HUELLA

MEASURING THE IMPACT of development projects

Marta Ruiz-Arranz
Lucía Martín
Giulia Lotti
Werner Peña
Francisco Bolaños

IDB

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Key Words: HUELLA, Impact Assessment, Development Projects, Satellite Imagery, Environmental Impacts, Economic Growth, Portfolio Analysis, Mexico, Costa Rica, Inter-American Development Bank.

ABSTRACT

HUELLA, an innovative methodology developed by the Inter-American Development Bank (IDB), represents a paradigm shift in evaluating development project impacts. By integrating advanced tools such as satellite imagery and leveraging a quasi-experimental design, HUELLA offers precise and scalable assessments of the cumulative effects of multiple projects at granular, subnational levels.

HUELLA focuses on the impact that IDB projects have in the locations where they are implemented. It systematically compares communities that receive IDB financing against similar ones that did not, evaluating whether IDB interventions make a lasting difference. The methodology overcomes traditional evaluation limitations by providing analyses at the portfolio level and incorporating non-traditional indicators like environmental and economic growth outcomes, enabling a more comprehensive impact analysis.

Applications in Mexico and Costa Rica demonstrate its effectiveness, revealing positive outcomes such as economic growth and reduced crime rates. However, the results underscore the importance of sustainably managing environmental trade-offs.

By complementing traditional evaluation frameworks, HUELLA enhances evidence-based decision-making, transparency, and stakeholder trust, establishing itself as a transformative tool in development impact assessment. The methodology's scalability and adaptability has the potential to drive informed, impactful community development.

Key Words: HUELLA, Impact Assessment, Development Projects, Satellite Imagery, Environmental Impacts, Economic Growth, Portfolio Analysis, Mexico, Costa Rica, Inter-American Development Bank.

PREFACE
by Vice President of Countries and Regional Integration

The Inter-American Development Bank (IDB) is committed to delivering tangible and lasting impact across Latin America and the Caribbean (LAC). Measuring results is crucial as it enables us to assess our progress, scale effective solutions, learn from successes and challenges, and adapt strategies to maximize long-term sustainability and efficiency. We remain dedicated to enhancing our measurement efforts to ensure that every initiative generates meaningful value for the region.

Our institution is undergoing a transformation through IDBImpact+, aimed at increasing the impact and scale of our work across LAC. The approval of our institutional strategy marks a pivotal moment for both our organization and the region. Our mandate is clear: to do more, to do it better, and to do it faster—always with a people-centered approach. To ensure we are meeting our goals, it is essential to have clear metrics and robust evidence to evaluate our efforts.

HUELLA builds upon the IDB's ongoing efforts to establish a comprehensive and rigorous evaluation framework for our operations. The Vice Presidency for Countries and Regional Integration (VPC) takes pride in this tool, which highlights the critical role of data and technology in providing solid evidence of the results we are delivering. HUELLA represents just the beginning of unprecedented opportunities presented by innovative tools, such as satellite imagery, to facilitate the measurement of our impact. Technology has become a key ally in assessing our work at a highly granular level and in determining whether we are truly driving meaningful change in the communities we serve.

This methodological note presents case studies showcasing the application of HUELLA in Mexico and Costa Rica, highlighting the positive impact of the Bank's initiatives in these countries. It marks the beginning of a promising agenda to measure the outcomes of our interventions across LAC using this innovative tool. By leveraging new technologies to bridge information gaps, HUELLA offers a significant advantage in providing valuable insights, even in countries with limited data and statistical capabilities.

Together with our institutional evaluation instruments, HUELLA provides the insights needed to make strategic decisions and to ensure that our efforts are focused on operations that deliver tangible results. This reflects the commitment of VPC to continuously build on our experiences, enabling us to improve and fulfill our institutional mandate of achieving measurable outcomes.

Initiatives such as HUELLA position the IDB at the forefront of results measurement. I am confident that this and other innovative tools will continue to enhance our ability to rise to the challenge of doing more, doing it better, and doing it faster to improve lives across the region.

Anabel González
Vice President for Countries and Regional Integration
IDB Group
January 2025

PREFACE
by CID Manager

At its core, development is about people and their hopes for a better future. With every project we undertake, we aim to improve the lives of individuals, families, and communities across the region. This is why I am proud to present HUELLA and its application in Mexico and Costa Rica. The launch of this initiative comes at a pivotal moment for the IDB. In 2024, we renewed our Institutional Strategy with the goal of maximizing the scale and impact of our work. The Regional Country Department of Central America Haiti, Mexico, Panama and Dominican Republic (CID), is committed to raising impact measurement standards to ensure that our projects achieve their objectives and that we maximize the value of every dollar invested, and transform it into better conditions for our countries and their people.

HUELLA represents a shift in our approach to impact measurement by leveraging innovative tools and non-traditional data sources, such as geospatial data. Additionally, HUELLA offers a programmatic perspective, enabling us to assess the cumulative impact of multiple projects with similar objectives and to estimate their long-term sustainability. This comprehensive approach provides valuable insights into the overall impact of our project portfolio.

Tools such as HUELLA strengthen our engagement with Goverments by reinforcing our commitment to transparency and accountability—key pillars in our relationships with partner countries. Being transparent about our results builds trust and enhances communication with governments, citizens, and the communities we serve. Accountability fosters a culture of responsibility and is essential for improving the effectiveness and efficiency of our interventions.

In an era of rapid technological and informational advancements, relying solely on conventional approaches to impact measurement is no longer sufficient. HUELLA represents a major step forward in leveraging non-traditional data and innovative methodologies to assess our impact more effectively. By utilizing granular data, it enables us to capture meaningful changes in community well-being that might otherwise go unnoticed in national statistics, providing a deeper and more accurate understanding of our efforts.

In CID we are committed to being a key development partner, reducing poverty and inequality, addressing climate change, and fostering regional growth. HUELLA is more than a tool; it's a reflection of our promise to learn, adapt, and improve, ensuring that every effort we make translates into meaningful change. Together, we can create a legacy of impact that truly improves lives.

Tomás Bermudez
Manager, Central America - Haiti, Mexico, Panama
and the Dominican Republic Regional Country Department
IDB Group
January 2025

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EXECUTIVE SUMMARY

The Inter-American Development Bank (IDB) has reaffirmed its commitment to maximizing development impact in Latin America and the Caribbean (LAC) through the introduction of its Impact+ Strategy in 2024. A persistent challenge in measuring the true breadth of the Bank's contributions, however, lies in traditional evaluation methods, which often focus on individual projects and sometimes lack the necessary data. Answering the call to increase impact and address these gaps, this document presents HUELLA, an innovative methodology designed to evaluate the collective impact of an entire portfolio of interventions, even in data-constrained environments.

HUELLA redefines impact assessment by integrating advanced analytical tools and leveraging non-traditional data sources, such as satellite imagery, to track economic, social, and environmental outcomes at highly granular, subnational levels. This approach not only captures localized changes but also helps overcome data availability challenges by utilizing alternative datasets when traditional sources are incomplete or unavailable. Its quasi-experimental design allows to compare communities that receive IDB financing against similar ones that did not, enabling the IDB to determine whether observed changes can be directly linked to its interventions under specific assumptions.

One of HUELLA's key advantages is its ability to deliver analyses at the portfolio level, providing timely information that can inform adaptive decision-making. Unlike conventional evaluation frameworks that often require significant time and resources to assess individual projects, HUELLA evaluates the cumulative impact of a portfolio of interventions, offering a more strategic, long-term perspective. Its scalability across countries ensures that lessons learned can be applied regionally, amplifying its value as a strategic tool.

Early applications of HUELLA in Mexico and Costa Rica illustrate its potential. In Mexico, IDB interventions have spurred economic growth, urban expansion, and infrastructure development. Similarly, in Costa Rica, investments in transportation and security have reduced crime and enhanced economic activity. Importantly, in both cases, these economic gains were achieved without corresponding increases in pollution levels. However, a reduction in vegetation was observed, underscoring the importance of reforestation efforts to mitigate environmental trade-offs.

Answering the call to increase impact and address these gaps, this document presents HUELLA, an innovative methodology designed to evaluate the collective impact of an entire portfolio of interventions, not only of the IDB but of development projects in general, even in data-constrained environments. By addressing data availability challenges, focusing on cumulative outcomes, and providing actionable insights, it enhances the IDB's ability to drive sustainable growth, improve transparency, and build trust with stakeholders. This innovative methodology positions the IDB as a leader in development evaluation, delivering lasting benefits to the communities it serves.

INTRODUCTION AND MOTIVATION

Impact lies at the core of the Inter-American Development Bank (IDB) Group's mission, which led to the approval of the Impact+ Strategy in 2024. The new institutional strategy aims at increasing the impact and scale of the outcomes of our interventions.

Still, the IDB effectiveness indicators are modest, showing that only 33% of projects received a positive rating in effectiveness in 2023. This seemingly lackluster performance warrants closer examination. To some extent, this could reflect the existence of methodological and data limitations to accurately capture the multifaceted outcomes of development projects. Therefore, the critical question that emerges is: how can we measure the results of IDB's operations more effectively and in a timely manner?

If alternative ways to assess impact can be devised, we could gain deeper insights into the impact of IDB Group's projects, leading to more informed decision-making and ultimately improving the lives of the communities it serves. This led us to reflect on what we are truly measuring and to ask ourselves whether the issue is low effectiveness, or if the tools we use face challenges that prevent us from fully capturing our impact in the region.

With these questions in mind, HUELLA was born. HUELLA, which means "footprint" in Spanish, proposes a new way of measuring impact, using cutting-edge and innovative datasets. HUELLA focuses on the impact that IDB projects have in the locations where they are implemented, measuring changes at a highly granular geographical level. It also offers a new strategy for addressing attribution challenges - answering whether the changes we observe in the areas where we operate are truly a result of the Bank's presence.

The Bank has made significant efforts to integrate evidence on what works into project design, establishing metrics for monitoring implementation, and adopting rigorous methods for evaluating outcomes. Currently, the Bank has a fully implemented evaluation and validation framework, which includes qualitative project completion assessments, known as Project Completion Reports (PCRs). Moreover, approximately one third of projects undergo rigorous impact evaluations.

HUELLA aims to complement the Bank's existing evaluation framework. It is not intended to replace the Bank's evaluation tools, but rather to expand the types of questions we can address. For example, HUELLA has the capability to assess the development outcomes across a portfolio of projects, whereas self-assessment evaluations and impact evaluations are focused on individual projects. This provides a more holistic view of the Bank's long-term effectiveness in transforming the communities where the IDB is present.

At the heart of our approach is the transformative power of data. HUELLA leverages indicators that go beyond those used in traditional evaluations, unlocking new dimensions of impact measurement. The rapid growth in data generation offers unprecedented opportunities: with increasingly sophisticated data from non-traditional sources, such as satellite imagery, we can capture insights at a granular level, signaling the start of what's truly possible. Precise, localized data allows us to measure outcomes tailored to each community, offering a richer understanding of the unique effects of each project and fostering continuous improvement.

HUELLA serves as a powerful tool for building transparency and trust, maximizing our impact through data-driven insights. LAC countries face fiscal challenges, including limited fiscal space and high public debt. Governments and key stakeholders rely on IDB to invest wisely, optimizing the use of these resources to maximize the value generated for communities. By clearly showing how and where investments are directed, we reinforce our commitment to transparency and build stronger relationships with governments, communities and other critical stakeholders.

Ultimately, by measuring impact and maximizing value, we can track progress towards our objectives, optimize resource allocation, and improve project design on an ongoing basis. This data-driven approach not only enhances our effectiveness but also strengthens the trust and confidence placed in us by all stakeholders.

The HUELLA methodology has proven to be effective. Its application in Mexico and Costa Rica demonstrates that IDB projects have driven positive changes in the economic activity of local communities, as evidenced by increases in real Gross Domestic Product (GDP), energy consumption, and night-time lights. Moreover, there were no significant changes in pollution levels in areas where IDB projects were implemented, although a slight decrease in vegetation indices was observed. Notably, the IDB's security portfolio in Costa Rica has shown positive impacts, including reductions in domestic violence and other crimes.

Looking ahead, HUELLA represents a significant step forward in how we measure and understand the impact of our operations across the region. To our knowledge, no other organization is implementing a methodology similar to HUELLA, highlighting the tool's potential in the field of development. By incorporating innovative methodologies and leveraging non-traditional data sources, it enables us to capture development outcomes with a level of granularity that was previously unattainable.

As we refine HUELLA and explore its broader applications in programming and monitoring, we strengthen our ability to assess the wider effects of our interventions while complementing existing evaluation frameworks. HUELLA underscores the Bank's commitment to transparency and accountability, offering stakeholders valuable insights into IDB operations. This supports informed decision-making, optimizes resources, and ensures our efforts deliver measurable, lasting benefits to communities across LAC.

1.

HUELLA

REVOLUTIONIZING how we measure results

1. HUELLA:
REVOLUTIONIZING how we measure results

HUELLA is an innovative methodology for measuring the impact of IDB operations, developed to overcome attribution challenges and offering several key advantages. Among the most significant benefits we have identified are: (i) its cost-effectiveness, (ii) its ability to measure impact at a highly granular geographic level, (iii) its capacity to provide a comprehensive portfolio view and assess the cumulative impact of a group of projects in the long-term and (iv) its capacity to evaluate non-traditional outcomes.

There are three aspects that make this methodology more **cost-effective** and **time-efficient** than traditional evaluations:

- From a *scalability perspective*, this methodology, once refined, can be applied to more countries. The most significant effort has been the initial investment in developing the methodology and conducting fine-tuning processes, such as robustness checks. Moving forward, the application of the HUELLA model will become increasingly efficient and cost-effective.
- From an *operational standpoint*, as explained in methodology chapter, the approach does not require the ex-ante construction of a control group of municipalities. Instead, it employs a quasi-experimental methodology, comparing municipalities with IDB-financed projects to similar municipalities that did not receive such financing. This enables the assessment of whether IDB-supported municipalities show better outcomes.
- In terms of *timing*, impact evaluations can be costly and take years to complete. Many of these evaluations are considerably delayed and miss the window of opportunity to influence policy.[1] In contrast, HUELLA provides insights into impacts more timely, enabling the IDB to adjust actions more swiftly to align with the evolving needs of municipalities and the overarching objectives of its projects.

Additionally, HUELLA measures impact at a highly **granular geographical level**, capturing changes that assessments conducted at a more aggregate level might overlook. IDB financing often represents only a fraction of a country's overall financing needs, making national-level indicators an imperfect tool for evaluating effectiveness. The subnational detail offered by HUELLA allows for a closer examination of local realities, enabling us to assess whether meaningful changes are occurring in a community following an IDB intervention.

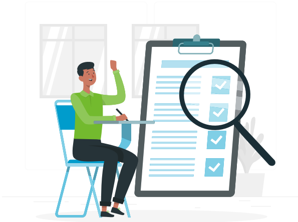
1 Puri, J. *Often late and costs a pretty penny: do impact evaluations meet the opportunity window?* Independent Evaluation Unit Blog. July, 2019.

HUELLA offers a programmatic and **portfolio approach**, as it measures the impact of a group of operations and its cumulative impact. A methodology that focuses on portfolio-level impact not only enriches the understanding of each individual project but also provides a broader strategic perspective that is critical to the long-term success of the organization. Key advantages of this portfolio approach include:

- The *individuation of the synergies and interrelationships between projects:* often, the benefits of one project can positively influence other projects, creating added value that would not be captured in an isolated assessment.
- Unlike PCRs, which are prepared six months after the project's closure, this methodology allows for the analysis of a *longer time horizon* by tracking outcome variables over an extended period. This is particularly important, as development results often take time to materialize.
- The *programmatic approach* informs new project design by highlighting what works and what does not. By providing impact results, it shifts the focus toward evidence-based decision-making, where impact drives project development. This approach fosters innovation, identifies best practices, and strengthens the credibility of projects when presenting and justifying them.
- In terms of *risk management*, understanding portfolio-level impact helps identify risks and opportunities associated with a group of projects. This analysis enables proactive and strategic management, reducing exposure to potential isolated failures.
- Regarding *communication and stakeholder engagement*, presenting a programmatic impact framework makes it easier to communicate results to stakeholders and fosters collaborative discussions.

Finally, HUELLA introduces variables not included in traditional evaluations, such as economic growth, settlement growth, or pollution. The measurement of these variables aims to capture spillovers from projects in the communities where they operate, something that is often overlooked in other evaluations.

2. METHODOLOGY



2. METHODOLOGY

The HUELLA methodology was developed in response to key challenges in evaluating the impacts of our projects, including limitations in data availability, quality, and accessibility, and tying observed changes directly to the projects. We will delve into data solutions in the next section. Here we begin by addressing attribution challenges –ensuring that the observed changes in municipalities benefiting from IDB projects can be linked directly to the projects themselves. As IDB projects are not randomly distributed across municipalities, the challenge of attribution becomes particularly pronounced, making it difficult to isolate the effects of the IDB intervention from other influencing factors. Various external variables, such as socio-economic conditions, concurrent policies, and environmental changes, can affect the outcomes, making it hard to determine whether observed outcomes can be attributed to the IDB.

The question therefore is: *how can we effectively address this challenge?*

Let us imagine two municipalities within the same country that have similar socioeconomic characteristics, such as a comparable trend in economic growth over time before the IDB's intervention.

In this scenario, one of the municipalities, Municipality B, receives the IDB intervention at a specific time (t), while the other, Municipality A, does not, with all other conditions remaining constant; the only change is the IDB intervention (Figure 1).

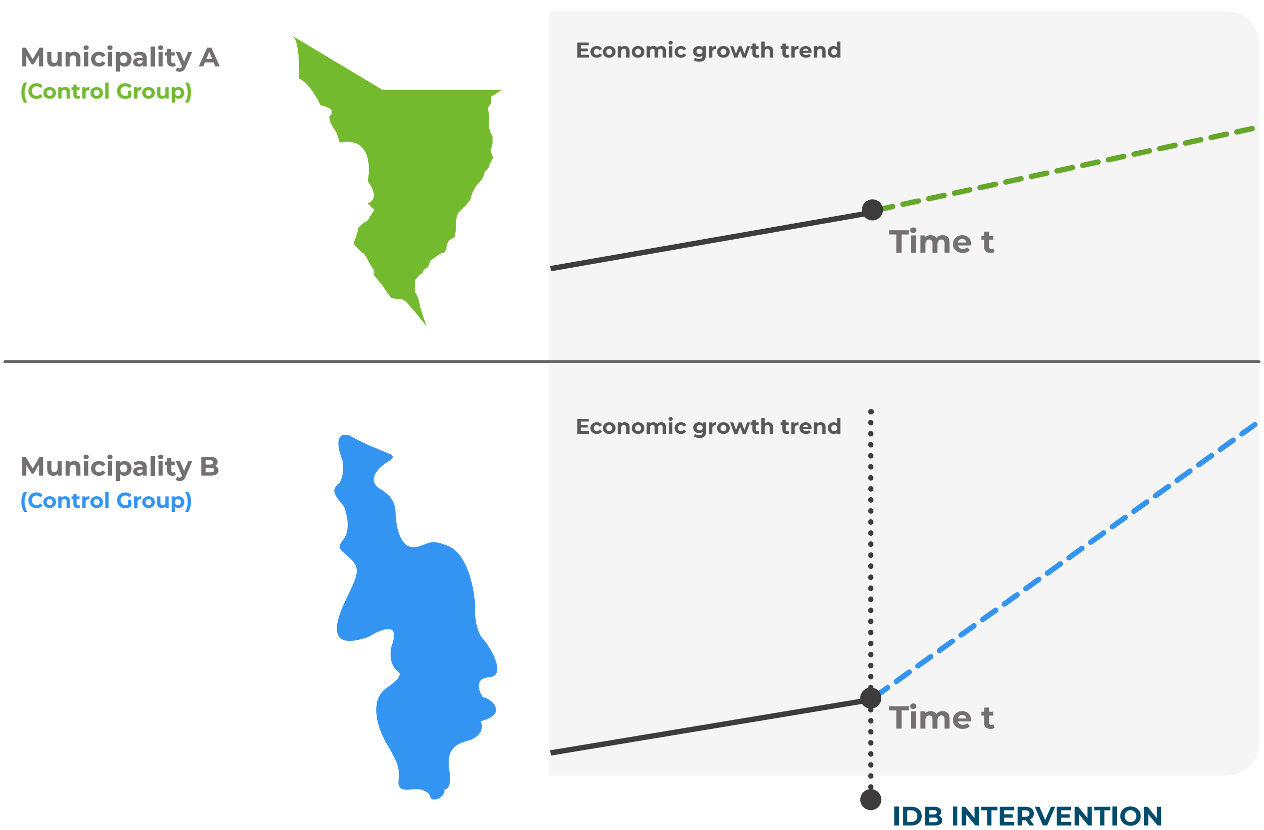
If, as time passes, the municipality that benefits from the IDB intervention experiences greater Gross Domestic Product (GDP) growth compared to the comparable control municipality that did not receive the intervention, the difference in growth between the two can be attributed to the projects implemented by the IDB.

This is the fundamental idea behind quasi-experimental evaluations, including the two methodologies we use, which are based on generalized synthetic controls (Xu, 2017) and difference-in-differences with multiple time periods (Callaway & Sant'Anna, 2021).[2] We implemented generalized synthetic controls for the estimations in Mexico and the estimations of transportation portfolio in Costa Rica. We implemented difference-in-differences with multiple time periods for the estimations of the security portfolio in Costa Rica. We chose the second method for the security portfolio because only three years of crime data were available for the pre-treatment period. Implementing generalized synthetic controls with too few pre-treatment data might have produced biased results due to the risk of overfitting the estimations. In this context, treatment essentially refers to the intervention being analyzed.

To conduct the evaluations, we need data available for all municipalities before and after the start of the projects. In addition, we require municipality-level variables to improve comparability between municipalities.

FIGURE 1

Illustration of Quasi-Experimental Design



Notes: The graph shows the economic growth trends for two municipalities over time: Municipality B - the treated unit (subject to an intervention) - and Municipality A – the control unit (not exposed to the intervention). Prior to the intervention, the two municipalities exhibit parallel trends, indicating comparable behavior. After the intervention (marked by the dashed vertical line at Time t), Municipality B demonstrates a deviation in its trend relative to Municipality A. This change, assuming all else remains equal, can be attributed to the effect of the IDB intervention.

2 For a more detailed explanation of the methodologies please refer to Annex I.

3.

BUILDING BLOCKS

3. BUILDING BLOCKS

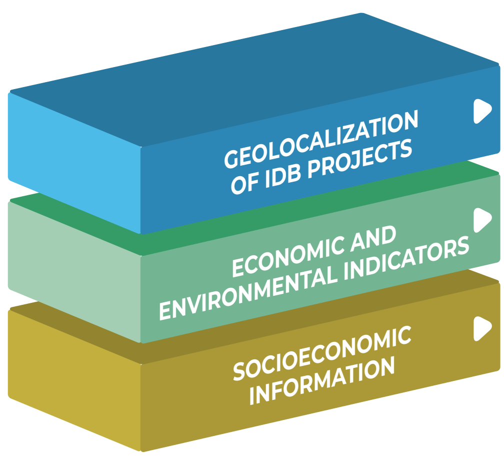
The application of the generalized synthetic controls and difference-in-differences methodologies requires territorial-level information.[3] First, it is essential to have precise data on the locations where IDB project outputs are delivered - in other words, the areas where the Bank operates within a country. Second, socioeconomic information about the municipalities is needed to assess whether IDB projects impact these indicators and to determine whether the municipalities being compared (treatment and control groups) are similar before and after IDB interventions. Third, climate change indicators are necessary to evaluate whether our interventions are having an impact on the environment.

However, the Bank currently lacks a centralized database containing georeferenced information on its operations. While notable efforts have been made, such as the MAPAMERICAS initiative,[4] which mapped operations in execution between 2010 and 2015, the data is not up to date.[5] Additionally, other efforts have been limited to specific countries, leading to inconsistencies in coverage and data formats. Likewise, there is no existing database that systematically and periodically produces socioeconomic and climate indicators at the subnational level.

To address this information gap, HUELLA has developed what we call the three Building Blocks:

1. The geographic location of IDB projects;
2. Socio-economic indicators at the subnational level;
3. Satellite-derived socio-economic and environmental indicator

FIGURE 2
The three building blocks



Source: own elaboration.

3 This requirement is also true for the Difference-in-Differences with multiple time periods.
4 MAPAMERICAS is an IDB an online interactive mapping that shows images, videos, news stories, statistics, project indicators and other documents relating to the bank's projects in the region.
5 MapaInversiones is an IDB initiative that promotes transparency in public spending, investments, and procurement across Latin America and the Caribbean through digital platforms that integrate and visualize public data. Although the tool is available for Costa Rica, including the localization of public works, georeferencing is not conducted at the product level, and its time frame is more limited compared to the one used in this study for HUELLA's application in Costa Rica. Nonetheless, the team is actively collaborating with the MapaInversiones technical team, with plans for the tool to serve as a valuable resource in other countries where HUELLA will be implemented.

3.1. Geolocalization of IDB projects

The geographic referencing of IDB projects at the municipal level is central to the HUELLA methodology, as it enables us to identify the municipalities that benefit from IDB financing. Georeferencing is a complex process that involves an extensive desk review of project documents, validation of the geographical scope with project teams to ensure accuracy, and the final localization of the project using mapping services.

The georeferencing of the CID country portfolio was conducted at the output level, with the exception of Costa Rica. In this case, georeferencing was carried out at the works level, leveraging the detailed information provided by Atlas. The box below summarizes the portfolio's figures after the georeferencing exercise, with additional details presented in Annex II.

Total IDB Portfolio:

Georeferenced portfolio:
290 operations
Across 10 countries (Out of 750 total operations).

MEXICO PORTFOLIO:

51 operations
Georeferenced (2010-2023), Apanning 10 sectors.

- OUTPUTS: 231 mapped across 425 municipalities.
- **Evaluation-eligible operations:** Reduced to 27 operations (53%), based on data and methodological constraints.

COSTA RICA PORTFOLIO:

19 operations
Georeferenced (2010-2024), Spanning 8 sectors.

- **Works:** 504 works across 81 cantons.
- **Evaluation-eligible operations:** Reduced to 79 works (16%).

Transportation Sector:
- 61 project works (2010-2014), covering 42 cantons.

Security Sector:
- 18 project works (2013), covering 16 cantons.

- Excluded sectors: Water and Sanitation, Education, Regional Integration, Tourism, Energy, and SMEs.

3.1.1 The Data Sources

The georeferencing process relied on three main sources of information. The initial source was the MAPAMERICAS project. This initiative served as the foundational database, with records integrated into the Bank's systems, covering approximately 61% of all identified operations.

As a second source, records were retrieved from the Bank's repositories, including Ezshare folders, the Convergence system, and the IDB extranet, where comprehensive documentation on loan programs is stored. This included documents from the design and implementation phases of projects, such as the PCR and their annexes, mid-term and final evaluation reports, procurement documents, results matrices, progress reports, and other relevant project materials.

The third source involved reviewing information available on the websites of national institutions of beneficiary countries, specifically seeking geographical descriptions of the projects. Once all relevant documents were identified from these sources, they were meticulously analyzed to locate details on executed projects, focusing on intervention sites, geographic locations, beneficiary municipalities, and other critical data points.

For Costa Rica, we joined efforts with the Costa Rica operations teams and the Atlas initiative. Atlas is a tool that provides in a systematic and comparable way, a georeferenced overview of the relationship between road infrastructures -national and cantonal- with social, environmental and economic dimensions. In that sense, Atlas provides the precise location of all IDB Transportation works. Additionally, the Costa Rica operation team had systematized a georeferenced database of the full IDB portfolio in the country starting in 2010

3.1.2 Selection Filters

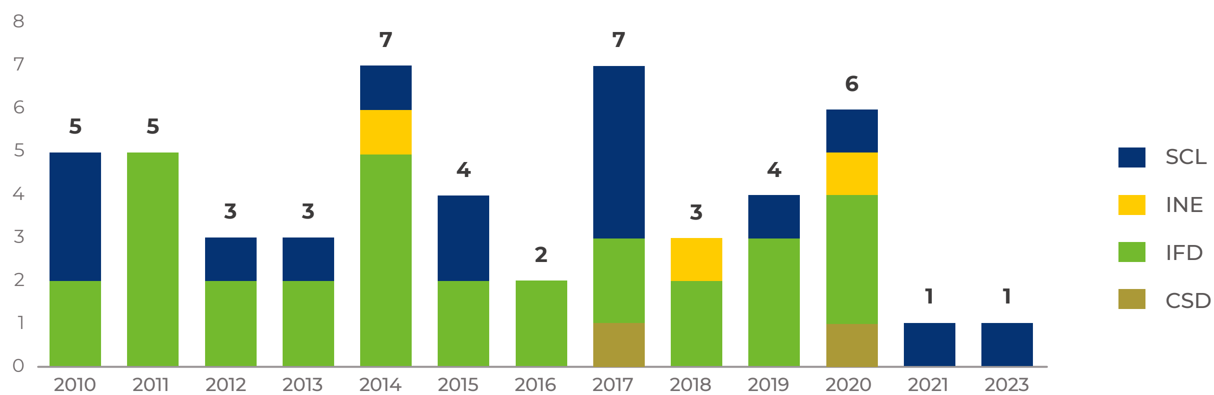
The initial selection of projects was refined using specific filters. Only sovereign-guaranteed (SG) investment loans were included, as georeferencing for non-sovereign-guaranteed (NSG) loans is more challenging. For instance, if financing is provided to a financial institution that lends to firms, the geographic location of the financial institution is insufficient, and identifying the locations of all recipient firms is significantly more complex. Policy-Based Loans (PBLs), Special Development Lending (SDL) and projects with nationwide coverage were excluded because the methodology requires geographic variability; if a project covers the entire country, it is impossible to identify control municipalities, which are essential for the analysis. Additionally, only projects "closed" between 2010 and 2023 were initially included, to be able to observe effects across time. Moreover, if the operation corresponds to loans that continued with other operations in subsequent phases under the same name, the original operation name is considered. Finally, only operations in municipalities with socio-economic indicators available were included.

3.1.3 Mexico portfolio in detail

Between 2010 and 2023, the IDB's portfolio in Mexico included 51 closed operations (Figure 3). The Institutions for Development (IFD) department was the most represented, accounting for 30 operations, with almost 66% directed toward the development of the financial system and climate change mitigation and adaptation. The Social Sector (SCL) ranked second with 16 operations spanning education, health, and social investments, including poverty alleviation, vocational training, and workforce development. The Infrastructure and Energy department (INE) followed with three operations, all dedicated to water and sanitation projects. Lastly, the Climate Change and Sustainable Development department (CSD) had two operations targeting agriculture and rural development.

FIGURE 3

Number of closed projects by year and department, total of the analyzed portfolio



Source: Authors' calculations.

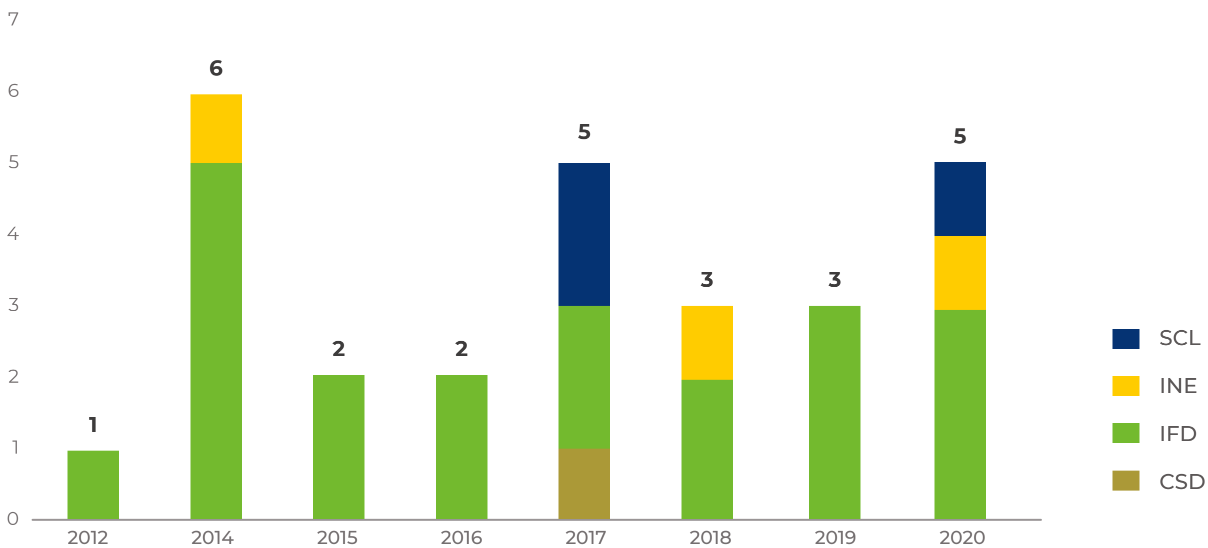
Notes: Climate Change and Sustainable Development department (CSD), Institutions for Development (IFD), Infrastructure and Energy (INE), Social Sector (SCL).

Included Operations in the Estimation

As mentioned, we applied several filters to identify the operations eligible for evaluation. These conditions left us with 27 operations to implement the HUELLA methodology. Consistent with the broader portfolio, the IFD sector is the most represented, accounting for almost 74% of the operations, particularly in the divisions of banking market development and climate change mitigation. The SCL and INE sectors follow in second place, each representing 11% of the operations, while CSD ranks last.

FIGURE 4

Number of closed projects by year and department, operations included in the estimation



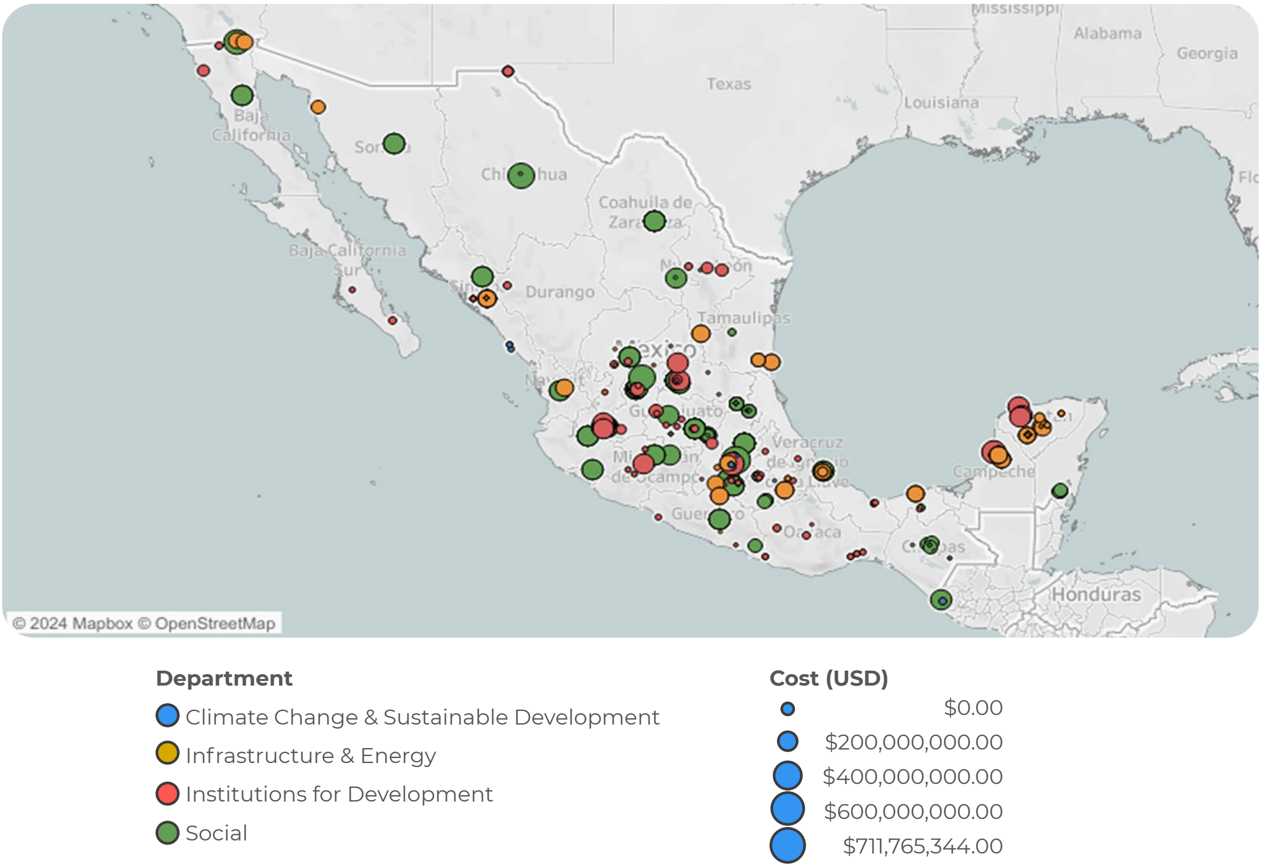
Source: Authors' calculations.

Notes: Climate Change and Sustainable Development department (CSD), Institutions for Development (IFD), Infrastructure and Energy (INE), Social Sector (SCL).

The map below, along with Figure 4, highlights that operations belonging to the IFD and SCL sectors have the greatest representation in the country in terms of amount and geographical coverage. The operations included in the estimation represent US$4.2 billion, or 42.2% of the total. The IFD sector accounts for 73% of the approved amounts, followed by the INE sector with 13.1%, and the remaining 13.9% allocated to the SCL and CSD sectors.

FIGURE 5

Geospatial location of products closed between 2010 and 2020, according to the operation amount and the department to which they belong

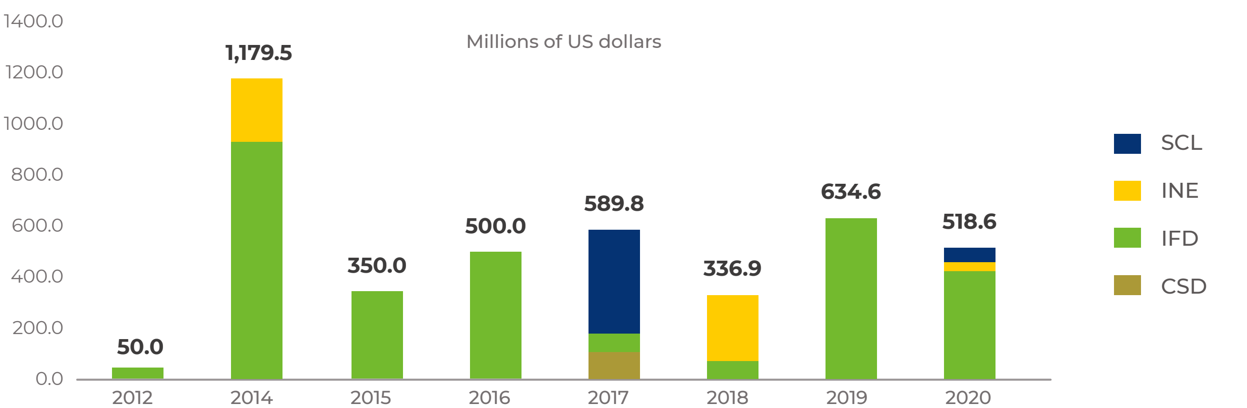


Source: Authors' calculations.

Notes: The bubbles on the map represent the projects closed between 2010 and 2020: while the color indicates the department to which they belong, the size is proportional to the cost of the project.

FIGURE 6

Approval amounts by closing year and department, operations included in the estimation



Source: Authors' calculations.

Notes: Climate Change and Sustainable Development sector department (CSD), Institutions for Development (IFD), Infrastructure and Energy sector (INE), Social Sector (SCL).

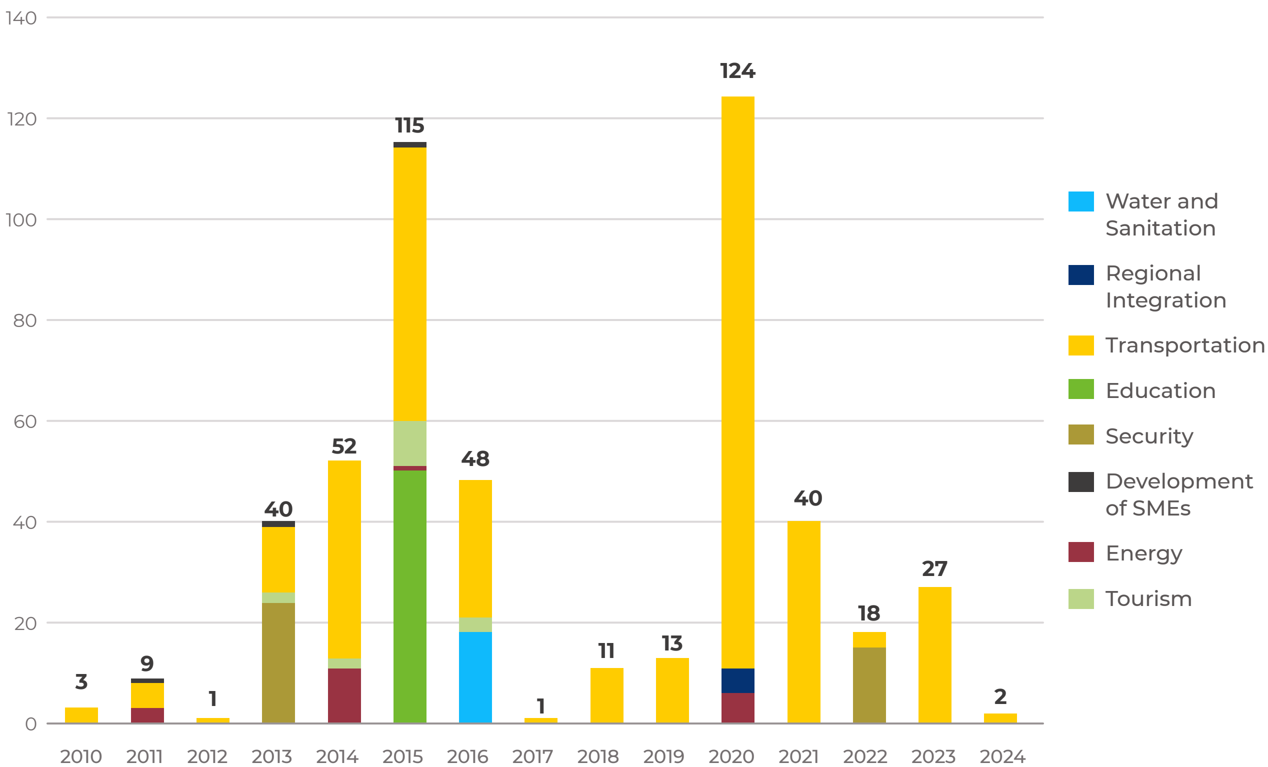
3.1.4 Costa Rica Portfolio in detail

Between 2010 and 2024, the IDB's portfolio in Costa Rica included 19 operations and 504 works. In terms of sector division, the Transportation sector had 6 operations, the Energy sector 4 operations, Development of SMEs 3 operations, Security 2 operations, Water and Sanitation 1 operation, Education 1 operation, Tourism 1 operation and Regional Integration 1 operation.

When looking at the number of projects works for each sector (Figure 7), the Transportation sector was the most represented with 352 works, representing 70% of all works. The Education sector was ranked second with 50 works, followed by Security with 39 works, Energy with 21 works, Water and Sanitation with 18 works, Tourism with 16 works, Regional Integration with 5 works and Development of SMEs with 3 works.

FIGURE 7

Number of project works in the IDB portfolio in Costa Rica, by sector and starting year



Source: Authors' calculations.

Notes: The figure represents the number of project works belonging to the IDB portfolio in Costa Rica: the color represents the sector, while the numbers are the starting year of the project works. For instance, in 2020 more than 120 project works had started, mostly in the Transportation sector.

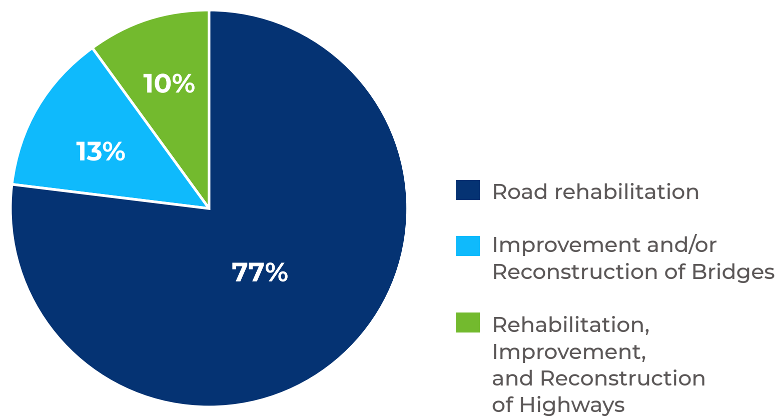
Included Operations in the Estimation

The HUELLA methodology was applied to the Transportation and Security portfolios. This methodological decision was guided by the quality, granularity, and availability of data, as well as the ability to measure significant and attributable impacts in these sectors. Transportation and Security were the only sectors with sufficiently detailed and reliable data at the cantonal level to conduct rigorous impact analyses, while other portfolios, such as Energy, Education, Tourism, Water and Sanitation, Regional Integration and Development of SMEs lacked specific indicators or consistent geographic data to measure their effects locally. [6]

The evaluation of the transportation portfolio included 61 works that were in execution between 2010 and 2014. Of the 61 works in the transportation portfolio, 47 were road rehabilitation works, 8 were bridge improvement and/or reconstruction works, and 6 were highway rehabilitation, improvement, and reconstruction works (Figure 8).

The 61 works amounted to US$320.82 million. In Costa Rica, the complete transportation portfolio was US$2.39 billion, hence the amount of the works included in the estimation represented 13% of the total transportation portfolio amount.

FIGURE 8
Distribution of transportation portfolio projects by type of works

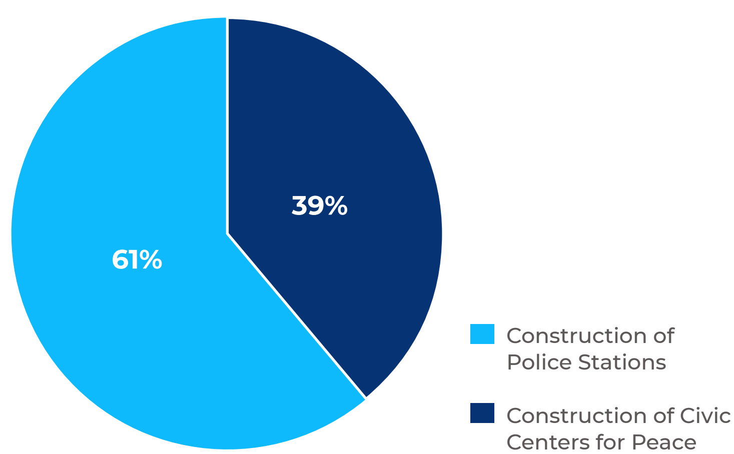


Source: Authors' calculations.

Notes: The pie represents how the projects were distributed in the portfolio of the transportation sector, by type of works.

The evaluation of the security portfolio included 18 projects. Of the 18 works in the security portfolio, 11 involved the construction of police stations, and 7 were the construction of Civic Centers for Peace (Figure 9). The 18 works cost US$99.33 million, with all the works starting in 2013. The entire security portfolio amounted to US$232.44 million, therefore the works included in the estimation represented 43% of the total security portfolio amount.

FIGURE 9
Distribution of security portfolio projects by type of works



Source: Authors' calculations.

Notes: The pie represents how the projects were distributed in the portfolio of the security sector, by type of works.

6 Energy projects, for instance, primarily involved hydroelectric plants or substations, whose benefits were country-wide, making it impossible to identify direct impacts on individual cantons. Available education indicators were projections based on 2011 regression models and did not directly reflect the effects of IDB projects, such as school construction. For the Tourism and Water and Sanitation portfolios, adequate cantonal data to measure impacts was missing.

3.2. Indicators to evaluate the impact of IDB projects

Key for the application of the HUELLA methodology is the **construction of a set of relevant indicators** against which the impact of IDB projects will be evaluated. To this end, two types of indicators, from different sources, are generated at the municipal level:

a. Socioeconomic indicators at the municipal level from household surveys and administrative data;

b. Economic and environmental indicators at the municipal level from satellite imagery.

3.2.1 Socioeconomic information from household surveys and administrative data

Household and labor force surveys conducted by statistical offices serve as a first natural source of socioeconomic indicators (as long as they are statistical representative at the subnational/municipality level). From these sources, we collected data on education, employment, and household characteristics, among others. Other relevant sectoral indicators at the municipal level were gathered from official sources to assess the impact of IDB projects in relevant sectors and to ensure socioeconomic comparability between target and control geographical units. Examples of such indicators are population density, maternal mortality rates, adolescent birth rates, school enrollment, insecurity indicators such as homicides, robberies and thefts, domestic violence, among others.

Importantly, HUELLA's methodology could accommodate other indicators to evaluate a wide range of operations, such as chronic malnutrition, maternal and infant morbidity, territorial development, employment, quality of dwellings, among others. This list is not exhaustive, and the variables to be used will vary depending on the country, the availability of information, and the correspondence with the projects under study. Notice that the construction of the databases requires a process of harmonization of municipal/cantonal codes across sub databases. In the final database each municipality and canton have their own unique administrative number.[7]

7 The harmonization was performed using the administrative boundaries provided by: https://data.humdata.org/

A word of caution should be noted regarding the statistical information from household or similar types of surveys. In some cases, survey data is representative both at more aggregate subdivisions and at the national level. However, due to their nature and objectives, household surveys conducted annually or quarterly often fail to ensure representativeness at subnational levels.[8] This limitation can impose significant restrictions on our analysis. One option to overcome the problem is to relax the representativeness requirement, allowing the inclusion of municipalities not initially part of the estimation dominium (self-represented in the sample). For instance, in the case of Mexico, the National Occupation and Employment Survey (ENOE) is used, which is conducted quarterly and began in 2005. This provides survey data for Mexico starting from that year. ENOE ensures population-level representativeness for 39 cities, encompassing 208 municipalities. In these evaluations, we used 158 of these 208 municipalities as the pool from which the treated and control units were drawn, supplementing this with data from an additional 185 municipalities that met the criteria for sufficient observations.[9]

In the case of Costa Rica, security indicators were taken from the Violence Observatory of Costa Rica (*Observatorio de la Violencia de Costa Rica*). These indicators are available starting in 2010 and include data on robberies and thefts against personal belongings, real estate property and vehicles, domestic violence, violence against women, sexual crimes (rape or attempted rape), weapons and explosives law violations, and psychotropic law violations. The crime rates per 100,000 inhabitants were calculated using population data from the National Institute of Statistics and Census of Costa Rica. From this latter source, we also used population density.

The main source of social indicators, in the case of Costa Rica, was the Cantonal Human Development Atlas prepared by the United Nations Development Programme (UNDP) in Costa Rica. The Cantonal Human Development Atlas included information on expected years of schooling, average years of schooling, life expectancy at birth, maternal mortality rates, adolescent birth rates and labor force participation rates.

3.2.2 Information from satellite imagery: economic activity at the municipal level, and environmental indicators

An integral aspect of evaluating IDB's projects involves assessing their impact on economic activity at the municipal level. Due to the absence of GDP data at this granular level in most countries,[10] alternative procedures are required based on night-time light (NTL) data from satellite imagery and based on the methodology employed by a growing literature (Elvidge et al., 1997; Doll et al., 2000; Ebener et al., 2005; Henderson et al., 2012)

NTL serves as a widely recognized proxy for economic activity. For this analysis, NTL was sourced from two distinct sources: the Defense Meteorological Satellite Program (DMSP) (1992-2012) and the Visible Infrared Imaging Radiometer Suite (VIIRS) (2013 onwards). Imagery from 2012 to 2019 demonstrates higher quality due to advancements in sensor technology.

8 For instance, in El Salvador, the EHPM (Encuesta de Hogares y Propósitos Múltiples, in Spanish) ensures total population representativeness for 50 out of 262 municipalities, while the ENOE (Encuesta Nacional de Ocupación y Empleo) in Mexico ensures total population representativeness for 39 cities. In the Dominican Republic, the ENFT/ENCFT (Encuesta Continua) only assures population representativeness for six municipalities, and the EPHPM (Encuesta Permanente de Hogares y Propósitos Múltiples) in Honduras assures total population representativeness for only one municipality.

9 We applied strict criteria to determine whether a municipality had sufficient observations for inclusion. We initially selected the 208 municipalities in the 39 self-represented cities, narrowing this to 158 by excluding those with missing data in any given year across 16 socio-economic variables. Applying the same criteria to municipalities outside these 39 cities added 185 municipalities. With an annual average of 1,089 observations per municipality, we believe this number provides an arguably reasonable socioeconomic characterization of the selected municipalities.

10 In Mexico, the Instituto Nacional de *Estadística y Geografía* (INEGI) produces and publishes subnational GDP figures at the state level, with data available from 2003. In contrast, within Central America, Costa Rica stands out as the only country that produces and publicly shares subnational GDP data, covering regional, provincial, and cantonal levels. However, the Central Bank of Costa Rica only began publishing this series in 2019, limiting the availability of data points for inclusion in our analysis.

To ensure consistency and comparability across time, we used the harmonized NTL dataset developed by Li et al. (2020a and 2020b). This dataset applies harmonization techniques to integrate DMSP and VIIRS data, providing a globally consistent NTL series from 1992 to 2021. As an additional measure of economic activity, we used the real GDP and electricity consumption (kilowatt hours) series constructed by Chen et al. (2022).[11] For our analysis, we aggregated this data at the municipal level, enabling precise evaluations of IDB project impacts. We then used the results of this municipal-level estimation to construct weights for each municipality, enabling the distribution of GDP and energy consumption across municipalities for each year. This ensures that the total GDP and total energy consumption align precisely with the constant GDP figures in local currency provided by the IMF's World Economic Outlook (WEO) database for each year, and the country's energy consumption collected by International Energy Agency (IEA) and World Development Indicators (WDI). In the case of Mexico, the GDP distribution is further calibrated to match the constant state-level GDP data produced by INEGI. To capture the effects not only on economic activity overall, but also on the economy in per capital levels, we adjusted these indicators by population from household surveys and censuses.

We also used the global built settlement growth published by WorldPop.[12] This indicator measures the changes in urbanization (transition pixels from non-built settlement area to a built settlement area) observed at a very granular level, providing an additional perspective for measuring a different facet of economic activity.

Environmental impacts were assessed using satellite imagery from Google Earth, focusing on vegetation and pollution. Vegetation changes were measured through the Normalized Difference Vegetation Index (NDVI), which evaluates near-infrared and red-light reflectance to estimate vegetation density. Values closer to 1 indicate denser vegetation, while those near 0 reflect barren land or urbanized areas, and near -1 indicate presence of water.[13] While the NDVI index, as the global settlement growth, is a proxy to urbanization, it also offers insights on the health of vegetation and its land density, providing information on the possible impacts that IDB's projects might have on green areas.

Air quality was evaluated using daily aerosol optical depth (AOD) measurements at a 1-kilometer resolution from NASA's Terra and Aqua satellites.[14] This data helped assess the potential impacts of IDB projects on pollution levels, offering a broader view of their environmental outcomes.

11 These datasets leverage NTL data from DMSP and VIIRS satellites, processed using advanced techniques such as the Particle Swarm Optimization-Back Propagation (PSO-BP) algorithm. This approach ensures the harmonization of data from different sensors, addressing challenges like saturation, inconsistencies, and temporal discontinuities. By combining NTL data with national statistics, the researchers applied a top-down method to generate globally gridded GDP and electricity consumption estimates at a 1 km × 1 km resolution. The result is a dataset spanning 1992–2019, offering high spatial and temporal detail.

12 Using a built-settlement growth modelling framework (as the one developed by Nieves et al. 2020), subnational population data, environmental variables, machine learning techniques and dynamically-limited growth curves, it is possible to annually interpolate (for the years 2000 to 2014) and project (for the years 2015 to 2020) the growth of urban settlements.

13 However, in the case of Mexico and Costa Rica the average NDVI index obtained for each municipality and canton are greater than zero.

14 By capturing the levels of scattering and/or sunlight absorption of aerosols present in the atmosphere, the AOD provides a proxy of aerosol exposure and air quality, derived from human activity, at very granular levels.

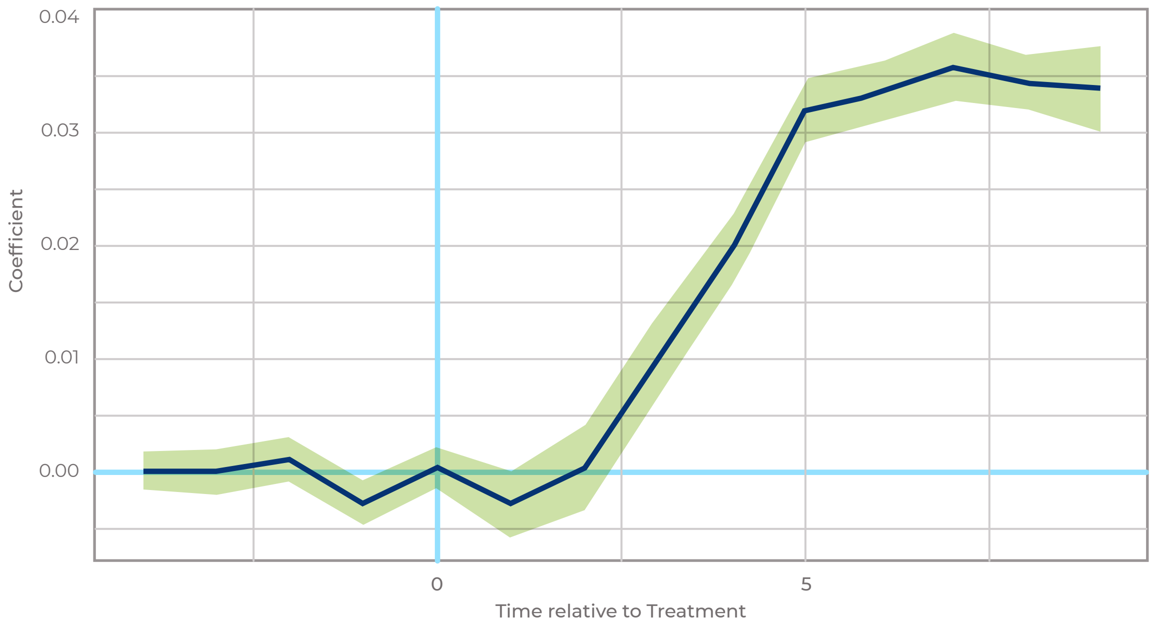
4.

RESULTS:
the case of Mexico

4. RESULTS: the case of Mexico

We will now present the impact of IDB investments on different outcomes over time. The following figures illustrate the gap in the outcome of interest between the treated municipalities and their synthetic control municipalities. In simple words, the gap indicates how much larger (or smaller) the outcome variable is compared to the hypothetical scenario without IDB intervention. The x-axis in each of them represents the timeline, with zero indicating when projects start to disburse, positive values corresponding to years after the intervention, and negative values to years before. The y-axis indicates the estimated coefficient of impact. The black line thus represents the average estimated impact in each year, while the shaded area represents the confidence intervals (uncertainty around the estimates). In Figure 10 the effects of the IDB portfolio on economic growth are shown. The figure illustrates that IDB projects have a significant and positive impact three years after the first disbursement. On average, GDP in treated municipalities is 2% higher compared to their synthetic control counterparts.

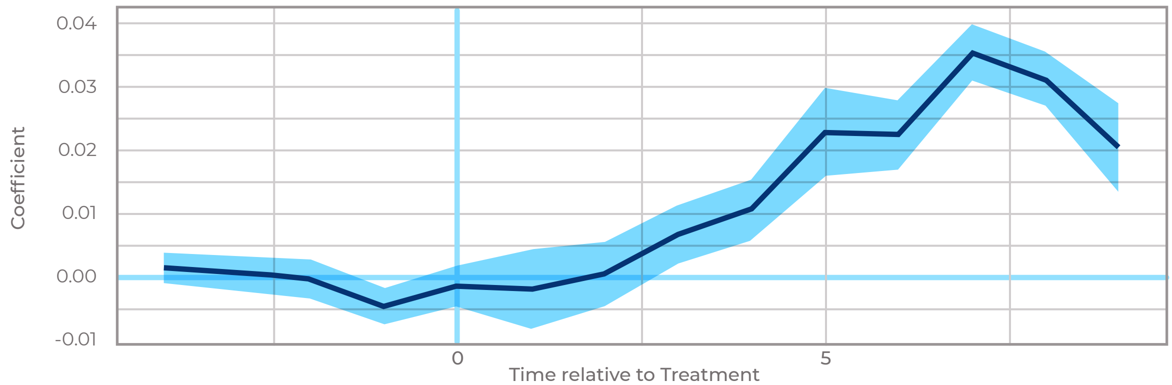
FIGURE 10
Impact of IDB Portfolio on Real GDP



Source: Authors' calculations.

Notes: this figure depicts the average real GDP percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

FIGURE 11
Impact of IDB Portfolio on Real GDP per capita

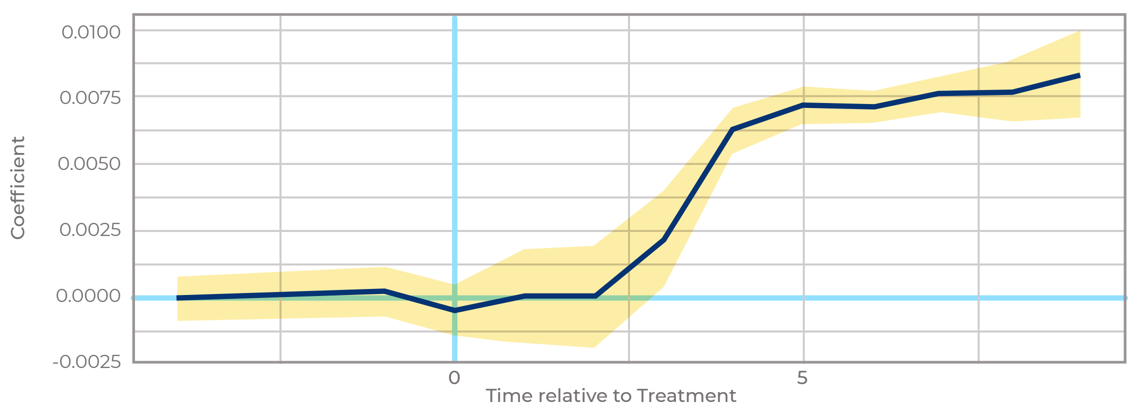


Source: Authors' calculations.

Notes: this figure depicts the average real GDP per capita percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

In Figure 11 it is possible to observe how the GDP per capita mirrors the trends in overall GDP. Before IDB projects start disbursing, real GDP per capita is not significantly different between treated municipalities and their synthetic counterparts. However, once execution starts, municipalities benefiting from IDB projects register a real GDP per capita that is, on average, 1.4% higher than the production per capita in synthetic control municipalities (hypothetical scenario without IDB intervention), starting from the 3rd year after the first disbursement.

FIGURE 12
Impact of IDB Portfolio on Electricity Consumption



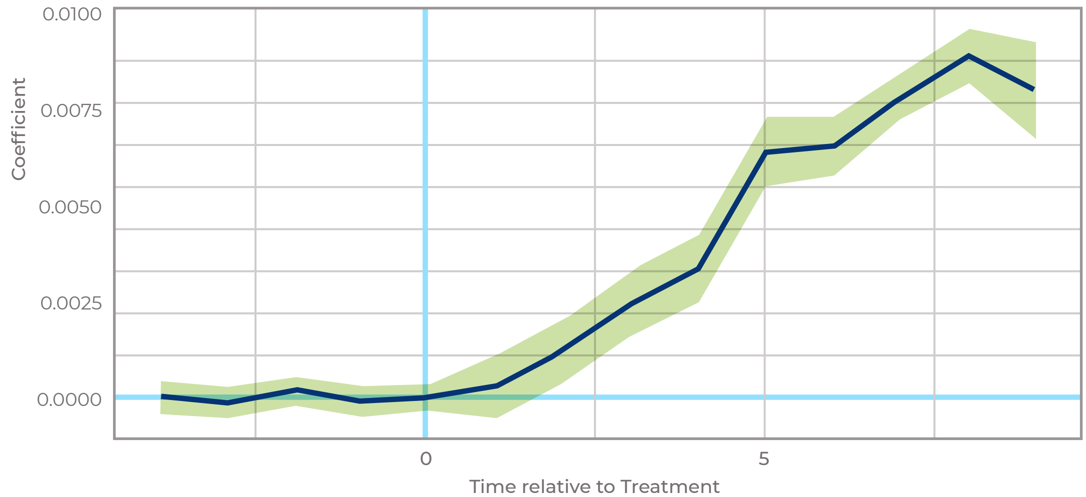
Source: Authors' calculations.

Notes: This figure depicts the average electricity consumption (KWH) percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

Figure 12 reports the effects on electricity consumption. The rising trend after the intervention highlights how economic activity improves also when measured by electricity consumption, with effects intensifying over time.

FIGURE 13

Impact of IDB Portfolio on Settlement Growth



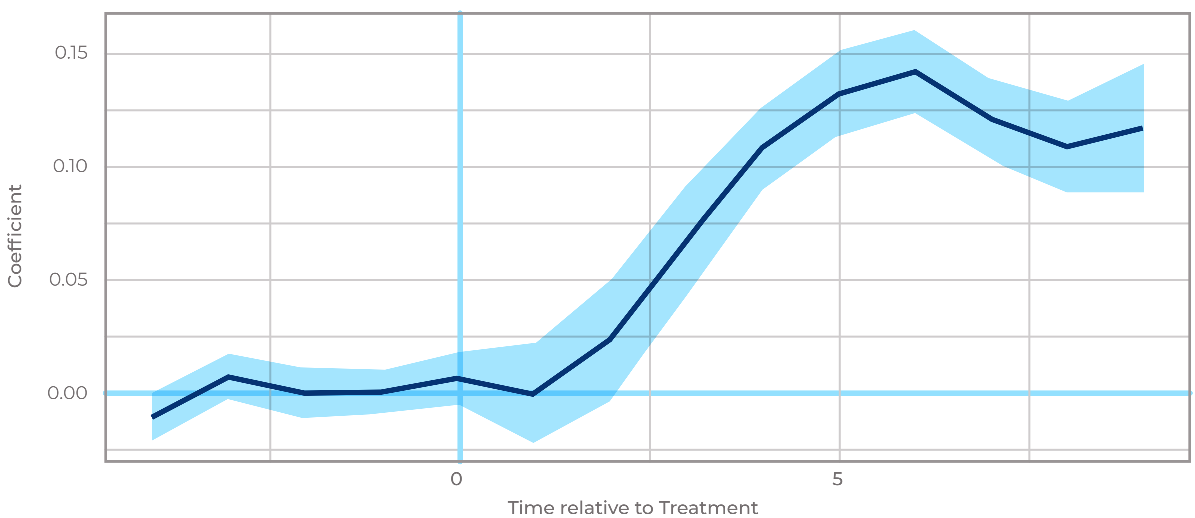
Source: Authors' calculations.

Notes: This figure depicts the average percentage point difference between the average proportion of urbanized area in the treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

Settlement growth increases on average by 0.5 percentage point more in municipalities with IDB interventions, from the 2nd year since disbursement (Figure 13). The steady and accelerating increase in settlement growth highlights that the projects might be fostering urban expansion, but effects are small in magnitude when compared to economic activity.

FIGURE 14

Impact of IDB Portfolio on Luminosity Produced by Night-Time Lights



Source: Authors' calculations.

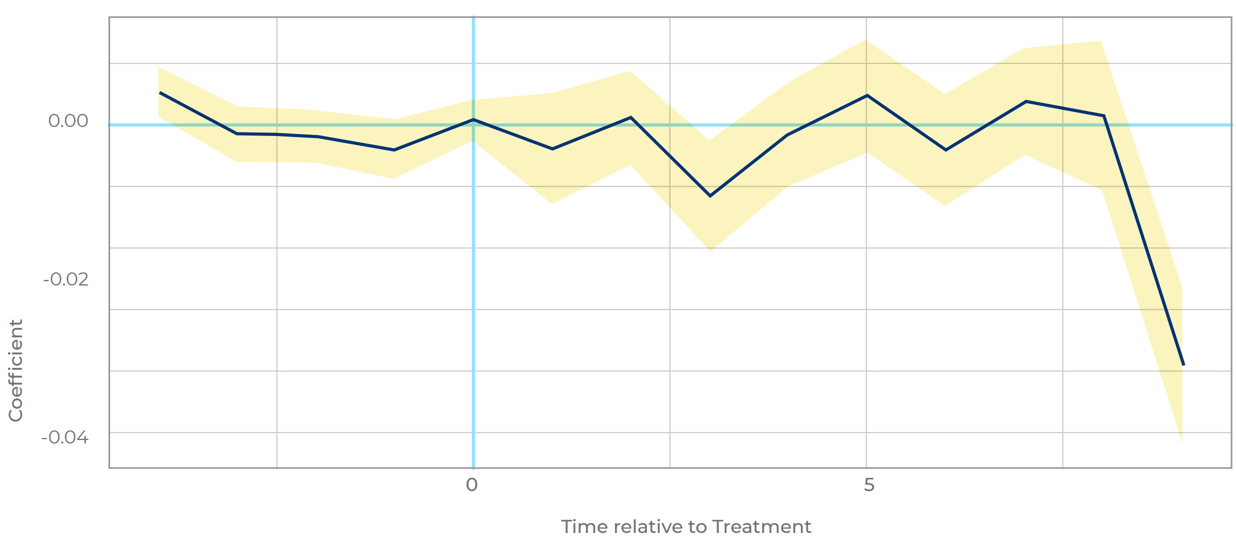
Notes: This figure depicts the average luminosity percentage difference produced by nighttime lights between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

The average luminosity produced by NTL is 8% higher in municipalities with IDB interventions when compared to the hypothetical scenario where there are not IDB interventions (Figure 14). As observed, the impact on NTL is higher in comparison to the one estimated for GDP. Our interpretation of these results is that NTL are highly sensitive to localized economic activities, such as infrastructure development, electrification, or urban expansion, which may not translate proportionally into GDP growth. GDP, being an aggregate measure, might not fully capture these micro-level improvements. The argument is less strong when we compare NTL with electricity consumption, however, as electricity consumption closely follows the GDP. We attribute the differential impact between electricity consumption and NTL to measurement issues.

Overall, the positive impacts observed across different satellite-derived indicators – ranging from infrastructure improvements and urban growth (reflected in settlement growth and NTL) to broader economic activity (measured through GDP approximations) and resource utilization (indicated by electricity consumption) - provide strong evidence of the transformative impact of IDB operations at the subnational level.

FIGURE 15

Impact of IDB Portfolio on Pollution



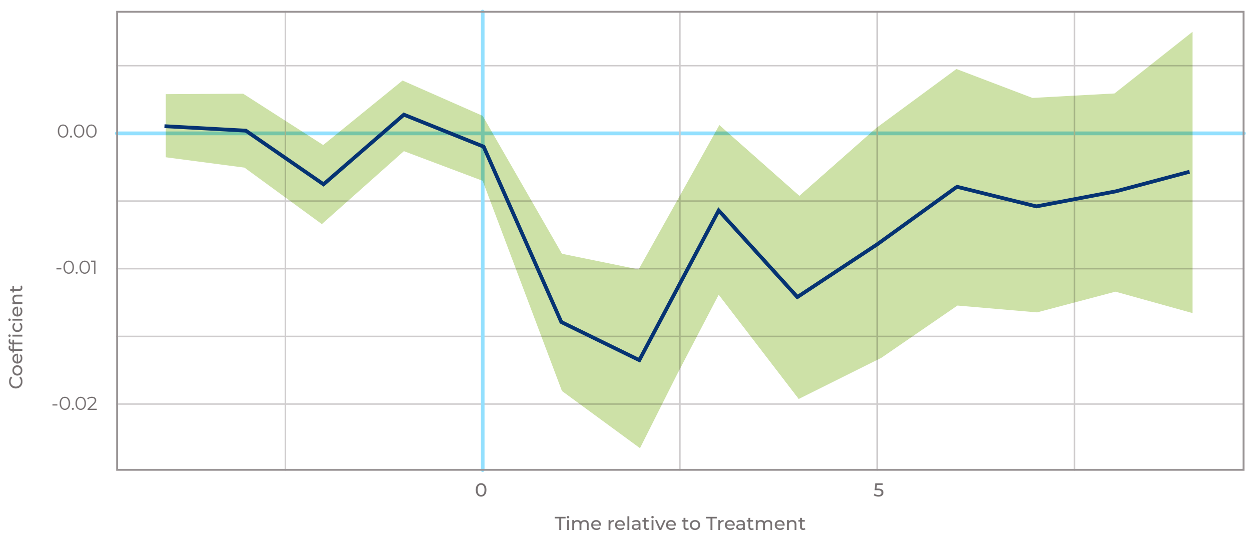
Source: Authors' calculations.

Notes: This figure depicts the average pollution (aerosol optical depth (AOD) measurements) percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

Higher levels of economic activity are usually associated with a deterioration in environmental indicators. Nevertheless, once we examine whether projects affected pollution levels, we see that contamination did not increase after projects started disbursing (Figure 16). The fact that pollution levels did not rise after project disbursements began demonstrates that IDB operations can stimulate economic activity while maintaining environmental sustainability. This result underscores the potential of development projects to achieve a balance between economic progress and ecological preservation.

FIGURE 16

Impact of IDB Portfolio on Normalized Difference Vegetation



Source: Authors' calculations.

Notes: This figure depicts the average NDVI percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) municipalities. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the municipalities where IDB applied an intervention and municipalities without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

However, the NDVI is, on average, 1% smaller in municipalities where IDB projects are executed (Figure 17). The gradual decline in NDVI, with a pronounced drop in initial periods, indicates a reduction in vegetation health or coverage, which might reflect the conversion of green spaces into built-up areas such as housing, factories, and infrastructure, consistent with the urban expansion typically associated with increased economic activity. While the impacts on economic growth are positive, they appear to come at the cost of reduced green cover, even though small, which could impact local ecosystems and biodiversity. Authorities are encouraged to balance economic growth with environmental sustainability, potentially through reforestation efforts, green infrastructure, urban greening projects, or strict zoning laws to protect natural habitats.

Overall, the IDB portfolio seems to have improved economic growth, irrespective of the indicator considered, positioning the benefitting municipalities as more prosperous and dynamic areas. Such growth could attract businesses, workers, and investments, creating a virtuous cycle of development. These benefits did not come at the cost of higher pollution levels. However, they can come with other challenges, as reflected in the decrease in vegetation. By addressing these challenges through strategic planning and sustainable practices, the municipalities can maximize the long-term positive impact of IDB projects while minimizing potential downsides.

5.

RESULTS: the case of Costa Rica

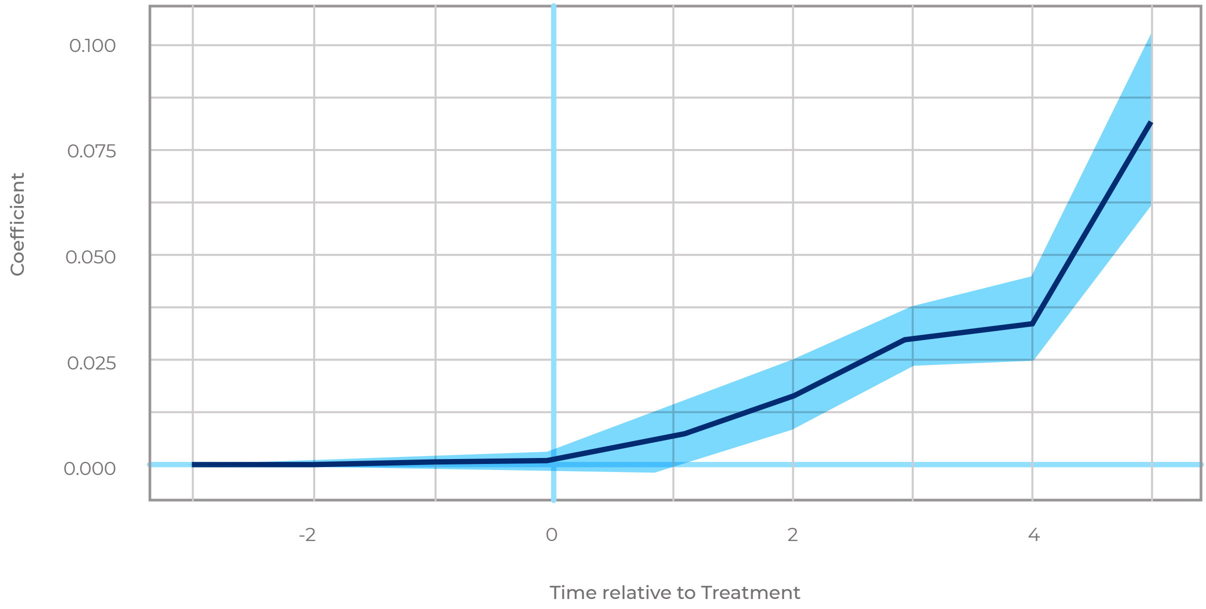
5. RESULTS: the case of Costa Rica

In Costa Rica, we evaluated the IDB portfolios in the sectors of Transportation and Security.

5.1 Impacts of the Transportation Portfolio on Economic Growth

The cantons that benefited from the IDB's transportation infrastructure projects experienced above-average economic growth compared to the cantons that did not benefit. Figure 17 shows the results of the annual effect of the transportation portfolio on economic growth.

FIGURE 17
Impact of IDB Portfolio on Real GDP



Source: Authors' calculations.

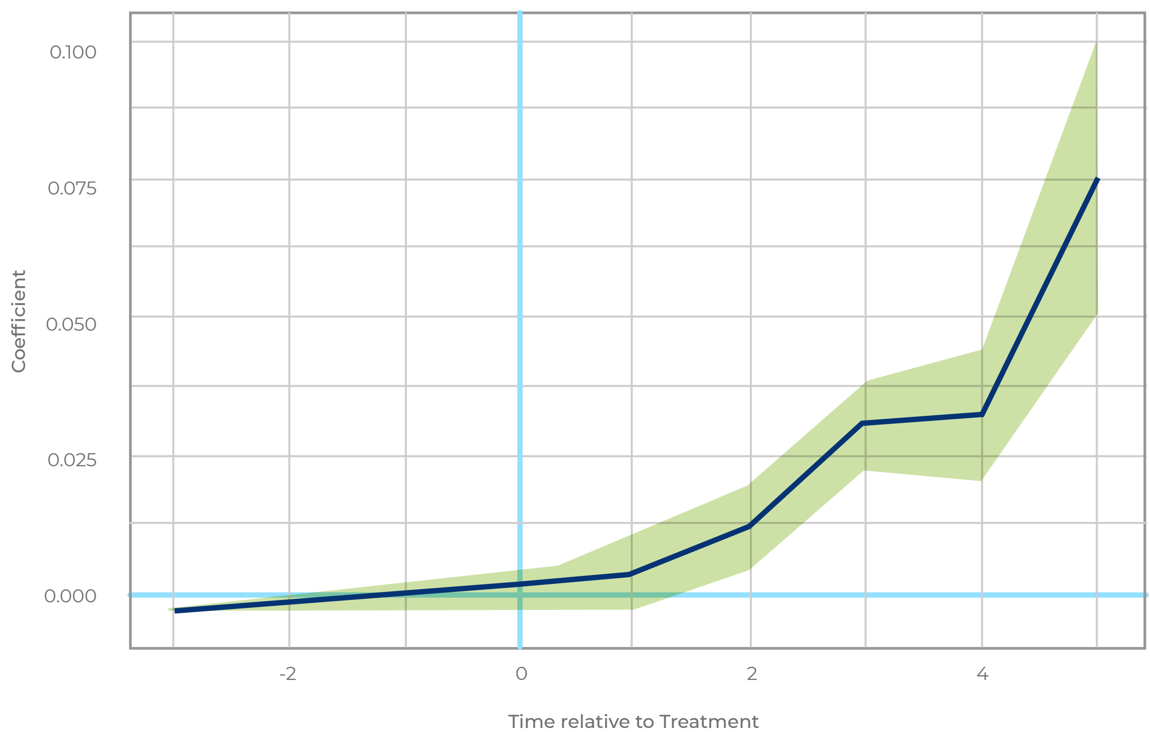
Notes: This figure depicts the average real GDP percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

The cantons benefiting from Transportation projects register an average annual real GDP that is, on average, 1.7% higher than their counterparts' real GDP. This positive effect reflects the effectiveness of the IDB's infrastructure projects in fostering a more dynamic economic environment. Similar to the case of Mexico, the positive impact on real GDP grows over time, underscoring the sustained economic benefits from these transportation projects.

Furthermore, the cantons benefiting from IDB's transportation projects showed greater average increases across several indicators compared to those that did not. These include real GDP per capita (1.4% higher), electricity consumption (2% higher), per capita electricity consumption (1.6% higher), and NTL (7.9% higher). These positive effects also show a tendency to increase over time (Figures 17 to 21). Collectively, the positive effects across all the indicators reinforce the consistency of evaluation results.

FIGURE 18

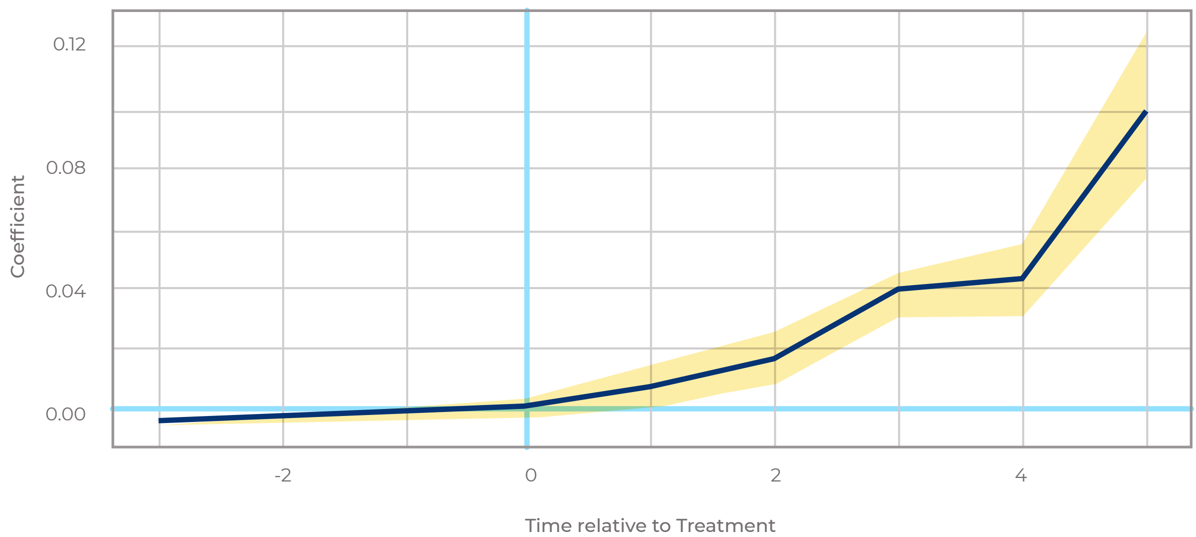
Impact of IDB Portfolio on Real GDP per capita



Source: Authors' calculations.

Notes: This figure depicts the average real GDP per capita percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

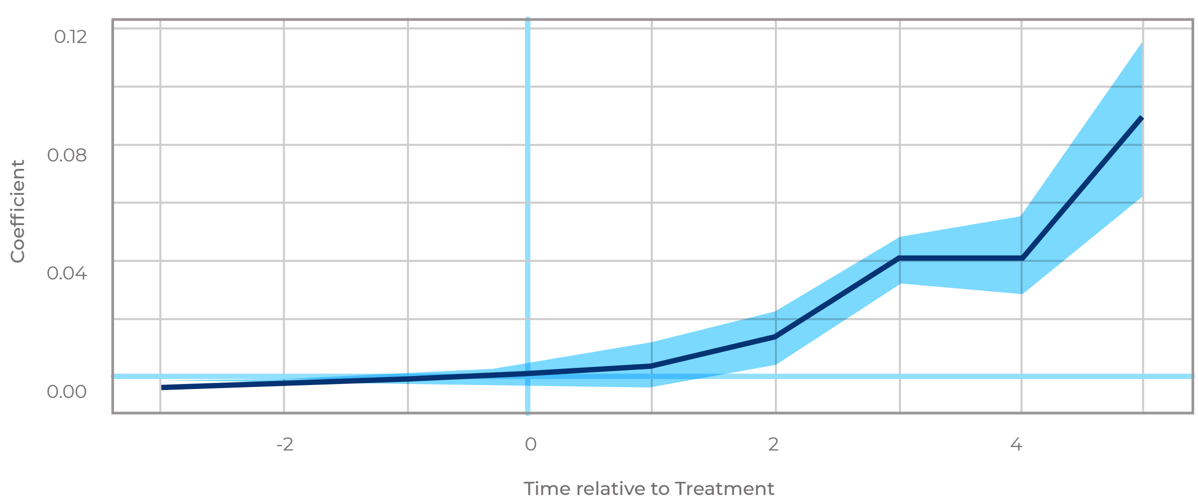
FIGURE 19
Impact of IDB Portfolio on Electricity Consumption



Source: Authors' calculations.

Notes: This figure depicts the average electricity consumption (KWH) percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

FIGURE 20
Impact of IDB Portfolio on Electricity Consumption per capita

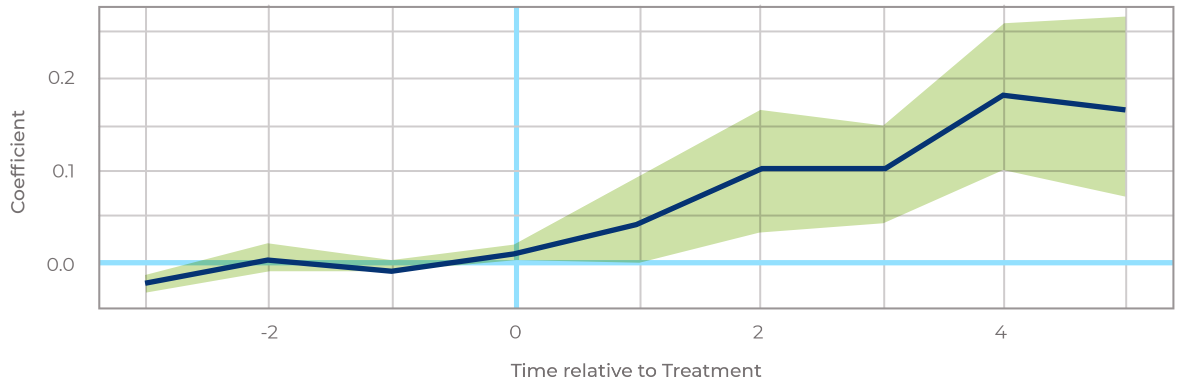


Source: Authors' calculations.

Notes: This figure depicts the average electricity consumption (KWH) per capita percentage difference between treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

FIGURE 21

Impact of IDB Portfolio Luminosity Produced by Night-Time Lights



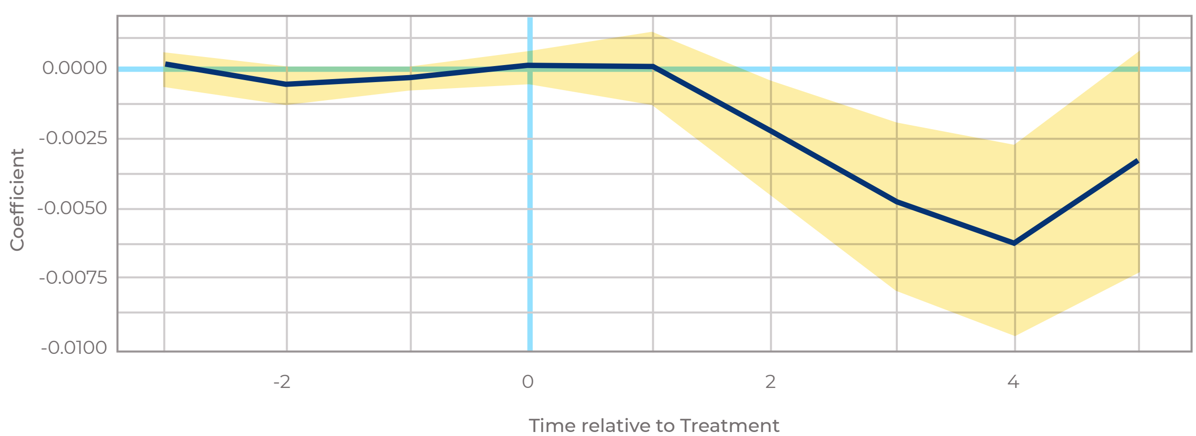
Source: Authors' calculations.

Notes: This figure depicts the average luminosity percentage difference produced by nighttime lights between treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

Regarding population settlements, one would expect growth due to increased economic activity in the cantons that benefited from transportation investments, compared to the control group. However, settlement growth is 0.18 percentage points smaller in those cantons that benefited from the transportation projects compared to the synthetic control cantons (Figure 22). This indicates that, in the treated cantons, there was a reduction in the presence of population settlements compared to the hypothetical scenario of no IDB intervention. In fact, when examining the trend of the treatment and control groups in the post-treatment period, it was found that the proportion of population settlements decreased in both groups, but this reduction was more pronounced in the treatment group.

FIGURE 22

Impact of IDB Portfolio on Settlement Growth



Source: Authors' calculations.

Notes: This figure depicts the average percentage point difference between the average proportion of urbanized area in the treated (with IDB intervention) and synthetic control (without IDB intervention) cantons. The x-axis represents the timeline, with zero indicating when projects start to disburse. The y-axis indicates the estimated coefficient of impact. The black line represents the difference in impact between the cantons where IDB applied an intervention and cantons without it. The shaded area represents the confidence intervals (uncertainty around the estimates).

We found no significant impact on air pollution levels, indicating that the projects, on average, did not harm air quality. However, cantons with transportation investments relative to GDP above the cantonal median experienced 1.8% smaller air pollution levels compared to the synthetic control group.

Conversely, the vegetation index is, on average, 1% smaller in treated cantons. A closer analysis shows this reduction occurred only in cantons with transportation investments relative to GDP at or below the cantonal median, where the NDVI is 1.8% smaller than in the synthetic control cantons. This decline in vegetation was expected, given the focus of the transportation projects on road infrastructure development. While these negative effects on vegetation are clear, they should be viewed as part of the social costs associated with this type of infrastructure.

5.2 Security Investments and Their Impact

Security investments supported by the IDB have had significant effects on rates of domestic violence, sexual offenses, vehicle theft, and psychotropic law violations. The impacts are correlated with investment levels, showing that the intensity of intervention plays a key role in the effectiveness of IDB's investments in citizen security. However, no significant effects were observed for other security indicators.

In cantons receiving security investments above the median,[15] significant reductions were observed in domestic violence and sexual offense rates (rape or attempted rape). Annually, domestic violence decreased by an average of 129 offenses per 100,000 inhabitants, and sexual offense rates dropped by an average of 8 per 100,000 inhabitants compared to control cantons. These results suggest that higher IDB investments in security are associated with reduced interpersonal violence.

In cantons with security investments below the median relative to their economies,[16] vehicle thefts decreased by an average of 37 per 100,000 inhabitants annually compared to control cantons. This result suggests that lower relative investment might have acted as a deterrent to vehicle thefts, whereas higher relative investment did not. However, this counterintuitive relationship was not confirmed in the evaluation and requires further analysis to uncover the factors behind this inverse relationship.

In cantons with above-median investments (in absolute terms), there was an average annual increase of 480 psychotropic law violations per 100,000 inhabitants compared to control cantons. This rise may be attributed to enhanced police surveillance and patrol capabilities enabled by IDB investments. Strengthened law enforcement operations likely led to increased detection of offenses that might have otherwise gone unnoticed. However, this hypothesis requires further validation.

The findings reveal a dual impact of security investments:

- They can help reduce violence and specific crimes.
- They can enhance law enforcement capabilities, leading to increased detection and reporting of certain infractions, such as psychotropic substance violations.

These results underline the importance of nuanced, context-specific approaches when designing and evaluating security interventions, ensuring both crime reduction and effective law enforcement.

15 The median absolute investment in security in the cantons included in the estimations is 2757.9 million Costa Rican *colones*.
16 The median relative investment in security in the cantons included in the estimations is 0.88%.

Overall, IDB projects have had a positive effect on Costa Rica's well-being through economic growth and the reduction of criminal activity. While immediate effects on economic growth may be modest, their impact increases over time, particularly in cantons that received larger amounts of investment, both in absolute terms and relative to the size of their economies. This finding highlights the importance of planning investments with a long-term perspective to amplify economic growth over time. Furthermore, the effects on growth are consistent across various economic activity indicators, supporting the robustness of the results.

Additionally, the reduction of population settlements due to transportation infrastructure investments is marginal. In environmental terms, no negative effects on air pollution were found. Nevertheless, negative impacts on vegetation were observed, underscoring the importance of reforestation efforts. Regarding security, IDB investments contributed to reducing criminal activity, particularly in rates of domestic violence, rape (or attempted rape), and vehicle theft. We found a direct relationship between higher security investments and reductions in some interpersonal violence crimes (domestic violence and sexual offenses). However, the impact of these investments does not always follow a straightforward relationship between greater resources and lower violence. In some cases, relatively smaller investment levels have led to significant reductions in certain crimes (vehicle theft rates), while higher investments can increase the number of reports due to improved police capacity to detect and record criminal activity (psychotropic law violation rates). This suggests that the effectiveness of security investments depends on the type of crime and the socioeconomic characteristics of each canton, highlighting the need for differentiated approaches and detailed investment plans.

6.

Limitations AND NEXT STEPS

6. LIMITATIONS AND NEXT STEPS

This section outlines the key limitations encountered during the analysis, highlighting the challenges posed by data availability and methodological constraints.

The availability of data in smaller countries often poses a significant challenge for conducting robust analyses. Specifically, the absence of comprehensive data makes it more difficult to construct appropriate control groups that would allow for more accurate comparisons. Additionally, in smaller countries, the number of municipalities may be limited, making it harder to have enough to select from to form the appropriate control group. This limitation can affect the validity of findings by reducing the ability to isolate causal relationships. One way forward that we are exploring is to conduct the analysis through a difference-in-differences approach at the square kilometer level. This method allows us not to rely on a limited number of available municipalities to form the control group and does not require as many control variables to construct the appropriate control group.

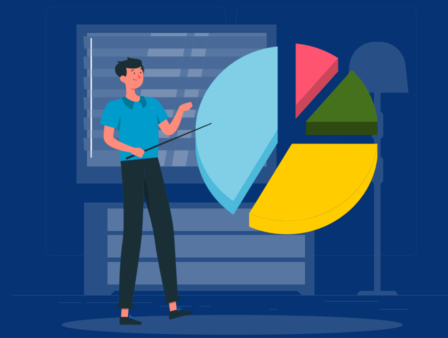
Household surveys, which are a primary data source for many analyses, do not always provide representative data at the municipal level. This lack of granularity necessitates certain methodological decisions to ensure that the data can still be used effectively. These adjustments, while necessary, may introduce bias or limit the scope of the analysis. However, using alternative data sources such as satellite imagery can address this issue by providing consistent and granular data that complements or substitutes household survey information.

In Costa Rica, almost all municipalities were treated after 2015 (for transportation works), which presented a unique challenge for analysis. This universal treatment made it impossible to evaluate the effects of interventions after that year: since all municipalities received treatment, the potential for a control group was eliminated. Consequently, the findings for later periods can only be extrapolated given the positive effects found in earlier periods, but could not be evaluated.

Additionally, the IDB portfolio in Costa Rica included investments in energy, education, tourism, water and sanitation, and SMEs development, whose effects could not be evaluated for data limitations. The energy portfolio, which focused on expanding or reconstructing substations and hydroelectric plants, could not be assessed because the improvements in electricity availability benefited the entire national grid, not just the cantons where the projects were implemented, eliminating the possibility to build a control group. The education portfolio, centered on constructing secondary schools, was not evaluated because the available educational indicators were regression-based estimates from 2011 census data, which limited their ability to capture the direct impact of IDB projects. The tourism and water/sanitation portfolios were not evaluated due to the lack of specific cantonal indicators to measure their impact. Lastly, the SMEs development portfolio, consisting of NSG loans, faced challenges in identifying the locations of the benefiting firms, making it impossible to determine their exact impact. Thus, it was determined that the evaluations were feasible only for transportation and security portfolios. Having additional data would be crucial for evaluating the investment portfolio in the other sectors too.

The geolocalization exercise also faced challenges, such as the incomplete migration of documents between bank systems and the lack of full geographical information registered in the project documents. Going forward, if the exercise is to be replicated to other countries, there are alternatives that can be considered, such as the use of machine learning algorithms capable of doing a deep dive into the current and past bank systems. This information could be complemented and validated with interviews to project teams or members, although it could not be feasible at a larger scale. Other Bank initiatives or sources of information could be seized, such as the information contained in the procurement documents, and the CAPTUDATA platform.

In general, the results of this evaluation reflect the positive impact of IDB investments and the potential of geographic data to analyze the effects of these investments. However, there is room to explore new opportunities by expanding the availability of indicators to more sectors, analyzing longer time series, and accessing more granular geographic data. These advances would allow for a deeper understanding of the impact of the IDB portfolio and other public and private investments on the country's development.



7. FINAL REMARKS

This report introduces HUELLA, a new way of measuring impact, using cutting-edge and innovative datasets. HUELLA focuses on the impact that IDB projects have in the locations where they are implemented, measuring changes at a highly granular geographical level.

HUELLA responds to the need of putting the concept of impact in the spotlight, reminding that it is the center of the IDB Group's mission, as remarked with the approval of the Impact+ Strategy in 2024, which aims at increasing the impact and scale of the outcomes of our interventions. Designed to complement existing evaluation tools, HUELLA strengthens the Bank's ability to measure impact while promoting transparency and accountability. It expands the understanding of the legacy of IDB's work in the region, enabling long-term, portfolio-wide impact assessments at the subnational level.

HUELLA:
Measuring the impact of development projects

Pilot applications in **Mexico** and **Costa Rica** have demonstrated encouraging results, revealing positive impacts on economic growth, urban expansion, infrastructure development, and crime reduction. These results highlight HUELLA's value in capturing diverse dimensions of development.

HUELLA's cost- and time-efficiency compared to traditional evaluation methods, coupled with its adaptability to data-limited environments, positions it as a transformative tool for countries across LAC. Its future potential is vast, with opportunities to integrate new methodologies, technologies, and data sources, further enhancing its scope and accuracy.

We hope this report inspires operational teams, governments, partners, and other stakeholders—within and beyond the IDB—to collaborate, share data, and contribute to refining the HUELLA methodology. By working together, we can fully unlock the potential of HUELLA and enhance the evaluation of development portfolios. After all, this is just the beginning and there is still space to improve the impact evaluation process.

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ANNEX I. METHODOLOGY

To address the attribution challenges and develop the HUELLA methodology, we adopted two quasi-experimental designs, difference-in-differences (DID), and synthetic control methods (SCM). These methods come with their own limitations and assumptions that must be carefully managed to ensure the validity and reliability of the findings.

Traditional DID relies on the assumption that the treated and control groups would have followed parallel trends, which may not hold true if such control group does not exist. When possible, we have opted for the SCM technique, considering it best suited for our objectives Abadie and Gardeazabal (2003), relies on constructing a synthetic control unit for conducting causal inference. The synthetic control is formulated by assigning weights w to control units that most closely resemble the treated unit. Specifically, the weights are determined to construct a synthetic control that closely mirrors the characteristics of the treated unit prior to the intervention, enabling a reliable comparison to assess the treatment effect. Subsequently, the outcome of interest in the synthetic control group provides an estimate of the counterfactual, representing what would have been observed in the affected unit in the absence of treatment, that is, what would have happened to the municipality had it not received financing support from an IDB project. Formally and following Abadie (2021), for the unit $j = 1$ treated at time t the post-intervention period is defined as $t > T_0$ and then the effect of the treatment in unit j after T_0 is defined as:

$$\tau_{1t} = Y_{1t}^{I} - Y_{1t}^{N} \quad (1)$$

where Y_{1t}^{N} is the outcome of the treated unit that would have been observed in the absence of treatment.

Formally, the synthetic control estimators of Y_{1t}^{N} and τ_{1t} can be expressed as:

$$\hat{Y}_{1t}^{N} = \sum_{j=2}^{J+1} w_j Y_{jt} \qquad (2)$$

$$\hat{\tau}_{1t} = Y_{1t} - \hat{Y}_{1t}^{N} \qquad (3)$$

SCM only applies to the case of one treated unit. Recognizing this challenge, Xu (2017) proposed the Generalized Synthetic Control Method (GSCM). This method generalized SCM to the evaluation of multiple treated units and variable treatment periods, as is the case in our setting, where multiple municipalities have benefited from IDB projects. Like SCM, it is specifically designed for situations where the parallel trends assumption is unlikely to hold. However, since no observations are discarded from the control group, it uses more information and thus is more efficient than the synthetic matching method when the model is correctly specified. Under reasonable assumptions, a parametric bootstrap procedure based on simulated data provides valid inference.

We employed for the evaluation of the Mexico portfolio, and for the transport portfolio in Costa Rica.

$$Y_{it} = \delta_{it} D_{it} + X_{it}' \beta + \lambda' f_t + \varepsilon_{\{it} \qquad (4)$$

Where:

Y_{it} : Independent variable or socioeconomic indicator

D_{it} : Treatment indicator (indicates whether the canton was treated or not in a given year)

δ_{it} : Heterogeneous treatment effect

X'_{it} : Vector of observable covariates

β : Vector of unknown parameters

λ'_i : Vector of unknown factor weights

f_t : Vector of unobservable common factors

ε_{it} : Unobservable idiosyncratic shocks

Once the functional form estimates are obtained, the GSC method allows for the calculation of the annual effect for each post-treatment period. This is done by measuring the difference between the counterfactual and the treatment group in each period. Based on the annual effects of each period, the method then calculates the average treatment effect on the treated (ATT) for the entire post-intervention period. In other words, the average effect of all projects.

The ATT in the GSC method is expressed as follows:

$$ATT_{t,t>T_0} = \frac{1}{J}\sum_{i\in\mathcal{T}}\left[Y^I_{jt} - Y^N_{jt}\right] = \frac{1}{J}\sum_{i\in\mathcal{T}}\delta_{it} \qquad (5)$$

Where:

$ATT_{t,t>T_0}$:is the average treatment effect on the treated at time t during the post-treatment period

J : represents total number of treated municipalities

$\mathcal{T}$: represents the set of municipalities in the treatment group

For Mexico, the pre-treatment period spans from 2006 to 2010, while the post-treatment period extends from 2011 to 2019. In all the evaluation models for the transportation portfolio in Costa Rica, the pre-treatment period spanned from 2006 to 2009, while the post-treatment period covered 2010 to 2014.

Table AI.1 contains the summary of the dependent variables and covariates used to run the quasi-experimental evaluations for Mexico. In comparison to Costa Rica, the availability of the ENOE in Mexico allowed us to include a wider range of control variables, with the aim of reflecting several socioeconomic characteristics in each municipality. Ideally, this set of covariates would allow the GSCM to construct finer weights improving the construction of the synthetic control municipalities.

TABLE AI.1.

Mexico: Dependent and Covariate Variables in Portfolio Assessment Models

Dependent variables	Covariates
Real GDP Log	▪ Municipal average years of schooling ▪ Municipal population density ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size
Real GDP per capita Log	▪ Municipal average years of schooling ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size
Electricity consumption Log	▪ Municipal average years of schooling ▪ Municipal population density ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size
Nighttime lights Log	▪ Municipal average years of schooling ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size

Dependent variables	Covariates
Settlement growth	▪ Municipal average years of schooling ▪ Municipal population density ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size
NDVI Log	▪ Municipal average years of schooling ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size
Pollution Log	▪ Municipal average years of schooling ▪ Municipal share of households with female household head ▪ Municipal average age of household head ▪ Municipal share of population between 16 and 59 years of age ▪ Municipal share of population with more than 9 years of schooling ▪ Municipal average household size

Source: Authors' elaboration.

Table A1.2 provides a summary of the dependent variables and covariates for each of the transportation portfolio evaluation models in Costa Rica. Generally, the decision-making process for including covariates was guided by the degree of balance in the pre-treatment periods. The first step was to include all available covariates and assess balance during the pre-treatment periods. If an imbalance was identified, a gradual process was followed to determine the combination of covariates that would achieve balance in the pre-treatment periods.

TABLE AI.2.

Dependent and Covariate Variables in Transportation Infrastructure Portfolio Assessment Models.

Dependent variables	Covariates
Real GDP Log	▪ Population density ▪ Life expectancy
Log of real GDP per capita	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling
Electricity Consumption Log	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling
Log of Electricity Consumption per capita	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling
Night Lights Log	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling ▪ Average Years of Schooling Index
Population settlements	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling ▪ Average Years of Schooling Index
Pollution Index Log	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling ▪ Average Years of Schooling Index
NDVI Log	▪ Population density ▪ Life expectancy ▪ Index of Expected Years of Schooling ▪ Average Years of Schooling Index

Source: Authors' elaboration.

For the security evaluations in Costa Rica, we opted to use the doubly robust difference-in-differences method with simultaneous adoption for multiple groups and multiple time periods (DID DR), developed by Callaway and Sant'Anna (2021). All security projects began in the same year, 2013. This eliminated the need to stagger the effects over time and allowed us to estimate the ATT for the entire group of cantons benefiting from the security projects. In this case, the evaluations focused on directly comparing the outcomes of the treated group with those of the control group in the periods before and after the intervention, to then estimate the ATT of the intervention group.

The method implemented, following Callaway and Sant'Anna (2021), is an extension of the two-period, two-group method by Sant'Anna and Zhao (2020), adapted for multiple groups (multiple cantons) and multiple periods. Essentially, the method combines two main approaches: an outcome regression model and a propensity score model. In other words, the method uses both sources of information to estimate the treatment effect. The primary advantage of this approach is its double robustness, which ensures valid estimates as long as at least one of the two models is correctly specified. This is a significant advantage compared to traditional DID methods without control variables, DID conditional only on covariates, or traditional DID combined with propensity scores.

The method uses propensity scores to assign weights to units in the analysis. These weights create a control group that closely resembles the treated group in terms of observable characteristics prior to the intervention. The weights adjust the average covariates between the groups, correcting for potential initial biases. This ensures that control group units with similar characteristics to the treated group receive more weight.

Additionally, the method leverages information from observed covariates to adjust for initial differences between treated and untreated groups. This means that the trends between treated and untreated cantons are conditional on the covariates. This approach enhances causal validity by controlling for initial differences that could bias the estimates, improving comparability between groups.

Another advantage of this method is its ability to accommodate heterogeneity in treatment effects. It does not assume that the treatment has a uniform impact across all units or periods. This is particularly important because, in evaluations of IDB projects, it is realistic to expect that the effects may vary across cantons and over time.

In the security portfolio evaluation models, the pre-treatment period spanned from 2010 to 2012, while the post-treatment period covered 2013 to 2019.

Table A1.3 presents a summary of the dependent variables and covariates for each of the security portfolio evaluation models. The decision criterion for including or excluding covariates was based on the parallel trends assumption. Specifically, for each model, the first step was to include all available covariates and test the parallel trends assumption. If the assumption was not satisfied, a gradual process of covariate inclusion and exclusion was conducted to identify the combination of covariates that allowed the parallel trends assumption to hold.

TABLE AI.3.

Dependent variables and covariates in security portfolio evaluation models

<table>
<tr><th>Dependent variables</th><th>Covariates</th></tr>
<tr><td>Rate of residential burglary per 100,000 inhabitants</td><td rowspan="8">▪ Real GDP per capita
▪ Population density
▪ Life expectancy
▪ Index of Expected Years of Schooling
▪ Average Years of Schooling Index
▪ Maternal Mortality Rate
▪ Teen Birth Rate
▪ Labor force participation rate for men
▪ Labor Force Participation Rate for Women</td></tr>
<tr><td>Rate of residential burglary per 100,000 inhabitants</td></tr>
<tr><td>Rate of robberies from people per 100,000 inhabitants</td></tr>
<tr><td>Rate of theft from people per 100,000 inhabitants</td></tr>
<tr><td>Rate of violations of the law against the criminalization of violence against women per 100,000 inhabitants</td></tr>
<tr><td>Rape or attempted rape rate per 100,000 inhabitants</td></tr>
<tr><td>Rate of violations of the law on weapons and explosives per 100,000 inhabitants</td></tr>
<tr><td>Rate of violations of the psychotropic law per 100,000 inhabitants</td></tr>
<tr><td>Vehicle theft rate per 100,000 population</td><td>▪ Real GDP per capita
▪ Life expectancy
▪ Index of Expected Years of Schooling
▪ Average Years of Schooling Index
▪ Maternal Mortality Rate
▪ Teen Birth Rate
▪ Labor force participation rate for men
▪ Labor Force Participation Rate for Women</td></tr>
<tr><td>Domestic violence rate per 100,000 population</td><td>▪ Real GDP per capita
▪ Population density
▪ Life expectancy
▪ Maternal Mortality Rate
▪ Teen Birth Rate
▪ Labor force participation rate for men
▪ Labor Force Participation Rate for Women</td></tr>
</table>

Source: Authors' elaboration.

ANNEX II. GEOREFERENCE

Summary Box: The portfolio in numbers

Total IDB portfolio: Applying the criteria outlined in Section 3.1.2 to select the portfolio for evaluation narrows the focus to 290 operations across 10 countries, initially evaluated with one single point per operation, out of a total of 750. In the expanded phase, this effort was focused only on Mexico and Costa Rica, where all products of the loan programs –including those from programs that concluded up to 2024—were comprehensively georeferenced.

Mexico portfolio: In the case of Mexico, 51 operations with closing dates between 2010 and 2024 were successfully georeferenced. Since each operation comprises multiple outputs, a total of 231 components were mapped across 425 municipalities. These 51 operations span approximately 10 sectors and 31 subsectors of IDB operations. These operations are potential candidates for evaluation, but for an operation to be evaluated it is crucial that the municipalities where the operations were executed have the necessary socio-economic data required to conduct the evaluation. This imposes some constraints worth mentioning. First, the operation should have been executed in municipalities for which we have the socioeconomic data needed to conduct our evaluations. Second, to implement our quasi-experimental evaluation, we impose the need of having at least five years pre-intervention (i.e., years prior to the first disbursement), this combined with the fact that an important amount of our socioeconomic variables start between 2005 and 2006, means that we can evaluate only operations that have their first disbursement after 2010. These constraints, reduce operations evaluated down from 51 operations to 27 operations (53% of the candidate operations, spanning 10 sectors and 31 of IDB operations).

Costa Rica portfolio: In the case of Costa Rica, the Atlas Initiative georeferenced 19 operations with starting dates between 2010 and 2024, covering the 81 cantons of Costa Rica. These candidate operations include a total of 504 project works across 8 sectors and 13 subsectors of IDB operations. After considering selection filters, socioeconomic data availability and methodological considerations, we were under the obligation to reduce the number of operations from 19 to 3 operations, focusing only on the Transportation and Security sectors. Overall, the evaluation of the portfolio from Costa Rica includes only 16% of the total of candidate project works.

The Transportation sector evaluation includes 2 operations and 61 project works across 42 cantons, with starting dates between 2010 and 2014. A major reason to limit the starting date of projects works in the Transportation sector until 2014 was the rapid expansion of operations with potential direct effects on the economic growth to almost all cantons in 2015. While in 2014 there were 33 cantons available for the control group of the Transportation sector, the potential control group fell down to only 1 canton in 2015. This imposed an important restriction for the evaluation period because a reliable control group requires a relatively big number of cantons.

The Security sector includes 1 operation and 18 project works across 16 cantons, with the 18 project works starting in 2013. In this sector, 21 works are not included in the evaluations. From the 21 excluded works, 6 works are not included because we did not have indicators to measure the effect of these works. Furthermore, there are 15 project works starting in 2022, however, these were excluded from the evaluation because the socioeconomic data needed to conduct the evaluations was only available until 2019.

The operations from the sectors Water and Sanitation, Education, Regional Integration and Tourism are not included in the evaluations because we did not have access to georeferenced socioeconomic indicators associated with the potential direct effects caused by these sectors or specific project works. The Energy operations were not included because these have nationwide coverage, making it impossible to identify control cantons. The Development of Small and Medium Enterprises (SMEs) operations are all non-sovereign-guaranteed (NSG) loans and it was not possible to identify the locations of all SMEs recipients.

As the primary source, records were retrieved from the Bank's repositories, including the Ezshare folders, the convergence system, and the IDB extranet, where information and documentation on loan programs are available. This documentation includes: Project Completion Reports (PCR) and annexes, midterm and final evaluation reports, ex post evaluation reports, infrastructure and/or equipment project bidding documents, semi-annual progress reports, procurement plans, results matrices, disbursement justifications, and/or Loan Proposals.

In the convergence system, the results matrix and contract clauses sections were reviewed in particular, as they could validate the physical and financial execution of products and facilitate access to contractual compliance reports, such as the semi-annual progress reports detailing project execution for the relevant period.

As a secondary source, available information from the websites of national institutions was reviewed to find geographical descriptions of these projects with the information provided by Google Maps, the file was populated as follows (see Table A2.1.): column AC (geolocation), column AD (document reference where the location was identified), and columns AH and AI, representing polygons and roads, respectively, if applicable.

Data Collection and Validation

A database was created and exported from the Bank's systems, organized and completed according to the following structure.

TABLE A2.1.

Structure of the database created from the Bank's system

Colum n	Name	Description
A	operation_number	Loan number
B	operspanishnm	Name of the loan in spanish
C	sectorsubsector	Name of sector and subsector
D	apprvldt	Approval date

Column	Name	Description
E	curntdisbexprdt	Contractual date of last loan disbursement
F	disbextensioncalcmonths	Months extended from original last disbursement period
G	cntrybenfit	Country code
H	apprvldtyr	Approval year
I	closeddt	Closed date
J	cntrybenfitcopy	Beneficiary country
K	envmntlclssfctncd	Environmental and Social category. A, being the one with most potential impacts (resettlements, etc) and C no impact
L	frstdisbdt	First disbursement date
M	modalityenglnm	Modality of the operation in english
N	opertypenglnm	Funding type in english
O	disbamnthuseq	Amount disbursed
P	totlapprvdamnthuseq	Total approved amount
Q	latitude	Latitude of the geographic location of the Executing Unit
R	longitude	Longitude of the geographic location of the Executing Unit
S	component_id	Component ID
T	output_id	Output ID
U	cost_a	Output Cost
V	percentage_output_cost	Output cost as a percentage of total cost
W	component_name	Component name in english
X	output_name	Output name in english
Y	output_category	Output category
Z	visual_output_id	Visual Output ID
AA	vo_name	Specific name of the output
AB	vo_description	Descriptive Details of the output

Colum n	Name	Description
AC	geolocation	Coordinates (latitude and longitude) of the municipality, community and geographic location of project ouputs
AD	document_reference	Document reference that validates de geographic location of project outputs
AE	output_units_represented_by_vo	Number of outputs in the loan
AF	year_closed	Year of operation closing
AG	principal_product	Most important output measured by ouput cost
AH	polygon/Municipality	Beneficiary municipalities
AI	Roads	Operations that have street or highway interventions

Source: Authors' elaboration.

The information to be populated through the search described in the previous section includes: i) product description (column AB), geolocation (column AC), reference to the document that validates the product's location (column AD), mark if it corresponds to the main product (column AG), indicate if the beneficiaries are the inhabitants of the municipalities (column AH), and specify if the interventions are roads (column AI).

When identifying the name or description of an intervention, it is recorded in column AB, which indicates the point to be searched in Google Maps, for example: "Construction of the San Marino port."

The description of the georeferenced coordinates in column "AC" can be represented in three categories:

- **POINT (longitude latitude):** Refers to a specific point on the map.
- **MULTIPOINT ((longitude latitude), (longitude latitude), (longitude latitude), (longitude latitude)):** This format can represent multiple points for interventions, marking different sites on the same line, for example, "10 schools constructed."
- **LINESTRING (longitude latitude, longitude latitude, longitude latitude, longitude latitude):** it represents road interventions, with each point separated by a maximum distance of 5 km to mark segments of the intervened roads. This type of geolocation is used for transport sector loan programs (ENE/TSP).

Column AD indicates the reference to the document registry, for instance, the EZSHARE number of the Project Completion Report (PCR) where the information was found.

Initially, priority was given to georeferencing the main products, identified in column AG with the variable "1," as these received the highest allocation of financial resources. However, the scope was expanded to georeference all project products, except those meeting the criteria in section 2.6, marked as “2.”

The variable in column AH, labelled “Polygon,” was added to identify products that benefit a municipality due to the nature of interventions. This type of variable is generally relevant for projects involving healthcare, local job fairs, potable water and sanitation systems, student scholarships, and others not tied to a specific point, as in infrastructure projects.

Additionally, column AI, titled “roads,” was included to identify interventions related to road construction or improvement.

Location consistency is verified according to the country, department, and municipality associated with the Loan Program. This can be validated using Google Earth, where various points can be uploaded simultaneously for better map visualization.

By entering the site name into Google Maps, the existence and accuracy of the intervention site can be confirmed, yielding geographic coordinates in decimal format (longitude and latitude). If the site cannot be located, it can be cross-validated with nearby sites, which can often be found in IDB documents, counterpart websites with geographic addresses (referring to nearby locations), or other online publications.

For cases where municipalities are the beneficiaries, common interest sites, such as the central parks or town halls, are selected to highlight the community’s central location.

If the site cannot be identified on Google Maps, has no references on counterpart websites, and lacks information in the Bank’s archives, it is not georeferenced.

For some projects, challenges arose during the information search, such as missing files from older projects, especially those with an older last disbursement date. These records were stored in the IDBDOCs archive system, and when migrated to the EZSHARE system, institutional memory was partially lost, or the documents were visible but unavailable upon attempting to open them.

While it was possible to perform the review using the documents, it is recommended that teams register georeferencing information for their operations. Alternatively, it is recommended that the person doing the georeferencing validate the data by interviewing a team member who participated in the project, to capture institutional memory and local knowledge of the intervention site, which may not be in the recorded/archived documents.

It is advisable to consider options with the fiduciary sector (FMP) to create or generate accurate sources of information on the intervention sites for infrastructure or equipment acquisition projects, as these details are specified in bidding documents (BD). Moreover, consulting services for project supervision, which generally include intervention areas, are often managed for infrastructure projects.

Currently, the Bank has the CAPTUDATA platform, which is used in some countries, such as Costa Rica and Nicaragua, to measure the progress of infrastructure projects. This platform collects not only visit reports but also visualizations and geographic locations, provided it is updated by project supervisors.

For some projects (in a minority), lists of works, including geographic locations, were found in the Bank’s files. This information could be valuable if included as an annex to the PCR to build historical data as projects are closed, utilizing this experience to overlap with new projects in the closure phase.

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