

## CHAPTER 6

# Cost Benefit Analysis

LEONG Wai Yan and LIM Yong Long



*“We need to think about cost-benefit analysis more in terms of bringing procedural rationality to the decision-making process, than providing support for decisions, sometimes already made. The reality is that we often learn more about our options from the process of doing a CBA than we do from the final numerical results.”\**

*(Richard P.C. Brown 2015)*



### What Is Cost Benefit Analysis?

Cost Benefit Analysis (CBA) is a decision-making tool that uses a quantitative approach to assess the merits of a project. It evaluates the value of a project by assessing the costs and benefits to a community if the project is undertaken, compared to not undertaking it. To do so, two hypothetical scenarios are envisioned and compared—one with the project implemented, and one without. The investment will be deemed worth pursuing if the benefits produced by the project are greater than its opportunity costs (see **Box 1**).

For policymakers, undertaking a CBA requires them to consider the net impact of a project on society. This means going beyond revenue and costs generated by the project to take into account benefits and costs that might not be captured by market prices—externalities borne by third parties that are not involved in the consumption or production of the project.

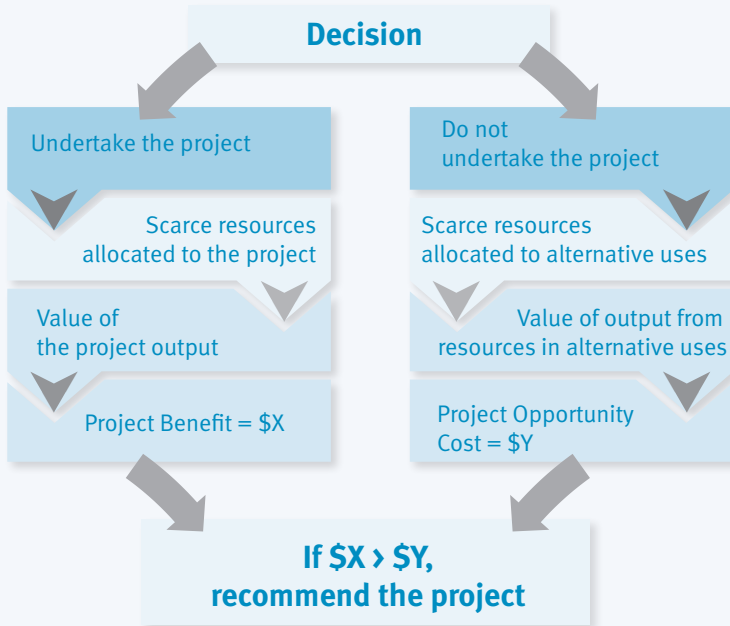
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\* Richard Brown, quote for Cost Benefit Analysis provided to the Civil Service College via email, May 18, 2015.

## BOX

1

# Cost Benefit Analysis



Source: Campbell and Brown 2003

Notes: For this example, the costs of the project and alternate project are the same as they utilise the same resources, hence for CBA only, the differences in benefits will be evaluated.

- First scenario where the project is implemented—Identify and measure the benefits of the project, i.e., the value of the extra output brought about by the project. This is usually measured by the amount that consumers are willing to spend—(\$X).
- Second scenario where the project is not implemented—Identify the highest-value alternative usage of the resources and measure the value of the extra output brought about by it—(\$Y).
- All future benefits and costs have to be discounted to present value. A riskless market rate of interest is usually applied as the discount rate.
- Evaluate and compare the present values of the two scenarios and recommend the project if the benefits exceed the costs, or if  $\$X > \$Y$ .

## When Can Cost Benefit Analysis Be Used?

Policymakers can use CBA at different stages of policy planning, for project appraisal and evaluation to improve the decision-making process. It can be used before a project is undertaken, during and after a project is implemented.

### *Before a Project Is Undertaken*

When policymakers are deliberating over a project or making a comparison between options, CBA can provide information in two ways:

#### *i. Will the project result in a net benefit or net cost to society?*

To measure the social net benefit of the project (i.e., an aggregated CBA), a CBA can be done. A positive social net benefit means that the benefits of the project exceed its costs, making it worthwhile to proceed. The evaluation of the North East Line (NEL) on the Mass Rapid Transit network in Singapore is an example of how wider economic benefits were used to measure social net benefit before it was constructed (see **Box 2**).

#### *ii. Will the project bring about any potential income redistribution effect?*

To identify any potential income redistribution effects, a CBA can be carried out for various sub-groups that are significantly affected by the policy (i.e., disaggregated CBA). This would quantify the gains of one group compared to the losses of another, thereby informing policymakers about the income redistribution effects of the project. Potential income redistribution effects may be more critical for policies where resource distribution and accessibility to the policy are key to its effectiveness, e.g., MediShield Life.

## BOX

### 2

## Incorporating Wider Economic Benefits in the Evaluation of the North East Line (NEL)

When evaluating the cost of infrastructural projects, the government takes into account the direct costs of construction, such as manpower and land uptake, as well as indirect costs such as temporary disamenities arising from noise pollution and diversion of traffic.

The Land Transport Authority (LTA) calculates the potential benefits of transport infrastructure via a Transport Model. Before the NEL was constructed, the Transport Model was used to model commuters' decisions based on travelling time and cost—to show travel time and cost savings arising from the NEL. For example, travel times from Seng Kang to town via the NEL versus taking a bus were compared to estimate any potential time savings enjoyed by commuters. The CBA also took into account additional wider economic benefits arising from the development potential of land. This was evident in the rapid development of Seng Kang and Punggol Towns and commercial developments along the NEL corridor (e.g., NEX, City Square mall). These benefits were estimated using the wider economics benefits methodology adopted in the UK.

### *During and after a Project Has Been Implemented*

Other than deciding on whether it is worth pursuing a project, it is equally important to evaluate the outcomes during and after it has been implemented to affirm initial projections. When deciding on whether to embark on a particular project, policymakers need to make projections to estimate the future benefits and costs despite the uncertainties faced. After the project has been implemented, a CBA based on actual data can be conducted to evaluate the progress of the project. This helps policymakers gain insights to how the project can be refined to maximise benefits. If costs outweigh the benefits, areas where remedial actions can be taken should be highlighted, or in the most extreme case, discontinuing the project could be justified. Furthermore, the CBA could provide crucial learning points on how future projects can be designed more robustly.

## Challenges and Limitations

CBA is appealing as it is a relatively simple and reliable decision-making tool that monetises the costs and benefits of a project. However, there are various challenges to using CBA in the context of public policy.

### *Value Judgement and Subjectivity*

In many cases, it is a lot more difficult to assign monetary values to non-marketed and non-traded goods as compared to marketed goods. When evaluating policies that have an impact on marketed goods, such as a CBA on the impact of a minimum wage law, the policymakers can take into consideration parameters such as wage rate, unemployment rates and output of the firm. These are readily measured as the outcome of trade and interactions in the labour and goods markets.

However, CBAs are also performed in cases where goods are non-marketed and non-traded. For example, in the case of transport infrastructure, it would be difficult to monetise the value of time saved by commuters since this could be highly subjective. When assessing if the development of a park has benefited residents, it would be equally challenging to monetise any increased well-being arising from living in a greener environment. Some level of value judgement and subjectivity becomes unavoidable when making approximations of more intangible costs and benefits.

Nonetheless, one should still be as objective as possible in getting an accurate representation of the value of goods that are non-marketed and non-traded. To determine the value of travel time, stated preference surveys are routinely used to obtain an individual's trade-off between money and time. It is important to ensure that the survey sample drawn is representative of the population. Hedonic price models can also be used to measure the implied value of certain non-marketed goods through its impact on market prices. An example would be the Active, Beautiful and Clean Waters (ABC Waters) Programme where environmental benefits of the park project were measured through the increase in the property prices around the park (see **Box 3**).

Alternatively, policymakers can consider using the benefit-transfer method, which uses the non-market values derived from other similar studies, as an approximation of the cost/benefit of the non-monetary component.

## BOX

### 3

## Cost Benefit Analysis of the Active, Beautiful and Clean Waters Programme

Launched in 2006, the Active, Beautiful and Clean Waters (ABC Waters) Programme is a long-term initiative by PUB (Singapore's National Water Agency) to transform Singapore's drains, canals and reservoirs into streams, rivers and lakes that are well integrated with surrounding parks and spaces, thereby creating new recreational spaces and focal points for community activities.

ABC Waters projects bring a variety of benefits including the direct use value that residents place on activities (e.g., jogging, enjoying the views). To quantify the direct use values that residents are willing to pay for, the price trends of properties located near the ABC Waters project at the Bishan-Ang Mo Kio Park (Bishan-AMK Park) were analysed. Specifically, a difference-in-difference methodology was employed to control for macroeconomic factors which may have affected the prices of all properties. The treatment and control groups were constructed based on the distance from the Bishan-AMK Park. In addition to the difference-in-difference framework, hedonic characteristics of the properties were also included as additional controls to account for the impact of other amenities near the property.

The results indicated that the completion of the ABC Waters project caused an increase in HDB resale prices for homes closer to the project—an indication of willingness by households to pay for the improvement

in the landscape and amenities associated with the project. The results were robust to choices of different treatment and controls groups, based on varying distances to Bishan-AMK Park. Overall, it was estimated that the premium in property prices would have more than offset the costs associated with the Bishan-AMK Park ABC Waters project. Nonetheless, the valuation obtained from the hedonic pricing methodology is likely to be an underestimate as the study did not account for other benefits. For instance, the indirect use value of features that would clean stormwater run-off for better quality water was not included in the study. Furthermore, the valuation only included use values of residents near Bishan-AMK Park and excluded the use values of all other park users.

Contributed by: Leong Chi Hoong, Environmental Policy Division, Ministry of the Environment and Water Resources, Singapore

### *Uncertainty and Irreversibility*

An important feature of CBA is the need to account for the time value of money when calculating future benefits and costs of a project. A dollar today will have a greater value than a dollar in the future due to inflation and the possibility that interest can be accrued on the dollar today. Hence, all benefits received and costs incurred at different points in time should be converted to present-day value to arrive at a *Net Present Value* (NPV), so that more accurate comparisons can be made. This is done by using a “discount rate”, or the prevailing rate at which future cash flows are adjusted to the present day (e.g., a riskless market rate of interest)<sup>1</sup> (see **Box 4**). A positive NPV means that present values of a project’s benefits outweigh the present values of its costs, meaning it will generate a positive return over time, and vice versa for a negative NPV.

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1. In Singapore’s public service context, the typical discount rate used is the average after-tax yield of the 10-year Singapore Government Securities bond.

**BOX****4****Worked Example on  
Calculating Net Present  
Value (NPV) in a CBA**

Consider a project with an initial cost of \$100 that generates benefits of \$20 in Year 1 and \$90 in Year 2. The project may seem to generate a positive net benefit if we were to just compare the absolute value of the costs (\$100) and benefits (\$110). However, if the time value of money is accounted for at a 10% discount rate, the Net Present Value (NPV) is negative, which makes taking up the project unfavourable.

Year	0	1	2
Net Cash Flow	-100	20	90
Net Benefit (absolute value of Cash Flow)	10		
Net Present Value of Benefit (based on 10% discount rate)	$[20/(1.1) + 90/(1.1)^2] - 100$ $= -7.44$		

Although the NPV rule is simple to apply, the challenge is that uncertainty in the external environment and irreversibility of large-scale projects make it difficult to make reliable decisions. How should one estimate the expected stream of costs and benefits, and what discount rate should be used, are among the uncertainties that policymakers face. For projects that produce streams of costs and benefits over time, there are also many uncertainties in the external environment that may impact the estimation of the NPV. Another uncertainty is that the NPV of an investment may seem small when viewed in isolation, but may actually create options or opportunities that the government can choose to undertake in the future. A good example is research and development (R&D) where there could be underinvestment if the calculated NPV does not take into account the opportunities that R&D investments can create.



In addition, when a decision has been made to invest in a large-scale project, it is not possible to simply reverse the decision if it turns out to be less than ideal midway, due to the large amount of resources and sunk costs incurred. This means the project will continue to draw on resources to keep it alive. With such irreversibility and the possibility of yielding a lower NPV than estimated, there is a need to manage risks by setting a higher bar before making an investment decision. In other words, the present value of the project must not just be positive, but must exceed the cost of the project by an amount equal to the value of keeping this investment option alive (Dixit and Pindyck 1995).

## Conclusion

While CBA helps to inform the policymaking process, policymakers should not rely on it solely when making decisions. Instead, CBA should be seen as a guideline that adds to better decision making, and the assessment should be made in the context of other considerations that are key to a policy's effectiveness, e.g., social acceptability, distribution of wealth and environment sustainability. Policymakers would also need to make a judgement call on the validity of the assumptions used in the CBA and if there are other non-market benefits that would still justify a project with a seemingly negative CBA result.

## References

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Dixit, A. K., and R. S. Pindyck. "The Options Approach to Capital Investment". *Harvard Business Review* (May–June 1995): 105–115.