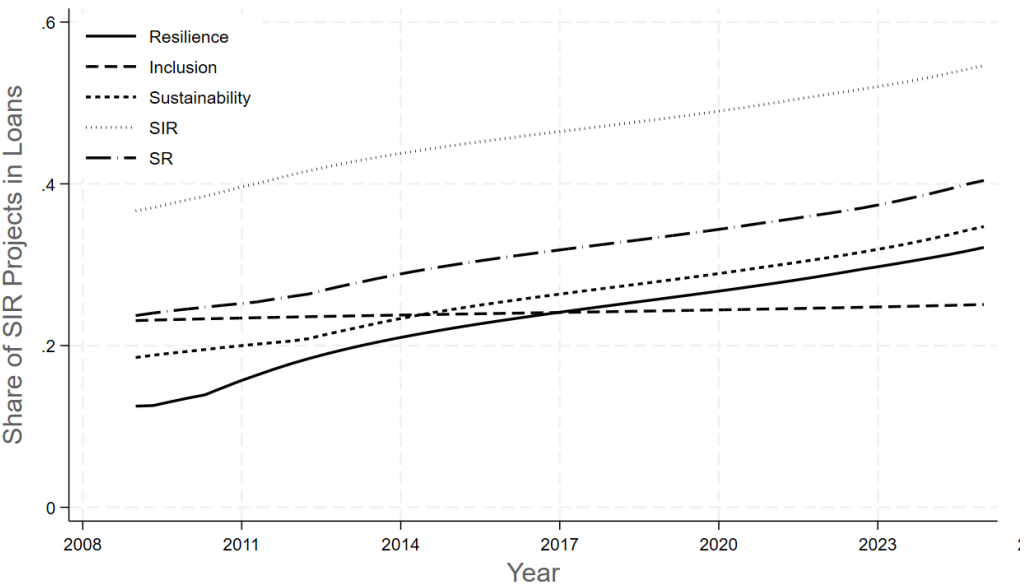
This pattern is consistent with other regional analyses that show how multilateral development banks have played an important role in supporting resilient and sustainable infrastructure investment in Latin America and the Caribbean. Recent Multilateral Development Banks (MDBs) climate finance reports also document a steady rise in mitigation and adaptation commitments. Climate-related financing reached USD 74.7 billion in 2023 (up from USD 23.8 billion in 2013), with the World Bank Group, the Asian Development Bank, and the IDB as major contributors (Bagnoli, et al., 2025).⁷ In the case of the IDB, authors show that climate finance

⁷ See Box 4.2 in (Bagnoli et al., 2025).

represented nearly half of total financing. Within this amount, infrastructure-related climate finance accounted for about 40 percent, that has grown steadily over time, indicating a rising commitment to investments in resilient infrastructure. This broader shift toward climate- and resilience-oriented lending provides additional context for the increasing share of SIR-related loan allocations shown in Figure 3.

Building on the information compiled from project appraisal documents, we also harmonized project characteristics to ensure consistency across sources and comparability across operations. To accurately implement the empirical strategy, each project was classified into standardized subsectors within the three main infrastructure sectors: energy, transport, and water and sanitation. By grouping projects into homogeneous subsectors, we improve the comparability between treated and control projects in the propensity score matching procedure. The distribution of projects in our sample across subsectors is presented in Table A1.

Figure 3. Share of Approved Loan Amounts Allocated to SIR-Related Projects



Note: This graph shows the polynomial-smoothed trend in the share of loan value corresponding to projects that include SIR components over time.

Similarly, we classify projects into regions based on the country in which they were implemented. Table A2 presents the regional categories used in the analysis. Because the number of projects is limited for several individual countries, we aggregate them into broader regional groups to preserve sufficient variation while accounting for geographical heterogeneity. This regional classification is also used to improve comparability in the matching procedure. As shown in the table, approximately 40% of the projects in our sample were implemented in the Southern Cone, with Brazil representing a substantial share of this group, accounting for 66 projects.

Finally, Table 2 reports the main descriptive statistics for the cost–benefit analysis (CBA) outcomes considered in this paper. On average, projects report an economic internal rate of return (IRR) of 27%, and a

benefit–cost ratio of 2.43, suggesting that overall evaluated operations are expected to generate positive net benefits.⁸ The cost structure index—defined as the ratio of discounted capital investment net flows to the sum of discounted capital investment and operating and maintenance cost net flows—is 0.92.⁹ Analyzing the cost components individually, the average discounted net flow of capital investment is USD 181.274 million, while the average discounted net flow of operating and maintenance costs is USD 2.925 million under the standard CBA calculation. Lastly, the logarithm of the net present value of the project’s economic costs (ln Costs) has a mean of 3.41, which corresponds to an average discounted net cost of approximately USD 30 million.

Table 2. Summary Statistics - Outcomes

CBA Outcome	Mean	SD	Min	Max	N
Internal Rate of Return (IRR)¹⁰	0.267	0.166	0.036	0.990	541
Ratio Benefits/Costs	2.431	5.005	-25.460	74.491	333
Cost Structure Index¹¹	0.919	0.323	0.063	3.417	184
Discounted Capital Investment (net flows)	181.274	587.565	0.330	4310.770	186
Discounted O&M costs¹² (net flows)	2.925	199.759	-1993.86	714.625	189
ln(Costs)	3.409	2.001	-3.700	9.330	335

The following section describes in detail the empirical strategy, which uses the dataset introduced above to examine whether the inclusion of sustainability, inclusion, and/or resilience (SIR) components is associated with differences in project evaluation outcomes.

4. Empirical Strategy

To estimate the effect of sustainability, inclusion, and resilience (SIR) components on cost–benefit analysis (CBA) outcomes for infrastructure projects in Latin America and the Caribbean, we apply a propensity score matching (PSM) approach, as proposed by Rosenbaum and Rubin (1983). This method addresses comparability issues by matching projects that include a given component, sustainability, inclusion, or resilience, with otherwise similar projects that do not incorporate that specific element in their main objectives.

The PSM procedure first estimates the probability that a project belongs to the treated group, defined by the inclusion of sustainability, inclusion, and/or resilience dimensions in its objectives. We assume that this probability depends on the region where the project was implemented (as shown in Table A2), the total loan

⁸ The dataset was winsorized by excluding observations whose internal rate of return (IRR) exceeded 100%.

⁹ Because project costs are reported over multiple years, we use the discounted present values of capital and operating and maintenance expenditures as provided in the economic evaluation documents.

¹⁰ Our sample includes projects reporting internal rates of return (IRRs) below the lower bounds typically suggested in the literature for financial attractiveness - generally between 10% and 12%. However, multilateral development banks and governments have increasingly considered lower rates for projects whose benefits materialize primarily in the long term, such as climate adaptation initiatives. For a detailed discussion on the role of discount rates in infrastructure project evaluation and the current debate in Latin America and the Caribbean, see Campos, Serebrisky, and Suárez-Alemán (2016).

¹¹ This variable was constructed as the ratio of discounted capital investment net flows to the sum of discounted capital investment and operating and maintenance cost net flows.

¹² Since costs and benefits in standard CBA are measured relative to a counterfactual “without-project” scenario, some discounted values may be negative. In particular, discounted O&M costs can be negative when the project reduces operating or maintenance expenditures relative to the baseline.

amount approved by the IDB or the World Bank, the project's sector and subsector classification (as defined in Table A1), and the period in which the operation was approved.¹³ Equation 1 summarizes the first step of the PSM procedure, which relies on a logit model.¹⁴

$$P(T_i = 1 | X_i) = \Lambda(\beta_0 + \beta_1 Region_i + \beta_2 LoanAmount_i + \beta_4 Subsector_i + \beta_5 Period_i) \quad (1)$$

The second step of the PSM procedure consists in matching projects in the treatment group with similar operations in the control group based on their estimated propensity scores. This step ensures that treated and untreated projects are comparable in terms of observable characteristics, reducing selection bias in the estimation of treatment effects (Rosenbaum & Rubin, 1983). In this stage, we confirm that the observations included in the analysis lie within the common support, which satisfies the overlap condition. Accordingly, the sample is restricted to projects whose estimated propensity scores fall within the range shared by the treated and control groups.

After constructing the common support, the matching algorithm pairs similar observations from the treated and control groups using a nearest-neighbor approach. In our main specification, each treated project is compared with its five nearest control projects. As a robustness check, we also consider alternative matching methods, including kernel and radius matching. Finally, the methodology estimates the Average Treatment Effect on the Treated (ATT) by computing the mean difference in outcomes between each treated project and its matched control(s), with weights determined by the chosen matching algorithm (see equation 3). To assess the precision of the estimates, we compute bootstrap standard errors. As we will discuss in the following section, we also employ the delta method to better understand some of the results.

$$ATT = \frac{1}{N_T} \sum_i \left(Y_i - \sum_{j:T_j=0} w_{ij} Y_j \right)^{15} \quad (2)$$

We use this methodology to evaluate four main CBA outcome variables: (i) the internal rate of return (IRR), (ii) the benefit–cost ratio (BCR), (iii) the logarithm of the economic discounted costs reported in the CBA for each project, and (iv) the cost structure index defined in the data section.¹⁶ As discussed previously, incorporating sustainability, inclusion, and resilience components can influence appraisal outcomes by altering both the cost structure and the temporal distribution of costs and benefits. These elements may also affect the type and magnitude of expected benefits (and incurred costs), which in turn requires different approaches to assess project profitability and economic rationale. For instance, resilience (adaptation) measures can reduce future maintenance or reconstruction costs by improving readiness to deal with the

¹³ We account for time variation in the PSM procedure by controlling for five-year periods.

¹⁴ As the sector dimension is already captured by subsector fixed effects, sector dummies are omitted from the main specification to avoid collinearity.

¹⁵ Y_i denotes each cost-benefit analysis outcome. In the empirical implementation, the matched ATT is computed as the average difference between treated projects and their matched controls, as shown in equation 2

¹⁶ To maintain a consistent interpretation of the results, we restrict the analysis to observations that report a positive discounted capital investment net flows. Because standard CBA measures discounted cost flows relative to a counterfactual without the project, some components may take negative present values. Restricting the sample to projects with positive discounted capital costs ensures a consistent and meaningful interpretation of the econometric results.

impact of extreme events; inclusion-related investments can raise social returns through broader access and productivity gains; and sustainability features may yield long-term environmental benefits that indirectly increase the overall welfare effects of the project.

5. Results

This section presents the main results and discusses their policy implications for infrastructure evaluation in Latin America. Before estimating the treatment effects, we first examine the distribution of estimated propensity scores for projects with and without SIR components. Figure 4 presents the common-support plot for the SIR composite index, which aggregates the three dimensions of sustainability, inclusion, and resilience into a single indicator.

As shown in Figure 4, there is a substantial degree of overlap between treated and control projects, indicating that the common-support condition is satisfied. In addition, treated projects tend to exhibit higher estimated propensity scores, suggesting that operations incorporating SIR components are more likely to be associated with certain observable characteristics, such as larger approved loan amounts, more recent approval periods, or sectors where SIR considerations are more systematically integrated. This pattern is consistent with our expectations and supports the quality of the underlying data and the accuracy of the propensity score estimation, since it reflects a logical association between the inclusion of SIR elements and project characteristics typically linked to more complex or recent infrastructure operations.

Table 3 presents the Average Treatment Effects on the Treated (ATT) estimated through the propensity score matching (PSM) approach. The estimation relies exclusively on matched observations within the region of common support to ensure comparability between treated and control projects. The results indicate that most cost–benefit analysis (CBA) outcomes do not differ significantly between the two groups. The differences in internal rates of return (IRR), benefit–cost ratios, and project costs are small and statistically insignificant, suggesting similar levels of overall economic performance. However, the cost structure index is significantly higher for treated projects, with an estimated effect of 0.14. This indicates that infrastructure developments incorporating SIR components allocate a larger share of total discounted costs, measured as the discounted capital and operating–maintenance net flows, to capital investments relative to traditional projects.

Figure 4. Propensity Score Distribution and Common Support for the SIR Composite Index

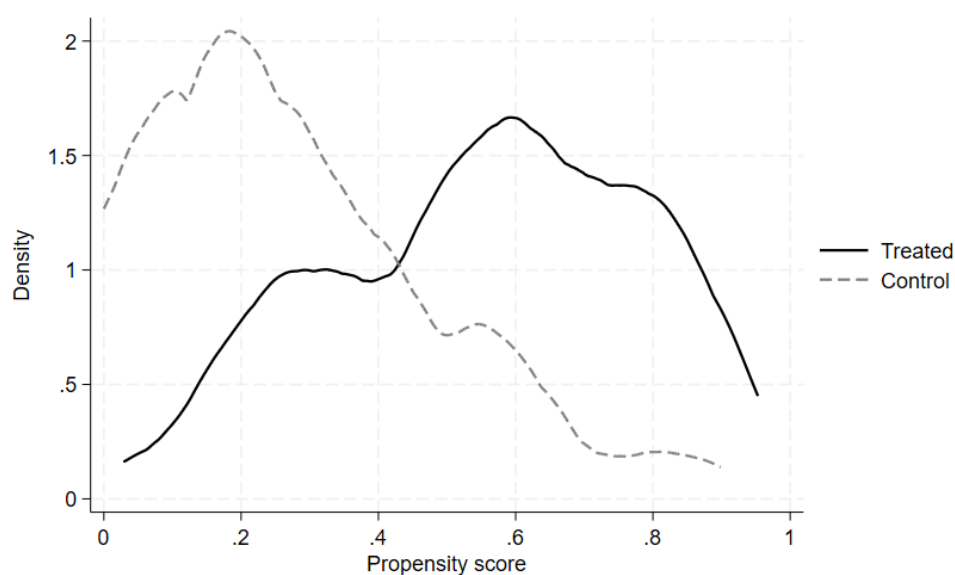


Table 3. Propensity Score Matching Results for Projects with SIR Components

Outcome	Treated mean	Control mean	ATT	t-stat	N Treat.	N Control
Internal Rate of Return (IRR)	0.253	0.232	0.021 (0.021)	0.988	169	294
Benefits/Costs Ratio	2.781	1.766	1.015 (0.820)	1.238	124	161
Cost Structure Index	0.995	0.851	0.139** (0.069)	1.993	71	75
ln(Costs)	3.327	3.012	0.314 (0.384)	0.818	124	162

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

Following the aggregate SIR analysis, we estimate the Average Treatment Effects on the Treated (ATT) for projects that specifically incorporate sustainability and resilience (SR) components. These projects tend to be more homogeneous in nature, as both dimensions emphasize long-term infrastructure performance, asset durability, and environmental risk reduction. As a result, they may share similar design features, such as investments in climate-resilient materials, efficient energy use, or ecosystem protection, which share comparable design features and implementation approaches. Figure 5 illustrates the common-support distribution for SR projects, showing broad overlap between treated and control groups and confirming the validity of the matching procedure. In addition, table 4 shows the results for this subset, that clearly mirror the patterns observed in the aggregate SIR analysis: while differences in internal rate of return, benefit–cost ratio, and total costs remain statistically insignificant, treated projects exhibit a significantly higher cost

structure index, suggesting a relatively higher share of discounted capital investment in total discounted costs.

Figure 5. Propensity Score Distribution and Common Support for the SR Composite Index

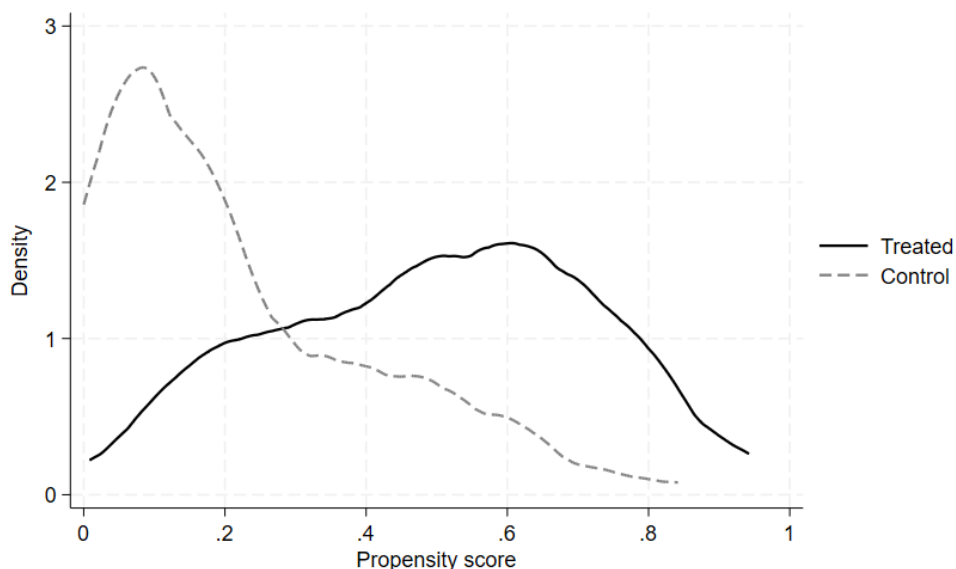


Table 4. Propensity Score Matching Results for Projects with SR Components

Outcome	Treated mean	Control mean	ATT	t-stat	N Treat.	N Control
Internal Rate of Return (IRR)	0.235	0.235	0.000 (0.021)	-0.007	129	331
Benefits/Costs Ratio	2.113	1.762	0.351 (0.611)	0.574	97	185
Cost Structure Index	0.980	0.844	0.136* (0.072)	1.886	44	96
ln(Costs)	3.367	3.222	0.145 (0.358)	0.405	98	186

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

To complement the aggregate analysis, we also estimate the Average Treatment Effects on the Treated (ATT) separately for each of the three components (sustainability, inclusion, and resilience) to better understand the individual contribution of each dimension. Table 5 reports the corresponding results, which show that the overall patterns observed in the SIR analysis are mainly driven by sustainability- and resilience-oriented projects. These operations display positive but moderate differences across most indicators, particularly in the participation of the net discounted value of capital investment in net discounted total costs, represented by the cost structure index.

Moreover, the results for inclusion-focused projects reveal a positive and slightly significant effect on the benefit–cost ratio, suggesting possibly that projects designed to improve accessibility and social integration may generate broader socioeconomic spillovers that are partially exhibited in this indicator. In contrast, resilience- and sustainability-oriented projects show no statistically significant differences across any of the cost–benefit indicators.

Table 5. Propensity Score Matching Results by SIR Component

Outcome	Sustainability		Inclusion		Resilience	
	ATT	t-stat	ATT	t-stat	ATT	t-stat
Internal Rate of Return (IRR)	-0.001 (0.023)	-0.026	0.023 (0.030)	0.749	-0.025 (0.026)	-0.960
Ratio Benefits/Costs	0.252 (0.491)	0.513	3.001* (1.793)	1.674	0.559 (1.553)	0.360
Cost Structure Index	0.083 (0.075)	1.115	0.034 (0.108)	0.317	0.010 (0.088)	0.116
ln(Costs)	-0.103 (0.339)	-0.304	-0.219 (0.392)	-0.560	0.311 (0.405)	0.767

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

To better understand our aggregate results, we use the delta method to decompose the change in the cost structure $Y = \frac{K}{K+O}$, where K denotes the discounted net flows of capital investment and O stands for the discounted net flows of operating and maintenance costs over the project lifecycle. The method relies on a first-order Taylor expansion of Y around baseline values of K and O , using the partial derivatives of the ratio to approximate how marginal changes in each component affect the overall share. This yields a linear decomposition in which the total change in Y can be expressed as the sum of the contribution from changes in K and the contribution from changes in O . This approach allows us to identify which cost component is primarily responsible for the observed variation in the cost structure index.¹⁷

The delta-method decomposition reveals a consistent pattern across both SIR and SR projects. In each case, the increase in the cost structure index is driven mainly by reductions in the discounted net flows of operating and maintenance costs rather than by changes in discounted net flows of capital investment. For SIR projects, operating and maintenance costs account for approximately 115 percent of the estimated change in the investment share, while capital investment contributes about –15 percent; for SR projects, the corresponding figures are roughly 113 percent and –13 percent. This method may report above 100 percent when the two components move in opposite directions. In this case, decreases in operating and maintenance costs raise the investment share, while changes in capital investment move the cost structure

¹⁷ For $Y = \frac{K}{K+O}$, the partial derivatives are $\frac{\partial Y}{\partial K} = \frac{O}{(K+O)^2}$, $\frac{\partial Y}{\partial O} = -\frac{K}{(K+O)^2}$. Using a first-order delta-method approximation, the change in the ratio can be written as $\Delta Y \approx \frac{O}{(K+O)^2} \Delta K - \frac{K}{(K+O)^2} \Delta O$, where ΔK and ΔO are the estimated effects on the discounted value of capital investment and operating and maintenance costs, respectively.

index in the opposite direction and only partially offset the effect of operating and maintenance costs. Overall, the findings indicate that the higher cost structure index observed in resilience-related projects is primarily associated with lower anticipated operating and maintenance costs over the project lifecycle.

Overall, the aggregate effects are consistent with the expected economic logic of sustainability and resilience-oriented interventions. These projects are designed to enhance efficiency, reliability, and resistance to future shocks, which can lead to lower operating and maintenance needs over the project lifecycle. This interpretation aligns with the decomposition results, which shows that the higher investment share—represented by a higher cost structure index—in SIR and SR projects is driven primarily by reductions in the discounted value of operating and maintenance costs, while changes in capital investment play a comparatively smaller and offsetting role. These findings suggest that SIR-related components influence the cost structure mainly through anticipated lifecycle savings.

This evidence highlights the importance of improving how cost–benefit analyses capture the broader economic and social benefits of such projects. The results also suggest that incorporating sustainability, inclusion, and resilience (SIR) components into infrastructure operations may generate positive externalities that are not explicitly measured in traditional appraisals, as illustrated by the inclusion component’s effect on the benefit–cost ratio. Strengthening the measurement of these indirect benefits is therefore essential for future policy guidelines and evaluation frameworks, ensuring that project assessments more accurately reflect the full economic and social value of SIR-oriented investments.

To validate our empirical findings, we estimate alternative specifications using three different matching procedures: nearest-neighbor matching with three neighbors, radius matching that pairs treated projects with control units whose propensity scores fall within a predefined range, and kernel matching, which assigns weights to control observations based on their proximity in the score distribution.¹⁸ Table A3 shows the results for both the aggregate SIR treatment and the SR subset. Overall, the conclusions are consistent across methods. For the internal rate of return (IRR), benefit–cost ratio, and project costs, the estimated effects remain small and statistically insignificant under all specifications, suggesting also the absence of systematic differences in these outcomes between treated and control projects. The cost structure index continues to exhibit a positive and some significant effect across all matching approaches and both treatment definitions. However, as discussed previously, this effect is primarily driven by a substantial reduction in discounted operating and maintenance cost net flows.¹⁹

In addition, we estimate our main specification using two alternative subsamples. First, we restrict the analysis to projects approved from 2010 onwards. Second, we split the sample according to the median value of the logarithm of the loan amount to explore whether the estimated effects differ by project size, given that SIR projects may require higher upfront investments.

¹⁸ We consider an Epanechnikov kernel to assign weights.

¹⁹ It is important to note that the absence of statistically significant effects on all CBA outcomes can be partially attributed to limitations in statistical power. The number of evaluable projects in the sample is limited, and the application of matching procedures further narrows the comparison set, which may affect the precision of the estimates. In addition, SIR components are not explicitly reported in standard CBA documents, meaning that their identification relies on external text-based classification rather than on direct valuation within the CBA itself. These challenges may obstruct observable differences between treated and control projects, as CBA indicators may not fully capture the mechanisms through which SIR elements operate.

Table A4 reports the results for projects approved since 2010. Overall, the findings closely resemble those reported in Table 3. In particular, SIR projects continue to exhibit a significantly higher share of capital expenditures in total costs, as reflected by the cost structure index, with a similar magnitude to that obtained in the baseline specification. The remaining outcomes also follow the same general pattern as the main results. These findings suggest that the baseline estimates are largely driven by projects approved after 2010, consistent with the increasing adoption of sustainability, inclusion, and resilience considerations in infrastructure projects over the last fifteen years, as illustrated in Figure 2.

Table A5 presents the results for projects with loan amounts above the median. For this subsample, the estimated effects generally follow the same direction as the baseline results. SIR projects continue to exhibit a higher share of capital expenditures in total costs, although the coefficient is no longer statistically significant. These results also provide limited support for the view that the baseline cost-structure finding is mechanically driven by project scale. If differences in capital expenditure shares simply exhibited the larger size of SIR projects, the estimated effect would be expected to be concentrated among the largest projects. However, within this subsample, the effect becomes less precise and is no longer statistically distinguishable from zero. This suggests that project size alone is unlikely to explain the baseline relationship between SIR components and project cost structures. Interestingly, the estimated internal rate of return (IRR) is larger for SIR projects than for comparable non-SIR projects, with statistical significance at the 10 percent level. This result suggests that, among larger and more expensive projects, SIR projects may be associated with higher expected returns. However, this higher estimated return is not accompanied by a higher benefit-cost ratio, which remains statistically indistinguishable from zero. Future research may help clarify this relationship and the mechanisms underlying it.

On the other hand, Table A6 reports the results for projects with loan amounts below the median. In this subsample, SIR projects exhibit significantly lower IRRs and substantially lower total costs than comparable non-SIR projects. The cost structure index is not statistically different from zero, providing evidence that the baseline cost-structure result is not mechanically driven by project scale. Considering this, the split-sample analysis suggests that differences in loan size alone are unlikely to explain the higher capital expenditure share observed in the baseline specification. Rather, the relationship between SIR considerations and project outcomes appears to vary across project scales, with the strongest cost differences concentrated among smaller projects and higher returns observed among larger developments.

6. Concluding Remarks

This paper explored whether incorporating sustainability, inclusion, and resilience (SIR) elements in infrastructure projects leads to systematic differences in economic appraisal outcomes in Latin America and the Caribbean. Leveraging a harmonized dataset of Multilateral Development Bank projects in LAC – representing, in principle, an upper bound in the integration of sustainability, resilience, and inclusion dimensions into project preparation, given the renewed missions and mandates of these institutions – and applying text-mining and propensity score matching techniques, we compared SIR-oriented and traditional operations. Across multiple estimators, we find no statistically significant differences in standard cost-benefit indicators – such as internal rates of return, benefit-cost ratios, or total economic costs – between

SIR and non-SIR projects. However, SIR-oriented projects exhibit a distinct cost structure: a higher share of discounted capital expenditures and lower operating and maintenance costs, suggesting a greater allocation of resources to upfront investment, consistent with resilience and sustainability objectives.

Decomposing this change reveals that it is primarily driven by reductions in discounted operating and maintenance flows. This pattern is consistent with the economic rationale behind SIR design, which emphasizes durability, risk mitigation, and efficiency gains that reduce long-term recurrent costs. These findings indicate that while upfront investment requirements rise, lifecycle costs decline, reflecting adaptation benefits that conventional appraisal metrics may not fully capture.

Beyond the observed variation in cost composition, these findings carry important policy implications. On the cost side, the fact that SIR projects concentrate a larger share of expenditures upfront while reducing operating and maintenance costs signals more than a design choice – it reflects better project preparation and greater transparency in total lifecycle costs. By making capital requirements explicit early on, SIR-oriented projects enhance cost predictability, which in turn supports more efficient resource allocation and strengthens fiscal responsibility. In this sense, SIR projects are fiscally more accountable, as they reduce uncertainty and facilitate long-term budget planning.

On the benefits side, however, the absence of significant differences in conventional indicators underscores a critical gap: what is not measured does not exist. While our analysis reveals meaningful cost-side adjustments, current appraisal methodologies fail to capture the nature of benefits associated with sustainability, inclusion, and resilience. This limitation affects the socio-economic evaluation of SIR projects, where costs are increasingly transparent, but the “delta” of benefits remains invisible. Addressing this gap requires adopting more sophisticated valuation frameworks capable of quantifying resilience, sustainability, and inclusion gains at the project level. Without such improvements, decision-makers lack the evidence needed to justify the additional upfront investment in SIR components, perpetuating an incomplete picture of their true value.

Future research should focus on richer datasets with explicit coding of specific SIR components, valuation techniques that quantify resilience, sustainability, and inclusion benefits. Strengthening the implementation of these tools will be essential to ensure that infrastructure investment decisions fully reflect evolving development priorities.

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Appendix

A. Primary sources of information to construct the dataset

This paper analyzes the effect of incorporating SIR components into infrastructure projects in Latin America on cost–benefit analysis outcomes. To do so, we construct a unique dataset containing project-level information, which enables a proper comparison between SIR-oriented operations and traditional infrastructure developments. As described in the data section, the information was extracted from publicly available documents from the World Bank and the Inter-American Development Bank, where project characteristics and appraisal details are reported.

We rely, when available, on three types of World Bank documents to extract appraisal indicators such as the Economic Internal Rate of Return (EIRR), the benefit–cost ratio, and the cost composition of each project. Such information is typically reported in Staff Appraisal Documents, Project Appraisal Documents, and Project Completion Reports (PCRs).

The Staff Appraisal Document shows the results of the Bank’s internal appraisal of a proposed project prior to approval. It includes detailed assessments of project design, objectives, technical feasibility, expected economic returns, financial analysis, risk evaluation, and implementation arrangements. It typically contains full cost–benefit analyses, including EIRR, benefit–cost ratios, and disaggregated cost structures.

A Project Appraisal Document is the main official document submitted to the Bank’s Board for project approval. It summarizes the project’s justification, objectives, technical components, financing plan, expected economic benefits, risk assessment, environmental and social safeguards, and monitoring indicators. These documents frequently, but not always, report economic valuation metrics such as expected EIRR, net present value, or cost–benefit ratios.

Finally, the Project Completion Reports are prepared after the execution of every project to evaluate its performance. It provides information on final costs, implementation challenges, outputs and outcomes achieved, and, when available, some ex-ante economic indicators.

On the other hand, the Inter-American Development Bank typically reports cost–benefit analysis outcomes in a dedicated economic evaluation document, which may be published in English, Spanish, or Portuguese. Accordingly, our sample includes only those projects for which this document is publicly accessible.

Finally, some project characteristics are obtained directly from the corresponding institutional websites, which report variables such as the amount approved for each project, the project’s main objective, the approval date, and other relevant descriptive information.

Figure A1. Total Number of Projects vs. Projects with CBA by Year

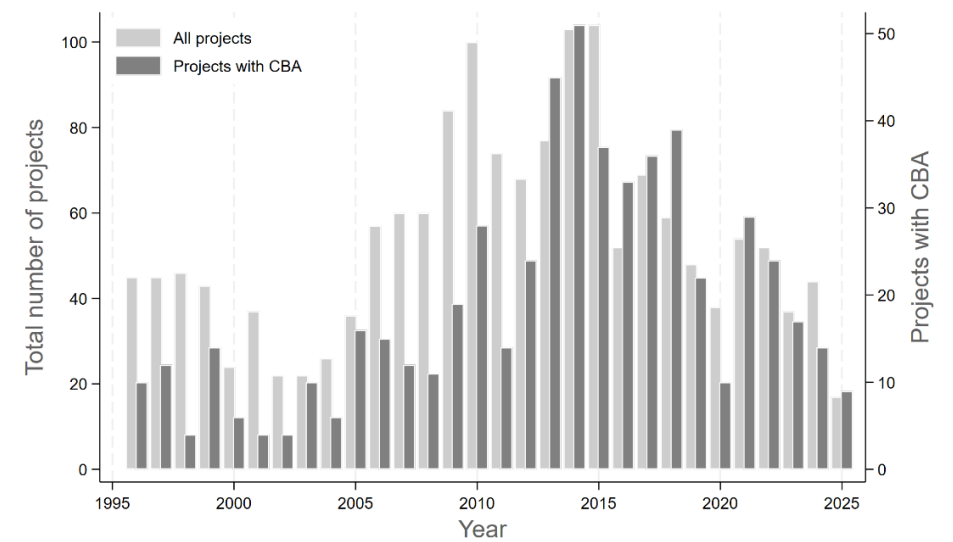


Figure A2. Total Amount Approved by Year

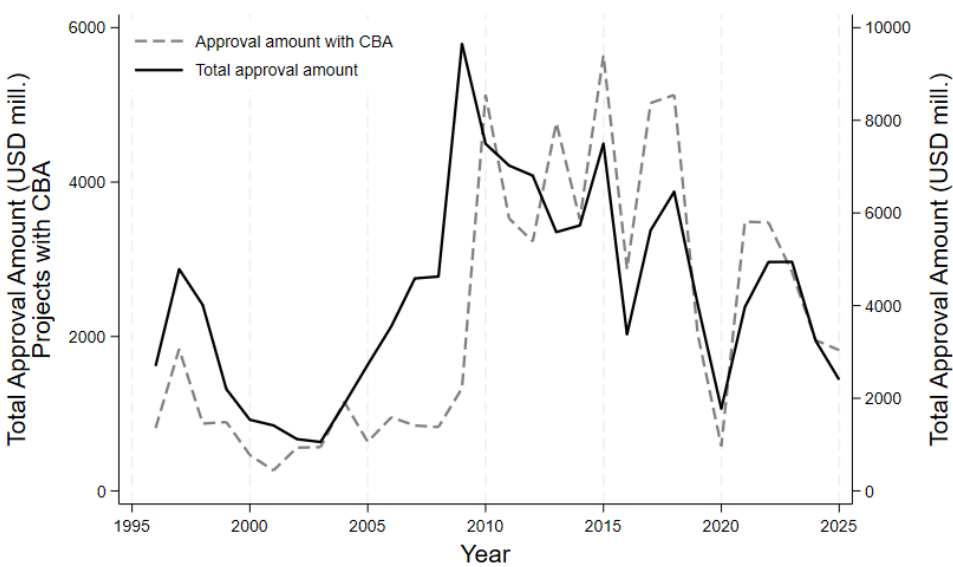


Table A1. Distribution of Projects Across Sectors and Subsectors

Sector and Subsectors	Number of Projects	Share within Sector
Energy		
Total	119	100.00%
Access & Off-grid (incl. Clean Cooking)	41	34.45%
Efficiency, Governance & Digital	35	29.41%
Renewables & Storage	17	14.29%
Transmission & Distribution (Grid & Gas/Oil)	17	14.29%
Thermal Generation (Fossil/Nuclear)	7	5.88%
Unclassified	2	1.68%
Transport		
Total	224	100.00%
Connectivity and Logistics	95	42.41%
Road Construction and Maintenance	38	16.96%
Urban and Public Transport	30	13.39%
Road Safety	29	12.95%
Ports, Rail, and Air Transport	19	8.48%
Unclassified	13	5.80%
Water and Sanitation		
Total	232	100.00%
Sanitation & Wastewater	150	64.66%
Multisectoral water projects	32	13.79%
Water Supply & Desalination	29	12.50%
Water Resources, Flood & Watershed	13	5.60%
Utility Governance, Efficiency & Digital	7	3.02%
Irrigation & Drainage (Agriculture)	1	0.43%

Table A2. Distribution of Projects Across Regions

Region	Projects	%
Total	575	100.00%
Southern Cone	235	40.87%
Andean Region	145	25.22%
Central America	98	17.04%
Caribbean	65	11.30%
Mexico / Other	29	5.04%
Unclassified	3	0.52%

Table A3. Robustness checks – PSM with Different Matching Methods

Outcome	Nearest neighbor (3)		Radius (0.05)		Kernel	
	SIR	SR	SIR	SR	SIR	SR
Internal Rate of Return (IRR)	0.022 (0.023)	0.005 (0.022)	0.013 (0.022)	-0.002 (0.022)	0.013 (0.022)	-0.002 (0.021)
Ratio Benefits/Costs	0.970 (0.878)	0.172 (0.499)	0.772 (0.876)	0.097 (1.007)	0.772 (0.876)	0.144 (1.016)
Cost Structure Index	0.124 (0.076)	0.137* (0.073)	0.133* (0.70)	0.116 (0.086)	0.131* (0.069)	0.122 (0.086)
ln(Costs)	0.316 (0.411)	-0.083 (0.367)	-0.053 (0.389)	0.168 (0.353)	-0.053 (0.389)	0.167 (0.347)

Table A4. Propensity Score Matching Results for Projects with SIR Components Approved Since 2010

Outcome	Treated mean	Control mean	ATT	t-stat	N Treat.	N Control
Internal Rate of Return (IRR)	0.257	0.224	0.033 (0.021)	1.576	164	223
Benefits/Costs Ratio	2.803	1.926	0.877 (0.767)	1.143	122	131
Cost Structure Index	0.992	0.859	0.133** (0.065)	2.045	75	67
ln(Costs)	3.342	3.294	0.048 (0.411)	0.116	123	132

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

Table A5. Propensity Score Matching Results for Projects with SIR Components Above the Median Loan Size

Outcome	Treated mean	Control mean	ATT	t-stat	N Treat.	N Control
Internal Rate of Return (IRR)	0.281	0.233	0.048* (0.029)	1.645	89	122
Benefits/Costs Ratio	3.505	2.616	0.889 (1.215)	0.732	68	73
Cost Structure Index	0.990	0.858	0.132 (0.087)	1.516	42	33
ln(Costs)	3.699	3.513	0.186 (0.473)	0.394	69	73

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

Table A6. Propensity Score Matching Results for Projects with SIR Components Below the Median Loan Size

Outcome	Treated mean	Control mean	ATT	t-stat	N Treat.	N Control
Internal Rate of Return (IRR)	0.222	0.291	-0.069* (0.040)	-1.714	62	112
Benefits/Costs Ratio	1.797	2.097	0.299 (1.104)	0.271	36	62
Cost Structure Index	1.025	1.032	-0.008 (0.115)	-0.067	22	34
ln(Costs)	2.813	4.194	-1.382*** (0.416)	-3.323	36	63

Note: Standard errors in parenthesis.

***p<0.01, **p<0.05, *p<0.01.

Ángel, D., Suárez-Alemán, A. (2026). The Delta of Sustainable, Inclusive, and Resilient Infrastructure Investment: Evidence from Cost-Benefit Appraisal.

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