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BCR: Benefit Cost Ratio or Barely Capturing Reality?

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Abstract

In this paper, we discuss some of the drawbacks of relying on one value to inform investment decisions. We discuss the need to change current appraisal guidelines to promote including a range of analysis with the underlying robustness of results clearly communicated. This often leads to effects being excluded from analysis. We highlight the risk of relying on one result to inform investment decisions. We consider two recent examples of projects where the benefit cost ratio is not able to convey the full extent of effects a project would bring, and a reluctance from policy leads to attempt more innovative analysis. We then consider examples from the UK for how they present results to include analysis with different levels of robustness and a range of outcomes in results. We conclude with three recommendations. The first is that a framework is developed to allow for inclusion of less robust analysis separate to results which are based on well-established methodology. Secondly, we recommend that a range of results are presented to decision makers to reduce reliance on one value and communicate the level of uncertainty around analysis. Finally, we recommend that reliable methods for collecting data are established so that the robustness of analysis in emerging areas can be improved over time.

1. Introduction

Cost Benefit Analysis (CBA) is a framework for quantifying all possible effects and comparing the positive against the negative. Overall, this gives an indication of whether an investment, a policy or any kind of decision is a good idea or not. Any effect which can be monetised can be included in a CBA. The benefit cost ratio (BCR) is estimated by summing the present value of all the benefits a project would deliver divided by the summed present value of all the costs, delivering a single numerical result from conducting a CBA. It presents a clear metric of value for money, or "bang per buck", demonstrating for every dollar spent the value of benefits you would expect a project to deliver. Often, the BCR is presented alongside other key metrics, such as:

- Net present value: sum of present value of all benefits a project would deliver minus the summed present value of all the costs
- Internal rate of return: the discount rate required for the BCR to equal 1 or the NPV to equal 0
- First year rate of return: the ratio of benefits in the first year divided by the capital costs of a project.

While each of these metrics is an output of the CBA, this paper focuses on the BCR. In our experience, the BCR is often quoted as the headline result on which decisions are based. However, many of the discussion points presented in this paper with respect to the BCR are also applicable to these other metrics.

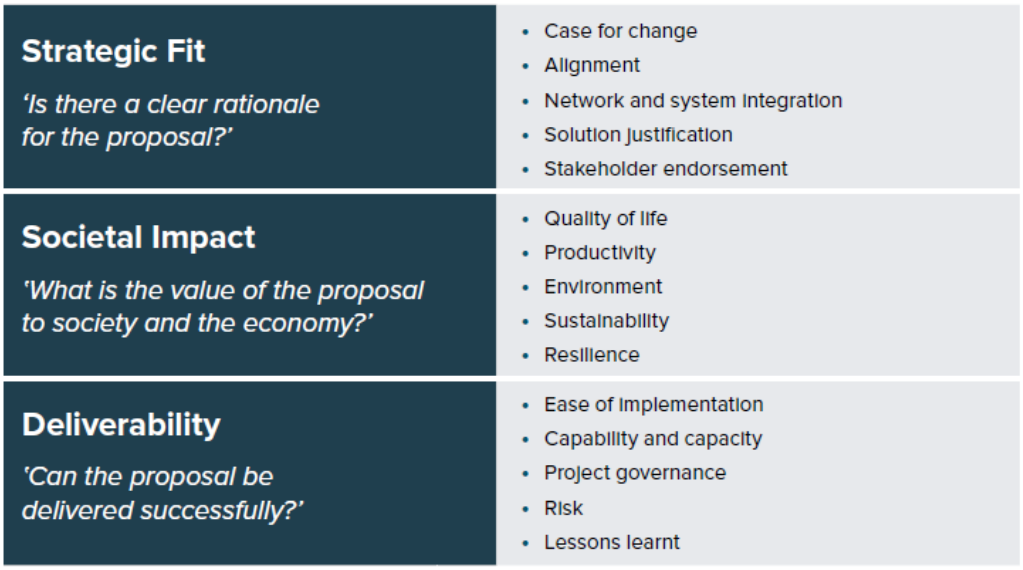
Both CBA and the resulting BCR metric are commonly used by government agencies to provide a clear and simple evaluation to demonstrate a project's value and are an important tool in investment decisions. CBA can be carried out on a range of projects and initiatives, making it easy to compare investments in different transport modes, projects which are of different scales or involve a policy change instead of a capital investment. However, one number cannot tell you everything you need to know about investing in a project. Practitioners are regularly faced with hesitancy around including less robustly quantified effects. Whilst the CBA framework theoretically allows for quantification of any effect, in practice this is often not the case.

Transport appraisal has historically focussed on improving the movement of people and freight around and between locations. More recently, there is a shift in government policy to also consider places as a location and the role transport connections play in developing that aspect. Terms like place-based planning, place making effects and amenity are becoming regular features in discussions on benefits mapping. Governments have realised that traditional appraisal approaches focussed on infrastructure planning and unimodal infrastructure proposals are not citizen centric. Important contributors to community health and well-being are undervalued in appraisal, or not considered at all. Approaches to assessing the value of, and prioritising proposals need to evolve to ensure they reflect the changing needs of the communities and the government agencies that support them.

A changing shift in focus will require investment in projects which deliver a wide range of benefits, beyond those currently captured in a transport appraisal. These have not traditionally been captured in economic appraisal and the guidance needs to adjust to allow for consideration of them. As the evidence evolves to be able to quantify effects, frameworks need to be in place which include all potential quantified effects, whilst allowing some differentiation between the confidence different analysis conveys.

Transport for NSW has recognised the need for guidance on appraisal of place effects alongside more traditional transport ones. It recently launched the Movement and Place Framework (Transport for NSW, 2021) which is being promoted and piloted across projects. Similarly, Infrastructure Australia recently released updated guidance providing more detail on the assessment criteria to include themes for consideration. These include consideration of Strategic Fit, Societal Impact and Deliverability to inform a broader evaluation of projects (Infrastructure Australia, 2021). These new frameworks point towards a need to consider effects from investment more widely than the current transport focus. This guidance is an important step towards broadening the transport focus but until the guidance is widely applied and accepted, analysts are likely to continue to encounter some difficulties in including non-traditional effects in a CBA.

Figure 1 Assessment Criteria and Themes



Source: Infrastructure Australia, Developing a business case: Stage 3 of the Assessment Framework (July 2021)

Our paper sets out some examples where the BCR does not provide a good measure of the effect an investment could have. It sets out some problems often faced by transport economists and proposes solutions to address the current shortcomings of a narrow focus on one BCR result.

2. Problem Statement

The BCR has some major shortcomings and cannot be relied on to tell you everything about the value for money that a project will deliver. Through our work preparing economic analyses for business cases, we have identified three causes where the BCR does not provide a good indication of the effect a project could have. These are:

1. Not all effects can be quantified
2. Appraisal does not accurately capture the intricacies of effects, such as transfers or distribution of effects
3. One result does not reflect the range of outcomes which could occur

There is significant ongoing research and an ever-evolving evidence base to support quantification of a wider range of effects, beyond the transport benefits which have traditionally been captured. These include developing methods for appraising the benefits to pedestrians of being in a nicer environment, land use change models which capture dynamic interactions between businesses and work to improve understanding behind behavioural changes. Currently, the evidence behind these appraisal frameworks is less robust, less well understood and less accepted in policy making compared to traditional transport (movement) effects.

Some effects are open to a wider interpretation than others. The NSW Future Transport Strategy (NSW Government, 2018) has six key themes, one objective of which is: "The liveability, amenity and economic success of communities and places are enhanced by transport". However, the effects arising from improvements in place-making are not easy to define and may be interpreted differently by different people. The benefit gained from improving the amenity of a place is more subjective than a reduction in travel time which can be based on wages, stated preference willingness-to-pay studies or revealed preferences through travel

choices. Therefore, whilst evidence is developing to allow analysis of place-based and other effects to be carried out, it will continue to be less robust than the well-established evidence base which supports transport effects.

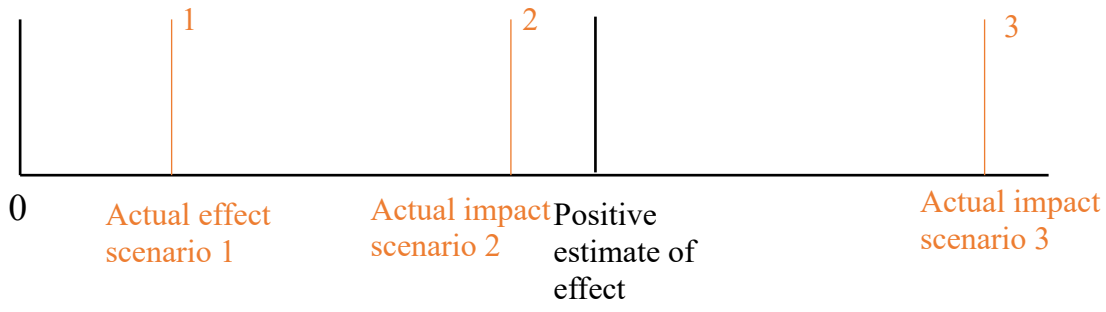
Current working practices do not provide a framework to separate benefits which can be robustly estimated and those which are less certain but can still be quantified to some degree. This often leads to situations where it is preferable to not include any additional analysis on effects which are less robust. The risk that robust elements of the analysis are discredited because they are viewed with the same level of confidence as the less robust elements outweighs the advantage that some understanding of less robust effects would bring. Infrastructure Australia guidance recommends reporting results for land use impacts and Wider Economic Benefits separately from more conventional CBA results. However, this is difficult to achieve in practice and could be expanded to include estimates of other less robust effects.

The recently updated Infrastructure Australia Guide to Economic Appraisal provides a range of benefit and cost items that may be monetised in CBAs. These are assumed to be included in the main case results. However, the inclusion of many of these impacts is challenging in practice, whether that be due to challenges in monetising the impacts or challenges associated with quantifying the underlying data. By way of example, the introduction of a new road corridor may improve access to health care which encourages people to access preventative measures of health care. In doing so, overall health costs may decline as more major procedures are avoided. While there are methods for monetising the change in health costs, determining the quantity of procedures avoided which can be attributed to the introduction of a new road is challenging.

In some instances, analysts know that there would be some benefit from an intervention and therefore any estimate has a greater chance of being closer to the actual effect than zero. To paraphrase, we know that an estimate of zero benefit is wrong. Therefore, almost any estimate is more likely to be closer to what is expected to happen than an estimate of zero.

The figure below demonstrates this concept. An estimate of the effect is calculated, which is greater than zero. If the actual effect resulting from the intervention is scenario 2 or scenario 3, the estimate calculated is better than no estimate at all. However, if the actual effect is closer to scenario 1, than including no effect would have been more accurate. Whilst there is always a risk that estimates will be wrong, including no effect in most cases is more likely to be wrong.

Figure 2 Estimated Effect Scenarios



As projects progress through approval stages, it is sometimes considered easier only to quantify and present the robust estimates rather than including less robust analysis which would need

further explanation and would likely invite additional scrutiny. However, this is counterproductive as the overall understanding of an investment is lower without consideration of all the potential effects. This omission of non-traditional benefits could result in an underestimate of the overall value for money delivered by the investment. This could lead to projects which deliver traditional benefits being favoured over those which have wider effects which were not quantified.

A BCR is often presented as the final answer. In reality, there is always some inherent uncertainty around analysis – demand take-up, population growth and human behaviour are key inputs into transport appraisal which are hard to predict, particularly in the current environment with working from home, snap lockdowns and closed borders disrupting regular travel patterns. The UK Institute for Government criticised an emphasis on headline value for money results in a recent report looking at how governments use evidence to make transport policy (IfG, 2021) Additionally, the level of confidence in a final BCR number may vary. Small, well-defined projects focusing on clearly measurable 'traditional' transport effects will have high confidence that the final result will be close to the actual outcome. In contrast, larger innovative projects which will bring a wide range of effects will likely be less certain in the results. Whilst sensitivity tests can capture some of the risks around changes to input values and provide a range of outputs, they do not typically capture inherent risk specific to an individual project. Presentation of one number does not convey the level of confidence in analysis, nor the range of outcomes which are most likely to occur.

3. Application to current work

Recent experience of projects we have worked on point to two examples where the presentation of a single BCR does not capture the full range of effects.

Project 1 –Road Upgrades, Sydney, NSW

A recent project to consider options for upgrading road infrastructure and the public transport offering along key corridors in NSW also included the objective of improving liveability of communities in the area. This project was intended to assess place-making effects alongside the changes to transport and movement of people. It presented a good opportunity to use the TfNSW Practitioner's Guide to Movement and Place, as well as piloting an approach similar to the Pedestrian Environment Review System developed by Transport for London. If successful, and considered to add value to investment decision making, this could have been rolled out more widely across future projects involving place.

When discussing the proposed methodology with project leads there was a reluctance to include less robust analysis alongside the traditional transport effects. This was based on three issues:

- Concern that the less robust analysis would discredit the more robust 'traditional' analysis, leading to overall questioning of the findings
- A disproportionate amount of work would be required to include place-making effects at a level of robustness which would be accepted and due to current lack of data to support calculations the estimated benefit was likely to be small
- The risk that if additional place-making analysis had been carried out, communicating multiple results per option in a business case could lead to confusion

These concerns resulted in only the transport effects being monetised and other place-making effects being discussed qualitatively in the assessment. The results were also distorted as the cost of place-making interventions had been included, but ultimately the benefits were not. This

example is not intended as criticism of the project team leading the work but illustrates the need for a stronger authorising environment so that project teams are better supported to trial new approaches, present results differently and challenge areas where the existing framework does not work for their project.

Project 2 – Road Upgrade, Cairns, QLD

Another recent project considered options for upgrading a road corridor between a major city and the surrounding region. Existing traffic volumes are comparatively low, but upgrading the corridor has the potential to have regional benefits for the surrounding areas. This includes a number of effects, including:

- The lack of available land in the city is expected to force housing prices up as the regional areas have poor access. Should access be improved, these regional centres would encourage developments in these areas
- Tourism is an important industry in this region, but the lack of access makes tours in the regions difficult, particularly when seeing multiple attractions in a single day. Should access be improved, the region may become more attractive for interstate and overseas tourism
- Agriculture is prominent in the area, but the cost of transport is high due to the limitations of the road network. Decreasing the cost of transport may encourage additional agricultural production
- Construction activity has been negatively impacted due to the limitations of the connecting roads with respect to heavy vehicle access. Improving access for heavy vehicles would facilitate the development of some major developments which are unable to proceed due to the road network.

In all of these cases, the quantification of effects was possible, albeit with a range of assumptions and limitations. In most cases, the quantification of effects would facilitate monetisation of benefit streams. However, due to uncertainties in the quantification and monetisation process, these effects were ultimately excluded from the headline results.

These projects demonstrate different situations in which the current framework for analysis does not encourage inclusion of less robust analysis, even when options to quantify effects are available. The projects differ in their objectives, challenges and effects but the analysis of each would be improved if decision makers were encouraged to consider a wider range of analysis with an understanding that results differ in their uncertainty.

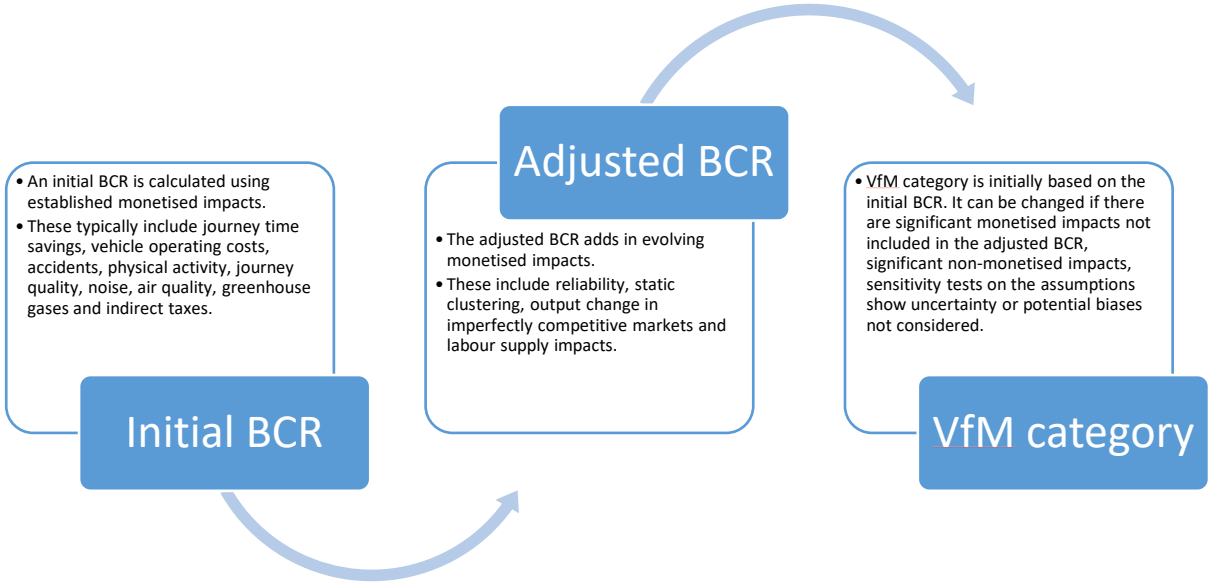
4. Proposed solution

Our experience would recommend two things need to change in the way in which results are presented. The first proposed change is to allow for less robust analysis to be included in results, whilst communicating the different levels of certainty associated with analysis. The second change needs to encourage presentation of a range of scenarios to show different outcomes which could occur and reduce the emphasis on one number as the final answer. Whilst sensitivity tests are often carried out, many of these are based on arbitrary changes to input values. In our experience, there is limited consideration of what these results mean in practice, or the wider considerations of how likely individual benefits are to be realised.

Change 1 – Including less robust analysis

UK Department for Transport guidance recommends presentation of an initial BCR which includes the most robust monetised effects and an adjusted BCR which adds in evolving monetised effects for which there is some evidence, but the research is less developed. In the UK framework, this includes analysis such as reliability effects and wider economic benefits. However, the same outline approach could be followed in Australia to include other effects, such as place making, as part of the adjusted BCR. The final step is to assign a Value for Money (VfM) Category which includes consideration of non-monetised effects, sensitivity tests and different scenarios to decide on the most likely outcome. The figure below shows this process.

Figure 3 UK Approach to Presenting Results



Source: Transport Analysis Guidance, UK Department of Transport (October 2013)

The benefits of this approach are numerous. A range of analysis can be conducted and included in results, but decision makers can choose the level of confidence they are happy to base decisions on. As an example, consider an investment which delivers poor value for money when only considering robust effects (initial BCR) but increases to medium value for money when wider effects are taken into account (adjusted BCR). This could be true for projects where large benefits are expected to come from wider economic impacts, such as transport investment in new infrastructure which encourages a large change in land use. This project may be funded in some cases but when budget constraints are tighter or projects more controversial, the evidence may need to be stronger and hence only projects which demonstrate good value for money in the initial BCR may be funded.

The segregation of effects into initial and adjusted categories provides space for more innovative analysis, without clouding the results of the traditional, robust analysis. This allows analysts flexibility to try out new approaches, using the best evidence available at the time, but without discrediting appraisal which is more grounded in research. As projects start to include these less robust effects, the methodology for assessing them, opportunities to evaluate outcomes against estimates and data available will all grow. Over time, this will improve the robustness of assessing these effects.

Finally, the allocation of a VfM category ensures that less emphasis is placed on one value of the BCR as a final answer. A range of considerations can be taken into account to decide the most likely outcome. This includes sensitivity tests, non-quantified effects and any scenarios which might significantly alter the results. The analyst can use their experience and understanding of the results to communicate key findings. Assignment of a VfM category also reduces the emphasis on a particular BCR estimate, which when reported to 2 decimal places may convey a spurious level of accuracy.

To support the inclusion of less robust analysis, infrastructure advisory bodes could provide practical guidance to help de-risk the process and establish an environment in which analysts feel they are able to trial new approaches to evaluating benefits. Some of this is already available as part of Infrastructure Australia's reform series to provide advice on certain key topics. In our experience, this guidance is not widely applied in practice and more needs to be done to ensure these approaches are embedded and accepted by risk averse project managers.

Change 2 – Presenting a range of outcomes

Decision makers need to be presented with information on how a project performs under a range of scenarios in order to determine where money is best spent. As Australia learns to live with COVID-19, investing in projects which offer flexibility to respond to different situations, provide open spaces when needed and can adapt as behaviour changes will be vital. Analysts typically conduct a range of sensitivity tests to understand the effect of changes to key inputs such as cost increases, different discount rates or if certain benefits are not realised. However, these focus on increasing or decreasing inputs and do not capture the outcomes of more complex scenarios, simultaneous changes to assumptions or external influences. To fully understand the potential range of outputs, scenarios need to be tested and the range of results presented to decision makers.

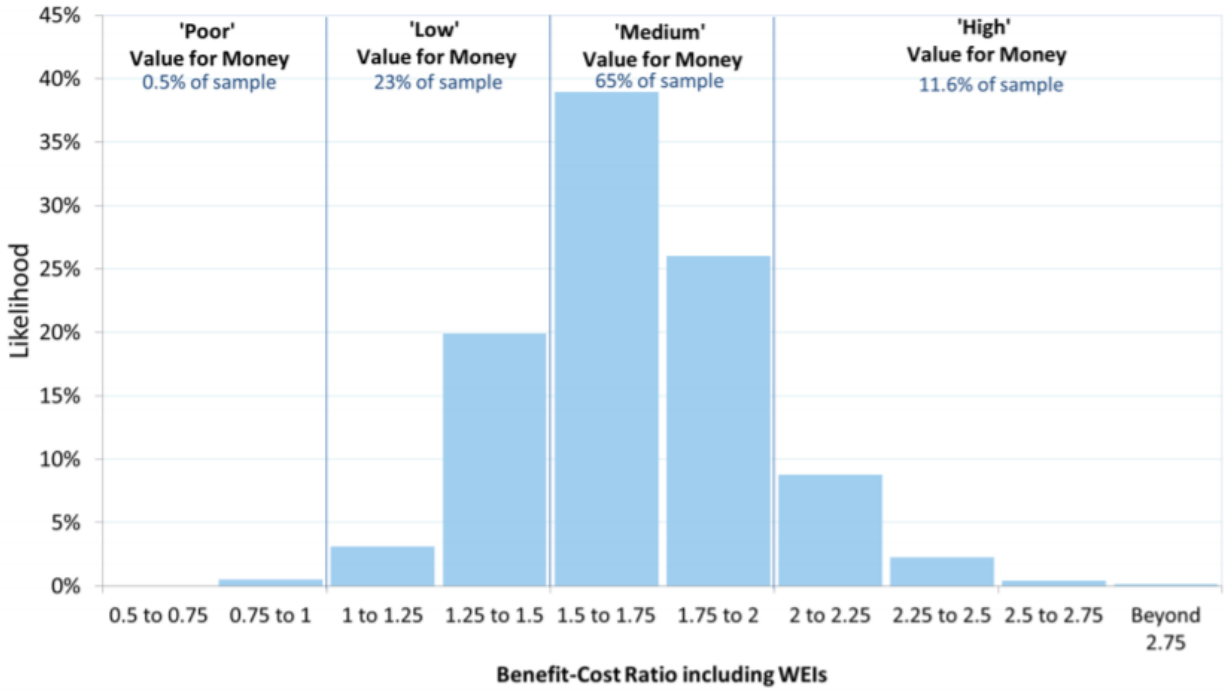
Example 1 – Probabilistic BCR Estimates

The UK is considering investment in a high-speed rail line which connects London with Birmingham (HS2 Phase 1), and then continues further north. Latest cost estimates are requesting funding of £45 million ($84 million) for Phase 1 alone. This multimillion-pound investment is conducting detailed analysis to understand the economic, environmental and social effects of the scheme.

In preparing the Outline Business Case (Department for Transport, UK, p48) a distribution of BCRs was presented. This used statistical techniques to identify the expected probability of different values occurring for key input assumptions based on historic information and the past performance of the forecasting tools used. These values were tested, and the distribution of outcomes was presented to understand the likelihood that the BCR would fall into different VfM categories.

The results for HS2 Phase 1 are shown below. From this, it can be seen that there are a small proportion of scenarios in which the investment would deliver poor value for money (defined as a BCR less than 1). However, the majority of situations present a BCR of at least 1.5, the typical minimum threshold needed to progress a business case in the UK. This visual representation helps convey the range of outcomes to decision makers, whilst demonstrating in this case that the risk of a BCR below 1 is very low.

Figure 4 HS2 Benefit-Cost Ratios



Source: HS2 Outline Business Case Economic Case, UK Department for Transport (2014)

Most CBAs include sensitivity testing of key variables, including testing of outcomes (such as overall benefits or particular benefit streams) and individual inputs (such as demand growth assumptions). Currently, these are usually based on a standard template without specific consideration for the project. This can lead to tables of numerous results being presented and information overload for the reader, without providing much additional insight into the expected project outcomes. Sensitivity testing could be used to support the development of probabilistic BCRs; however, this is challenging as the underlying risk occurrence and likelihood is difficult to determine based on available project data.

While this is a real challenge, CBAs incorporate probabilistic estimates of costs regularly. It may not be practical to undertake probabilistic benefit estimates on all projects, but even high-level assessment of risks and opportunities associated with benefit realisation would add further depth to the economic analysis.

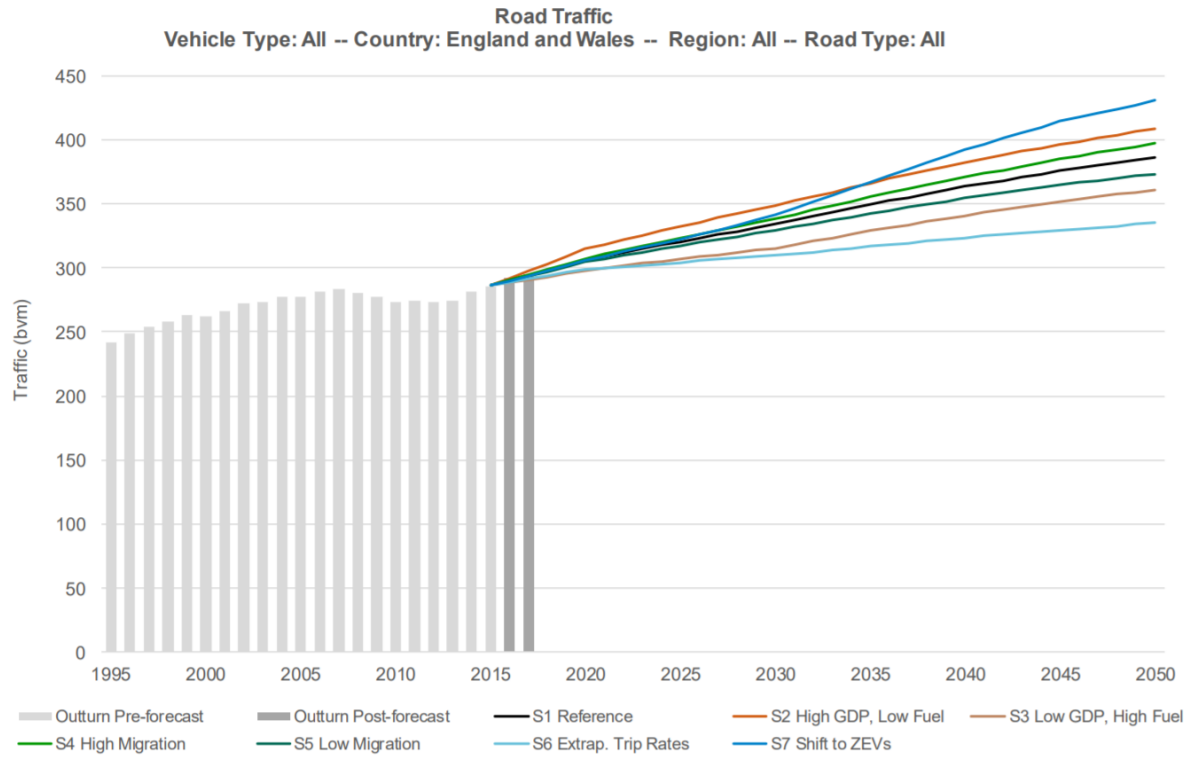
Example 2 – Scenario Testing

A second example of testing scenarios can be found in the Road Traffic Forecasts prepared by the UK Department for Transport (2018). In this forecast, seven different scenarios were presented to represent different potential futures which could occur. These include low migration, shift to zero emission vehicles and economic influences such as GDP and fuel costs. The scenarios are made up of combinations of input factors which are considered to have a key influence on road travel demand.

The figure below shows the output range for the 2018 Road Traffic Forecasts. These are a key input for cost-benefit analysis of road projects. Investment projects for a long-term road investment strategic considered how each investment would perform under each of the forecast scenarios. This provided decision makers with information to understand how each project

would perform under different scenarios and have confidence that the final package invested in would deliver value for money.

Figure 5 Road Traffic Forecast Scenarios



Source: Road Traffic Forecasts 2018, UK Department for Transport (2018)

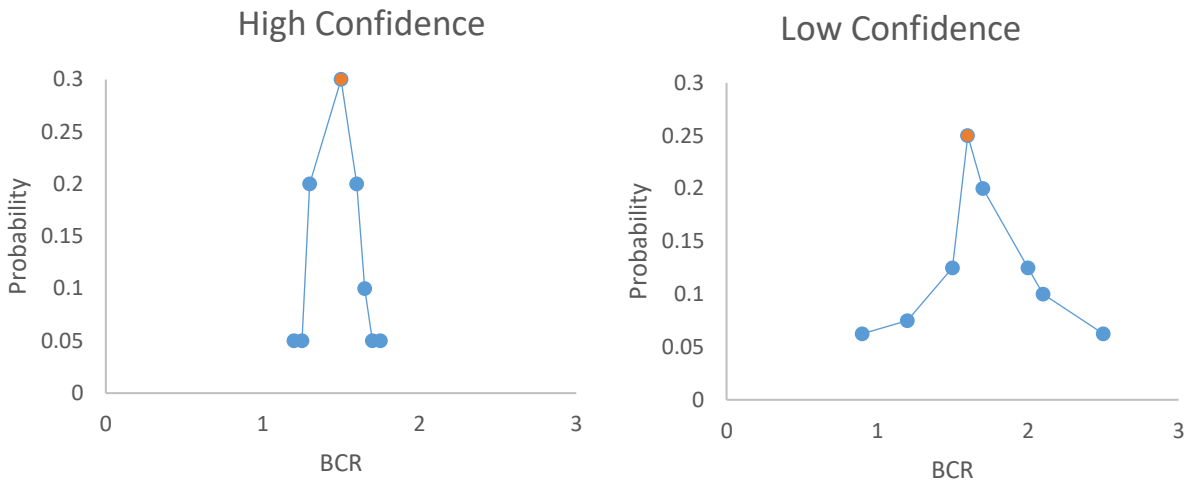
Whilst these approaches may not be proportionate for all projects, the presentation of a range of BCRs helps to demonstrate the likelihood of different outcomes. Latest guidance from Infrastructure Australia suggests probabilistic cost-benefit analysis may be relevant for projects with high risk or uncertainty. Developing scenarios and estimating the BCRs would provide a distribution of BCRs. This could be done through a probabilistic approach, similar to the high-speed rail example, or through specific scenarios, like the Road Traffic Forecasts. The distribution of BCR results can then inform the narrative when presenting results. Some examples are given below.

High confidence in a small range of results. This situation would arise when all of the scenarios tested give results in a similar range, as shown in the high confidence graph below. An example could be a road upgrade where demand is unlikely to be affected by external effects and the benefits can be easily quantified.

Large amount of uncertainty around the outcome. In this situation, the scenarios tested returned a large range of outcomes, as shown in the low confidence graph below. Further analysis may be required to understand which outcome is likely to occur. This could be a project which is highly sensitive to small changes in demand and where the future demand profile is uncertain. An example could be for additional passenger rail services during peak time in the current environment where commute patterns are changing, future population is affected by

migration and some employment is uncertain. In this example, the investment would only present good value for money in some situations, such as a return to full-time office working.

Figure 6 Confidence Intervals



Presentation of a range of BCRs based on scenarios would help communicate the range of outcomes which could occur. In the graphs above, if only the orange (most likely) BCR point was reported, decision makers would be taking a larger risk in investment compared to understanding the full picture. Inclusion of a range of scenarios clearly presented would help decision makers to better understand the level of certainty surrounding results and potential risks of investment.

5. Recommendations

This paper has proposed how some changes to the way in which analysis is presented could allow for greater consideration of less robust effects and consideration of a range of feasible outcomes. We think including these in the investment decision making process would lead to greater confidence that investments being made will deliver value for money, present the opportunity for a wider range of the types of outcomes being funded and ensure investments are robust to changing environments.

In conclusion, we recommend the following actions:

1. Develop a framework which allows for less robust analysis to be included in results and investment decisions, but with appropriate consideration of the confidence in analysis.
2. Consideration by practitioners of how results can be presented to demonstrate a range of scenarios and potential outcomes, reducing reliance on one value as the final answer.
3. Establish reliable methods for capturing data which can be used to inform new emerging analysis and improve the robustness over time.

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