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How governments can prioritize infrastructure stimulus investments

Moving beyond cost-benefit analysis

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Infrastructure spending has long been employed by governments to stimulate infrastructure investments. In 2021, for instance, the United States issued the US Bipartisan Infrastructure Law, which introduced US$550 billion in new spending, with US$284 billion allocated to surface transportation.[1] Similar global initiatives include the United Kingdom's National Infrastructure Strategy and the European Union's NextGen program. In fact, in 2022, G20 central governments set aside almost US$1 trillion for infrastructure investment.[2]

However, for these ambitious programs to drive economic recovery, address social issues, mitigate the effects of climate change, and meet the needs of the communities they serve, governments must get program funding right. Before that can happen, governments must understand how best to prioritize the potential infrastructure projects that they can select from.

1 "The US Bipartisan Infrastructure Law: Breaking it down," McKinsey & Company. November 12, 2021. Accessed at https://www.mckinsey.com/industries/public-and-social-sector/our-insights/the-us-bipartisan-infrastructure-law-breaking-it-down
2 "Transformative Outcomes Through Infrastructure," Global Infrastructure Hub. Accessed at https://infrastructure-outcomes.gihub.org/

The traditional approach: Cost-benefit analysis

Cost-benefit analysis (CBA) is a systematic process that evaluates the costs and benefits of project decisions to find the most cost-effective approach. Widely used by governments for infrastructure project appraisal and prioritization, CBA can be used across different types of projects to provide a well-documented and common way of comparing different options based on their net benefits. Some of the advantages of CBA for governments are that it:

- Makes decisions simpler by reducing them to costs versus benefits
- Uncovers hidden costs and benefits that may not be obvious at first glance, such as indirect or intangible effects
- Helps justify public spending by ostensibly demonstrating value for money

However, CBA has several significant limitations that governments should bear in mind. Specifically, when governments use CBA, they often:

- Struggle to predict all the variables that may affect the outcome of a project, especially in complex or uncertain situations
- Fail to capture all the social impacts of a project, such as its effects on equity, inclusion, resilience, or the environment
- Rely on subjective assumptions or biases in estimating costs and benefits, such as how they are measured, valued, and discounted over time
- Face politically motivated challenges for a different result

The first paper in this series, *How should governments prioritize infrastructure stimulus investments? Why governments must look beyond cost-benefit analysis,* took an in-depth look at the problems associated with relying solely on CBA and provided an overview of alternative approaches. This paper builds on that first installment. After setting out more detailed guidance on alternative and complementary approaches to assessing infrastructure investments, we recommend a more holistic approach to project evaluation—one that enables more accurate and comprehensive assessments of the social impacts of a project. By supporting better decision-making, this type of approach can help governments make more informed resource allocation decisions and empower them to prioritize infrastructure projects that deliver on both financial and public benefit outcomes.

CBA alternatives

As governments come to realize the risks associated with CBA, they are increasingly looking for ways to enhance the accuracy of their project appraisals. Fortunately, there are a wide variety of supplementary approaches that provide viable alternatives to CBA.

Cost-effectiveness analysis

Cost-effectiveness analysis (CEA) is an evaluation tool that compares the costs and outcomes of alternative infrastructure projects. Unlike cost-benefit analysis, which monetizes both costs and benefits, CEA measures outcomes in physical or natural units, such as lives saved, emissions reduced, or travel time saved.

CEA can help decision-makers select projects that achieve a given objective at the lowest cost or maximize an objective within a given budget. For example, CEA can be used to compare different transportation strategies based on their cost per mile, or different nature-based solutions for disaster risk and water resource management based on their cost per hectare. CEA also offers some additional advantages. For instance, it avoids some of the ethical and practical challenges associated with valuing non-market goods and services. Similarly, CEA makes it easier to compare projects with different types of outcomes by facilitating the use of standardized indicators for ranking projects. That said, CEA is not without its limitations. Notably, CEA cannot account for distributional effects, externalities or opportunity costs, may be sensitive to the choice of outcome measure and discount rate, and may not reflect social preferences.

Multi-criteria analysis

Multi-criteria analysis is used to assess how well projects perform across a range of factors and can be used to compare project options in the very early phases. First, the different criteria are weighted for their relative importance on a quantitative scale, for instance 0 to 10. Then the project options are scored against how well they achieve each of the factors. The criteria weighting is multiplied by the project score for that factor. These individual criteria scores are summed to produce an overall score for how well that project meets the criteria. This method naturally favors the project that delivers the most functionality without consideration for cost. An additional optional step to counter this is to divide the project criteria score by the risk adjusted cost estimate. This results in a measure of the potential value that the project could deliver.

One advantage of multi-criteria analysis is that it is extremely flexible and can be used to capture any element that the project team values. Careful criteria selection allows for comparison across different project types but there are limitations to this. For instance, it can be useful for comparing different transport projects to achieve mobility aims, but it would be less useful to make comparisons across different sectors, such as choosing between a hospital project and a road widening scheme.

Return on investment

Return on investment (ROI) is a strictly financial measure that looks at the expected return compared to the financial outlay. When used on projects, ROI is calculated as the net profits divided by the project costs and then multiplied by 100, to express it as a percentage. An advantage of this measurement approach is that it is clear and easily understood. This makes it easy to conduct comparisons between multiple projects.

However, ROI also represents quite a narrow focus for government bodies to take. Consider: if the projects are highly profitable on strict financial metrics, the private sector may well be better placed to deliver them, rather than governments. At the same time, ROI fails to take the full range of success variables into account. After all, most government initiatives are not generally focused on exclusively delivering maximum financial returns. As such, an over-reliance on ROI may result in a type of tunnel vision that prevents governments from accurately assessing the needs of taxpayers, residents, and other societal stakeholders.

Computable general equilibrium

Computable general equilibrium (CGE) models assess flows between governments, businesses, and households to determine the economic impact of government initiatives. These models are primarily used to assess policy, but because they are conducted at a macroeconomic level, CGEs can also be used to assess both the positive and negative potential impacts of government initiatives on portfolios and megaprojects. Given the scale of the analysis required, CGE is better suited to large portfolios and infrastructure ecosystems than to individual projects, but it can be used in tandem with other measurement systems to enhance decision-making. As an example, the New South Wales government uses CGE to measure economic impact and complements it with CBA to understand project benefits and costs.

Local effects analysis

Local effects analysis (LEA) is an overlay to a routine CBA that identifies how much of those benefits will stay within the local community. Each benefit is analyzed to determine whether it will impact people that live in the area near the project, both during the project and once its output is in operational use. The LEA captures factors such as how employment, income, footfall, the environment, and other salient elements will be impacted. This impact is assessed based on the net difference to the community if the project did not take place.

To understand how this might work in practice, consider a project that would provide 300 jobs in an area. In this case, the LEA would account for those additional expected jobs but would not include those jobs where an employee simply transfers to another role. As such, the project would include a proportion of the 300 jobs in the LEA. The income would then be compared with average incomes in the area to forecast the net difference the project would notionally deliver to the community. LEA is not a standalone method; it is used to communicate the change a project is anticipated to bring to a community.

Stochastic CBA

Stochastic cost-benefit analysis (CBA) is an evaluation tool that incorporates uncertainty and risk into the appraisal of infrastructure projects. Unlike deterministic CBA, which uses single point estimates for costs and benefits, stochastic CBA uses probabilistic simulation to generate a range of possible outcomes and their likelihoods. Stochastic CBA can help decision-makers to assess the robustness and sensitivity of project performance indicators, such as net present value (NPV) or benefit-cost ratio (BCR), under different scenarios. Some advantages of stochastic CBA are that it can capture complex interactions among variables, account for non-linear effects and extreme events, and provide more transparent and realistic information for risk management. However, stochastic CBA is limited by the fact that it requires more data and computational resources, may be subject to model uncertainty and bias, and may not adequately reflect social preferences or distributional impacts.

Figure 1: A comparative view of CBA alternatives

CBA alternative	Pros	Cons
CEA	1. Extremely flexible and can capture any element the project team values. 2. Simplifies the comparison of projects with different types of outcomes. 3. Facilitates the use of standardized indicators for ranking projects.	1. Cannot account for distributional effects or externalities. 2. May be sensitive to the choice of outcome measure and discount rates. 3. May not reflect social preferences or opportunity costs.
Multi-criteria analysis	1. Extremely flexible and can capture any element the project team values. 2. Allows for comparison across different project types with careful criteria selection. 3. Considers multiple factors, leading to more comprehensive decision-making.	1. Limited in comparing projects across different sectors. 2. Can be subjective in assigning weights to criteria. 3. More difficult to understand than methods with simpler metrics.
ROI	1. Simple and easily understood. 2. Easy to compare with other projects.	1. Narrow focus on financial returns, may not align with government objectives or be well-suited for many government initiatives. 2. Overlooks non-financial benefits and impacts. 3. Factors projects with immediate financial returns, which may not align with long-term goals.
CGE	1. Can be used for policy, portfolio, and megaproject evaluation. 2. Considers the macroeconomic landscape.	1. Primarily focused on economic flows, so does not capture all social or environmental impacts. 2. Requires significant data and expertise to develop and interpret models. 3. May not address distributional impacts or equity issues.
LEA	1. Considers local impacts of projects, so it is a powerful tool for communicating at a local level. 2. Captures broader societal factors such as employment, income, and environment. 3. Helps assess the net difference in benefits with and without the projects.	1. Does not capture broader regional or national impacts. 2. Requires detailed data on local conditions and project specifics. 3. Time consuming to address long-term or indirect effects of projects on local communities and economies.
Stochastic CBA	1. Provides a range of potential outcomes and their likelihoods, which is more informative than single point values. 2. Captures complex interactions among variables. 3. Accounts for non-linear effects and extreme events. 4. Provides more transparent and realistic information for risk management.	1. Requires more data and computational resources. 2. May not adequately reflect social preferences or distributional impacts.

Future-focused approaches

In addition to the six CBA alternatives outlined above, a range of future-focused approaches may provide governments with increasingly nuanced ways to analyze and prioritize their infrastructure stimulus investments. Here, we look at some of those emerging methodologies and share some real-world case studies that exemplify how they can be used.

Using procurement processes to drive social value and manage risk

To meet the aims of multifarious stakeholders, infrastructure investments are rarely focused on simply accomplishing one outcome. As such, it is not uncommon for governments to allocate a proportion of their infrastructure spending or broader procurement budgets towards historically disadvantaged groups.

To properly target these investment dollars, however, governments need visibility into the supply chain beyond their tier one or tier two contractors. Proper insight into the extended supply chain is critical not only to identify billing anomalies and risk patterns, but also to pinpoint potential supply chain waste or fraud.

In fact, a recent Deloitte survey found that 85% of surveyed global supply chains experienced at least one disruption due to fraud or abuse in the previous year.[3]

Without hard data on diversity within the supply chain for any specific project, spending agencies cannot assure compliance with the project's stated social goals. However, equipped with information about suppliers at each level, government buyers, prime contractors, and project risk managers can assess a range of potential supply chain risk, including the possibility of sourcing from those who use child or slave labor, operate in prohibited geographies, or have links to foreign organizations with undue state influence.

Case study: Using procurement platforms to manage risk

One way to gain the visibility needed to drive social value is by using procurement platforms that leverage data analytics and market intelligence to help manage risk. One such platform is EdgeworthBox, a set of tools that brings suppliers and buyers together to support collaborative procurement within and between organizations.

By providing contractors in a project-specific supply chain with access to EdgeworthBox, suppliers that are owned, operated, and controlled by people from historically disadvantaged backgrounds can identify and prove themselves as diverse entities. As a result, governments can obtain operating statistics about the amount of spending they direct towards targeted communities, while simultaneously improving the management of project risk.

Leveraging the power of data to improve project forecasting

Professor Philip Tetlock, author of *Superforecasting*: *The Art and Science of Prediction*, is a social scientist who has spent decades analyzing people's ability to foresee the future. During the course of his wide-ranging work, he has found that the accuracy of forecasts made by purported experts decays rapidly over time—and is ultimately little better than a chimpanzee throwing darts.[4] Whether due to biases that impact their ability to forecast accurately,[5] the lack of expertise in assessing uncertainty, or the inherent uncertainty of forecasts themselves, the most sought-after experts are frequently the worst at accurate forecasting.

3 https://www2.deloitte.com/us/en/pages/risk/articles/risk-management-in-supply-chain.html
4 Tetlock, Philip E. (2005). 'Expert Political Judgment: How Good Is It? How Can We Know?', Princeton: Princeton University Press.
5 Hubbard, D. (2009). 'The Failure of Risk Management: Why It's Broken and How to Fix It', New Jersey: John Wiley & Sons, Hoboken.

This is clearly problematic for government stakeholders charged with forecasting the future outcomes of major infrastructure projects. To improve project forecasting, it is consequently important to rely on empirical data collected from actual observations or experiments, rather than basing forecasts on assumptions or opinions.

Empirical data can help project managers to calibrate their models with realistic parameters, reduce bias and uncertainty, and validate their predictions with historical evidence. In fact, reference class forecasting—a method that postulates future outcomes by taking similar past situations into account—is recommended by Nobel Prize-winner Daniel Kahneman as "the single most important piece of advice regarding how to increase accuracy in forecasting."[6] Reference class forecasting debiases forecasts by bringing them in line with historic project performance using probabilistic modeling. It can also help project managers to apply other advanced techniques, such as earned value management, or neural networks, that can enhance the accuracy and reliability of project forecasts.

6 D. Kahneman, 'Thinking, Fast and Slow', New York: Farrar, Strauss and Giroux, 2011, p. 251.

Yet, despite the capacity of empirical data to improve the accuracy and credibility of project appraisal and selection, governments are often data rich and information poor. While they have access to mounds of data, they cannot always turn that data into insights. Fortunately, the rise of AI is enabling governments to better utilize this data to inform decision-making.

Case study: Hong Kong uses AI-based forecasting to develop early warning system

To gain greater insight into its project delivery capacity, Hong Kong's Project Strategy and Governance Office wanted to use its historical cashflow records to assess project efficiency. In response, Oxford Global Projects helped develop an AI model that used cashflow data from 849 construction projects to forecast future cost and schedule overruns. This Project Supervision System (PSS) assigned a red, amber, or green flag to live projects based on their cashflow progress in comparison to similar projects. This enabled the leadership team to assign proportionate assistance to projects rated red or amber. It also allowed the team to determine that overruns varied by type of project. For instance, building project performance was linked to project budgets, while non-building project performance hinged of the projects' planned duration. Since putting these AI tools in place, the Office's portfolio has saved more than US$6 billion across hundreds of projects.

The next phase of the AI development is to forecast final project costs and durations. This solution is currently being implemented and will also forecast the portfolio spend for the next five years using machine learning.

Case study: World Bank complex program evaluation

To help improve the scale, speed, and efficiency of complex portfolio evaluations, the World Bank's Independent Evaluation Group enlisted Oxford Global Projects and Octant AI to analyze the Bank's stunted growth and chronic malnutrition portfolio, which consisted of 392 unique project reports from 64 countries, representing a total commitment of US$28.8 billion.7 Ordinarily, this type of assessment would involve time-consuming and expensive reviews of hundreds of lengthy reports. By using AI-assisted content analysis, however, this wealth of data could be easily labeled and classified according to an outcome-based conceptual framework. This allowed the Bank to leverage AI to both identify risk drivers and predict project risk.

Case study: Planning Inspectorate reduces planning risk

One of the major risks for any kind of public project, be it a local development plan or a nuclear power plant, is public consultation. In some cases, stakeholder dissent can even lead to project cancellation, a frequent occurrence in nuclear storage projects, which are widely unpopular. Even when projects aren't cancelled, delays are common. In fact, it takes an average of 54 months to review and process all comments submitted for just one plan. For the UK Planning Inspectorate, processing comments was causing delays in roughly 86% of local development plans. To address this challenge, the Planning Inspectorate enlisted Oxford Global Projects to develop a large language model to both process the comments and to estimate time remaining for processing comments. Real data simulations show that the AI-based system cuts categorization time by more than half, which will significantly enhance planning efficiency and quality.

7 Franzen, Samuel, Cuong Quang, Lukas Schweizer, Alexander Budzier, Jenny Gold, Mercedes Vellez, Santiago Ramirez, and Estelle Raimondo. 2022. Advanced Content Analysis: Can Artificial Intelligence Accelerate Theory-Driven Complex Program Evaluation? IEG Methods and Evaluation Capacity Development Working Paper Series. Independent Evaluation Group. Washington, DC: World Bank https://ieg.worldbankgroup.org/sites/default/files/Data/Evaluation/files/Methods_AI.pdf

Picking the right appraisal methods

Despite the traditional reliance on CBA to prioritize infrastructure investments, both experience and research have exposed its critical weaknesses. To ensure that government funding is effectively allocated to the projects poised to deliver optimal outcomes, it is time for governments to expand their project appraisal toolkit beyond CBA.

Fortunately, there are numerous appraisal alternatives that can either replace or complement CBA. The key comes down to identifying the appropriate process to evaluate your options.. For instance, while CEA may help you compare projects with different outcomes, it may need to be combined with other approaches, such as multi-criteria analysis, to take social preferences into account. Similarly, just as you would not use a spanner to insert a nail, you would not use CGE to assess a footbridge renewal scheme. Each project will require a strategic analysis to identify the optimal appraisal approach.

To help you determine which methods are most appropriate to various scenarios, consider taking stock of the following factors:

- Size: Appraisal methods should be proportionate to the level of risk involved in the project. One indicator of risk is project size. This is clearest for larger projects, though, as significant projects require commensurate appraisal efforts.
- Complexity: Complex projects should generally use the more advanced forms of appraisal. Just because a project is relatively small does not mean it is not complex: sociopolitical impact and volatility in the project context serve to increase complexity.
- Impact: How broad are the potential implications of your decisions? Broader implications lend themselves to more holistic appraisal measures. If you are assessing a range of different project categories, make sure to use methods that allow for comparability across sectors.

It can also be helpful to keep in mind that there are various ways to enhance the appraisal process so that the proper projects are prioritized:

- Data: Don't rely on expert opinion alone, as this is subject to biases. Make use of historical performance data and apply a probabilistic rather than binary approach.
- AI: Consider ways in which you can embrace modern technology to make each appraisal more efficient or effective. In many cases, AI can deliver savings that are orders of magnitude quicker or cheaper than traditional approaches.
- Combine: These methods do not have to be used as standalone approaches. They often work best in tandem where one method can be used to counter the weaknesses of another. Combine these methods based on what is appropriate for each project.

Although there is no one-size-fits-all approach to project prioritization, there are best practices governments can use to strengthen the outcomes of their infrastructure investments. As in many scenarios, an ounce of prevention is worth a pound of cure. By investing in a more rigorous analysis upfront, governments can save significant resources when it comes time for infrastructure project execution. Beyond saving time and money, effective project prioritization can enhance social outcomes and support the development of equitable, sustainable, resilient, and future-proof assets that bolster citizen trust while meeting the needs of multiple stakeholders for decades to come.

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