Introduction

Infrastructure investment lies at the intersection of economics, engineering, and public policy. It shapes productivity, social inclusion, and environmental sustainability, yet it also involves complex decisions under uncertainty and imperfect information. The purpose of this book is to provide a coherent analytical framework to evaluate such decisions through Cost–Benefit Analysis (CBA), a method that translates the welfare implications of investment projects into measurable and comparable terms.

The intended readership of this volume comprises graduate students in economics and public policy, together with practitioners working in government agencies, international organizations, and consultancy firms who engage in project appraisal and evaluation. My aim is to bridge the gap between theoretical foundations and applied practice to show that CBA, far from being a mechanical checklist, is a consistent system of reasoning grounded in welfare economics, capable of guiding rational public choices even in complex and uncertain environments.

The origins of this textbook stem from two complementary observations: First, despite the wide diffusion of CBA in public-sector decision-making, the economic rationale underlying its procedures is often misunderstood. In many administrative contexts, CBA is reduced to a compliance exercise rather than a genuine tool for understanding the social efficiency of investment. This mechanical use weakens its intellectual coherence and deprives policymakers of its most valuable function: Clarifying the welfare logic that links resources, externalities, and time. Second, existing manuals tend to separate theory and practice. Academic texts often emphasize welfare theory, while operational guidelines, such as those of the European Commission, the World Bank, or national finance ministries, focus on procedures and formulas. The result is a fragmented learning experience, particularly for students entering the field of infrastructure economics. The ambition of this book is to integrate these dimensions, providing a unified exposition that connects the theoretical underpinnings of CBA to its institutional and empirical applications in infrastructure investment.

Infrastructure is both an economic good and a public choice. It provides the physical and organizational foundations for production and consumption, while embodying the long-term commitments of a society. The appraisal of infrastructure projects—be they roads, railways, energy grids, or digital networks—poses unique challenges that make it an ideal domain for learning CBA.

First, infrastructure projects are capital-intensive and irreversible. Once built,

they generate streams of benefits and costs over decades, often beyond the planning horizon of their promoters. The analyst must, therefore, account for intergenerational effects, distributional consequences, and environmental externalities.

Second, infrastructure decisions are rarely taken in competitive markets. They are collective choices, shaped by public budgets, regulations, and political priorities. This makes CBA not only a technical method but also a framework for understanding how economics interacts with governance.

Finally, infrastructure investment lies at the heart of today's grand policy challenges like sustainable mobility, digital connectivity, climate mitigation, and adaptation. Evaluating such projects demands that economists combine traditional welfare criteria with considerations of resilience, risk, and inclusiveness. For these reasons, the transport and infrastructure sectors provide both the motivation and the empirical context for this book.

The preparation of this book stems from more than two decades of teaching, research, and policy practice in the field of infrastructure economics and project evaluation. Over the years, I have had the privilege of working with graduate students, economists, engineers, public officials, and investors who share a common objective: To make better, more informed decisions about public investment. Yet, in these exchanges, a persistent gap has become evident between the analytical tools of economics and the institutional realities of policymaking.

This book is my attempt to bridge that gap. It aims to offer a comprehensive and methodologically coherent treatment of CBA, one that remains faithful to its theoretical foundations in welfare economics while responding to the demands of contemporary public policy. The result is neither a manual of formulas nor a treatise in pure theory, but rather a synthesis of both: A guide to the economic reasoning that underpins rational public investment.

CBA has accompanied the development of modern public economics for nearly a century. From its early applications to water-resource management in the United States during the 1930s to its institutionalization in the post-war period by the World Bank and UNIDO, it has become an essential tool for evaluating the efficiency of public spending. Today, it underpins much of the European Union's Cohesion Policy and forms a central component of international development finance.

Despite this long pedigree, the role of CBA has never been more vital—or more contested—than it is now. Governments face a new generation of challenges: Climate change, digital transformation, urbanization, demographic aging, and fiscal constraints. Public resources are limited, while the demands placed upon them are growing. In such a context, economic appraisal must do more than justify expenditure; it must help societies navigate complex trade-offs between growth, equity, and sustainability.

Infrastructure policy epitomizes this challenge. Investment in transport, energy, water, or broadband is not simply about building assets; it is about shaping the future spatial and economic structure of society. The long time horizons and irreversible nature of these projects require tools capable of weighing immediate costs against benefits that may accrue decades later. CBA, when properly understood and applied,

provides precisely that capacity: A rigorous framework to measure and compare the welfare consequences of alternative investments.

One of the central objectives of this book is, therefore, to reconnect CBA with its theoretical foundations. The core principles of shadow pricing, opportunity cost, and intertemporal welfare comparison are not mere technicalities; they embody deep ethical and analytical choices about how societies value time, risk, and distribution. Understanding these foundations is essential for meaningful application.

At the same time, I recognize that theory alone is insufficient. Appraisal does not occur in an abstract social planner's world, but within political and institutional systems shaped by incentives, asymmetries of information, and competing objectives. The book thus devotes substantial attention to the political economy of project appraisal and is accompanied by some case studies, in the text, or prepared along the book to be used in class.

Bringing these dimensions together is not only a matter of intellectual completeness; it is a precondition for the credibility of public decision-making. A CBA that is methodologically sound but institutionally detached risks being ignored. A CBA that is politically expedient but analytically weak undermines trust and efficiency. The ambition of this work is to articulate a synthesis where analytical rigor and institutional realism coexist.

This textbook is written primarily for graduate students in economics and public policy who seek to understand how welfare theory translates into applied analysis. However, it is equally addressed to professionals—policy analysts, engineers, civil servants, and consultants—who engage daily in project appraisal and seek to strengthen the economic reasoning behind their work.

This volume is offered to readers as both a textbook and a reflection. It seeks to convey the analytical precision of economics while remaining attentive to the broader questions of governance, accountability, and sustainability that define the public sector today.

For students, I hope it will serve as a rigorous and accessible entry into the field of CBA. For practitioners, I hope it will reaffirm that economic reasoning—when applied transparently and responsibly—remains an indispensable ally of good policy.

Ultimately, the evaluation of public projects is not an end in itself but a means to improve collective welfare. If this book helps its readers to approach that task with greater clarity, critical awareness, and ethical commitment, then it will have achieved its purpose.

This book adopts a stepwise structure, moving from foundational concepts to advanced applications. The structure mirrors the logic of project appraisal itself—from financial viability to social desirability, from private incentives to collective welfare.

- Chapter 2 introduces the basics of financial analysis, distinguishing between financial profitability (based on market returns) and economic profitability (based on social welfare). It also explores the role of public–private partnerships (PPPs) and the incentives shaping risk allocation between public and private actors.

- Chapter 3 establishes the theoretical framework of CBA within welfare economics, deriving the cost–benefit test from the maximization of a social welfare function and discussing the assumptions of marginality, perfect competition, and spatial boundaries.
- Chapter 4 develops the mechanics of CBA by defining shadow prices and monetization methods, linking theory to operational procedures in real-world project appraisal.
- Chapter 5 deals with externalities, reviewing both revealed-preference and stated-preference approaches for valuing nonmarket goods such as pollution, safety, and time.
- Chapter 6 analyzes discounting and intertemporal choice, exploring the ethical and empirical basis for social discount rates and their implications for intergenerational equity.
- Chapter 7 extends the framework to risk and uncertainty, presenting sensitivity and probabilistic analyses, as well as global sensitivity methods that help evaluate robustness under incomplete information.
- Chapter 8, finally, synthesizes the discussion, situating CBA within the broader political economy of infrastructure governance and the transition toward climate-resilient investment.

Throughout the volume, each chapter combines formal exposition with intuitive reasoning, drawing examples mainly from transport and environmental infrastructure—areas where the use of CBA is both mature and policy-relevant. Mathematical expressions are kept to the minimum necessary to ensure analytical rigor, while emphasis is placed on interpretation and policy implications.

By the end of this book, readers should be able to:

1. Understand the theoretical foundations of CBA and its derivation from welfare economics.
2. Apply CBA to real-world infrastructure projects, identifying, quantifying, and monetizing relevant costs and benefits.
3. Interpret shadow prices, discount rates, and risk measures in economic terms.
4. Critically evaluate CBA results, recognizing the limits of data, model assumptions, and institutional context.
5. Engage in informed dialog with policymakers, engineers, and stakeholders about the efficiency and equity of investment decisions.

For graduate students, these skills will provide a rigorous entry into applied welfare analysis and public–economics practice. For practitioners, they offer a structured approach to evidence-based policymaking and infrastructure governance.

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I also wish to acknowledge the contributions of the European institutions whose guidelines and methodologies have provided a testing ground for the ideas discussed here. The dialog between academic research and institutional practice is at the heart of this work, and it is to that dialog that the book hopes to contribute.

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This book is dedicated to my beloved family, who have supported me through all these years of teaching and commuting—enduring my absences and frustrations, and dispelling my fatigue with the power of their smiles and love.

The book is enriched with multimedia case studies—from the Messina Bridge to ancient Roman roads, from the European high-speed rail network to the Light Rail Transit system in Addis Ababa—available on https://digitabook.egeaonline.it.