Health Economics

Dr Pratap C Mohanty

Department of Humanities and Social Sciences,

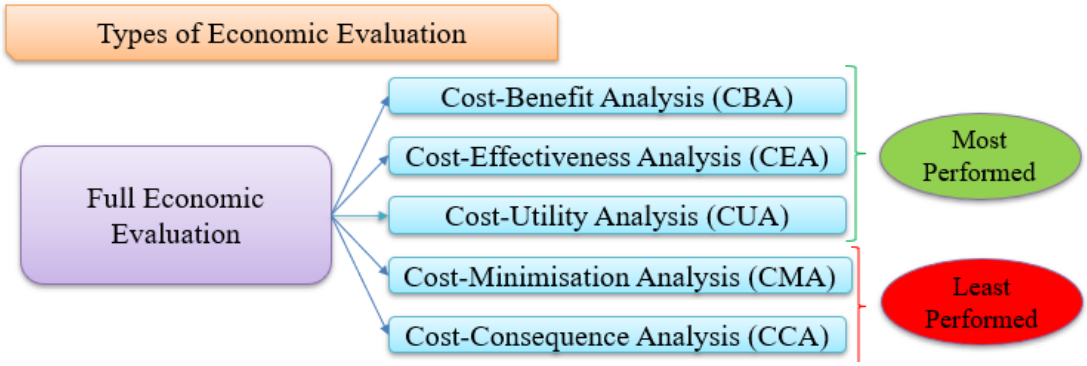
Indian Institute of Technology Roorkee

Week – 08

Lecture 39- Principles of Economic Evaluation: CMA, CCA, Cost- Benefit Analysis (CBA)

Welcome friends once again to our NPTEL-MOOC module on Health Economics. We have been discussing so far on- Theory and Principles of Economic Evaluation. This is our second part of understanding the 'Principles of Economic Evaluation'. What we did in the last lecture is all about introducing its principles. We also clarified about full and partial economic evaluation and types of full economic evaluation. And we also decided which type of evaluation we should choose.

In this lecture, we are trying to understand the further details of the least and most performed full economic evaluations. Among the five methods which we discussed, the least performed ones are CCA and CMA, but out of other three (which we said mostly used, but among those mostly used), the CBA (that is cost benefit analysis) is usually targeted and performed. So, as a snapshot of the previous lecture, once again, just to recap for your knowledge and for better understanding, let us understand what the types of economic evaluation are.



We discussed these five categories; out of that, we highlighted the first three and the next two. We also said that the first three are the most performed and the last two are the least performed. But why are the last two economic evaluation principles not usually performed? The simple answer to this is the assumptions that it has taken. These are based on the assumption of two evaluation principles that make it hard for the evaluator to compare the alternatives. That is one of the biggest problems of the CMA and CCA approach. Out of the CMA and CCA, this can be understood from the differences in the basic assumptions discussed in the last lecture as well (in terms of their cost, output or consequences and by their formula).

Type of Analysis	Cost	Output/ Consequence	Formula
Cost-Minimisation Analysis (CMA)	Money	Identical in all aspects	▲C (least cost alternative)
Cost-Consequence Analysis (CCA)	Set of Costs	Set of Consequences	Disaggregated evaluation approach

You can just see these two methods (CMA and CCA). It has a problem in terms of cost and output. Especially, in CMA method, you will find (so far as output is concerned) this is usually identical in all aspects. However, this is very rarely found. When we check with CCA (cost consequences analysis), the set of cost (i.e., set of consequences) is really hard to choose and compare. That is why CMA and CCA are less used. But, knowing how it is carried out is very important.

In terms of definition regarding CMA (cost minimization analysis), it is a form of comparative economic analysis that compares the cost of two or more policy alternatives, which are all assumed to have equivalent health effects (as mentioned by Turner et al. in 2021 study). The objective of this study is to minimize cost given the output which is similar in all aspects. That is why we said, identical in all respect related to the outcome is indeed very rare. Due to this limitation of the method, generally, CMA is not recommended because it ignores the fact that healthcare has a heterogeneity of outcome. For a more detailed discussion, you can refer to the paper by Briggs and O'Brien in 2001.

An example of CMA is also mentioned. Let us again take the hypothetical example of recent COVID-19 crisis, where we witnessed India-based vaccine by Bharat Biotech. It is the company that introduced the inter-nasal vaccine, named as INCOVACC. Another alternative is COVAXIN, a pre-existing injection-based vaccine (India's first indigenous COVID-19 vaccine). We also discussed a similar example earlier in the previous lecture.

Now, in this case, what are the problems? To determine which treatment option minimizes the cost while having the same output, i.e., curbing the spread of COVID-19. The government's approach was to allocate the health budget. And generally, the allocation is considered to be fixed and allocation was made with a target to acheive efficiency as it is important. So, we are just comparing INCOVACC and COVAXIN once again.

We mentioned that the cost per patient in the case of INCOVACC was 200 rupees, whereas the output was for COVID prevention. Another treatment is called COVAXIN which was the India's indigenous vaccine. For it, the cost per patient was 150, which was lesser than that of iNCOVACC, and output was the same. Now, let us assume that India aims to vaccinate a population of 90 crore. So, the total cost for treatment A (i.e., INCOVACC) is-

Total Cost (Treatment A) = Cost per patient (Treatment A) x Number of Patients
Total Cost (Treatment A) = ₹ 200 x 90= **₹ 18,000 Crore**

For treatment B (i.e., COVAXIN), it will be –

Total Cost (Treatment B) = Cost per patient (Treatment B) x Number of Patients
Total Cost (Treatment B) = ₹ 150 x 90 = ₹ 13,500 Crore

We can just see from this example that the total cost of treatment A is higher, but we will just check further.
In conclusion, as both treatments are equally effective, and both are controlling or preventing COVID-19. The Indian government will choose treatment B because of its low cost and budget. It is the most cost-effective option as the decision ensures savings of rupees 4500 crore (i.e., the difference between treatment B and treatment A). Although, we use this example to explain CMA. However, scenarios with identical health output or effectiveness are really rare (since we started with assumption that the output is identical). Now, we can answer the related questions as well. Question- In which of the following two scenarios, CMA would be used?

In scenario 1, imagine two brands for an identical generic drug. One is packaged in a standard bottle, and costs(C_S)=20 per unit. And the other is packed in an eco-friendly container and costs 30. The active ingredient and the effectiveness of both drugs are the same. In the 2nd scenario, imagine two brands of an identical generic drug, one package in a standard bottle of rupees 20 and the other one in an eco-friendly container. But, here the cost is 20 only. However, both drugs' active ingredient and effectiveness in this case are different. So, you can see where CMA would be most useful out of these options. You just check on your own answers with our definition, which we explained a couple of minutes back.

So, what is then the CCA? Once again, this is another least performed full economic evaluation principle of the last two principles that we have said. In fact, it is a form of comparative economic analysis that evaluates two or more policy alternatives in terms of their relative costs and outcomes. In other words, or in the words of Drummond and others (2005), cost consequences analysis (that is CCA) is a form of economic analysis, where disaggregated cost and a range of outcomes are presented, to allow readers to form their own opinions on their relevance and relative importance in the decision-making context.

CMA is where the identical outcome is considered. Whereas, in this case (CCA), multiple outcomes of interest are reported and CCA does not have a specific mathematical expression like the evaluation principles. If so, then how the evaluation is carried out? We will just explain this once again.

CCA shows results for different costs and effects separately so that each decision maker can choose which cost and effects are most relevant to their local content and viewpoint. CCA should capture as many relevant costs and impacts of the intervention as practically possible and list it in a tabulated form by costs and their outcome.

By cost, it might be the cost of intervention of primary and secondary units, informal care, social care, productivity and other costs. In terms of outcome, it may include broader health effects such as safety, adverse events, well-being and even the non-health effects such as

user experience, satisfaction, empowerment, social inclusion. On-patient effects such as health system efficiency, caregiver outcomes are also noted.

We will just try to understand this through another example. - Let's consider a healthcare decision involving two different treatment options for managing a particular medical condition, say- hypertension (high blood pressure). Here, one intervention is through blood pressure drugs used for stabilizing blood pressure. The second is called lifestyle modifications (in short LSM) such as exercise, diet-improvement, yoga, etc. In two interventions, we can compare their associated cost and their consequences. It is indeed important to note that you are not looking for a single summary measure like other evaluation principles but rather to provide a detailed account of these costs and various outcomes associated with each intervention.

So, the following are the associated interventions (intervention 1 and intervention 2) in terms of cost and output.

	Intervention 1	**Intervention 2**
Costs	Medication Cost	Cost of life-style counselling
	Physicians visits	Dietician
	Laboratory tests	Exercise Programs
	Any potential side effect	Potential adverse effects of LsM
Output	Systolic BP Reduction	Improved BP
	Diastolic blood pressure	Patient satisfaction
	Quality of life	Quality of life

So, in terms of cost for intervention 1, it may be medication cost, physicians' visits, laboratory test, or any potential side effect. In Intervention 2, we can see the costs for lifestyle modifications or lifestyle improvements or measures for their lifestyle counselling, diet, exercise programs, potential adverse effects, etc. In terms of output, we can check from intervention 2 (i.e., lifestyle improvement). We can check their improved BP, patient satisfaction, and quality of life. And the same quality of life can also be checked in the first intervention, where the cost of drugs is counted and usually in the first case, since drugs is

taken, so systolic BP reduction is counted, and similarly diastolic blood pressure can also be checked. A CCA table might look like this-

Intervention	Costs (₹)	Systolic BP Reduction (mmHg)	Diastolic BP Reduction (mmHg)	Patient Satisfaction (on a scale of 1 to 10)
Drug Bp	2,000	10	5	7
Lifestyle modification LM	500	8	4	8

You can just see their cost, systolic blood pressure readings, diastolic BP reduction, patient satisfaction on a scale of 1 to 10, etc. This kind of figure might be available, or researchers might collect it. Here, the healthcare decision-makers can use this information to make informed choices based on specific priorities. If reducing cost is a priority, they might lean towards lifestyle modifications or BP drug would be preferred otherwise (based on cost). CCA allows decision-makers to consider a range of factors beyond a single metric, making it a viable or valuable tool for complex healthcare decisions.

Another example we are just citing is to check the cost for another intervention: suppose a healthcare facility needs to choose between two different COVID-19 testing methods. The facility here is interested in comparing these testing methods' financial and non-financial consequences. There are two alternatives: one is for PCR testing and maybe rapid antigen testing.

Criteria	Alternative A (PCR Testing)	Alternative B (Rapid Antigen Testing)
Total Costs	₹50,000	₹30,000
Accuracy of Results	Accurate results	Lower sensitivity
Turnaround Time	Long processing time	Faster results (15-30 minutes)
Resource Utilization	High	Lower
Patient Discomfort	High	Less

So, the total cost in both cases, are 50,000 and 30,000. The accuracy of results, turnaround time, resource utilization, and patient discomfort are other factors you can check. Hence, this table provides a clear overview of each testing method's cost and various non-financial consequences. So, decision-makers use this information to trade-off between cost and consequences. The final reason depends on the relative importance of these criteria in terms of the facilities, goals and priorities.

Use of CCA: CCA has been recommended for complex interventions that have multiple effects. For example, lifestyle education in diabetes as mentioned by Drummond and Sculpher, et al. (2005). CCA may also be particularly useful in feasibility or pilot studies when it is not clear which costs and outcomes will be most relevant to future definitive

trials. Given the limited funding available for feasibility studies and the scarcity of health economists, the CCA can provide a less resource-intensive alternative.

So, there are disadvantages and advantages of CCA. So, you can just go through it. In terms of disadvantages, one can say there is no specific and definitive guidance. Further, it has a limited generalizability, and it is also more subjective in terms of interpretation. Whereas the advantages are like- it is easy to understand and apply, this presents a broader range of health and non-health costs, it can be an alternative approach to measuring cost and outcomes.

So far, we have discussed the least perform full economic evaluation principles: CMA and CCA. Now we will begin discussing the main economic evaluation tools, : CBA, CEA and CUA. We will start with the cost-benefit analysis (CBA), and then we will follow the other two. Even the welfare perspective will also be counted while understanding the analysis. The discussion about the main economic evaluation principle starts with a very basic approach called CBA. It is a form of comparative economic analysis that evaluates two or more policy alternative, in terms of their relative cost and outcomes. Here, both the cost and outcomes are expressed in monetary terms (highlighted and mentioned in Turner's et al. 2021 paper). In simple terms, the CBA counts all costs and benefits (whatever they are and whoever incurs them), which are weighed against each other, especially in monetary terms. And the specific objective of CBA is to maximize the achievements of decision-making goals and to identify Pareto improvements or potential Pareto improvements.

The features of CBA, that is (as I already said), the monetary evaluation of both cost and effects. Similar to CCA, CBA includes non-health benefits as well along with health benefits. For example- CBA enables evaluations of any interventions of health projects or studies that improve the quality and convenience of particular health service. When CBA only formally evaluates cost and consequences of a single policy option and do not appropriately account for the comparator or counterfactual scenario, they are called a partial evaluation (i.e., a kind of cost outcome study, but evaluation is partial). But how do we capture benefits and costs in monetary terms? So, in this case, in practice, various methods are there to quantify and capture the health consequences, especially those in monetary terms.

The two most widely used approaches are willingness to pay (WTP) or willingness to accept (WTA), and the second one is called valuing productivity gains. We will now start with the WTP (willingness to pay principle). This is based on certain premise, that the maximum amount an individual is willing to pay for a given commodity is an indicator of their value. So, the extent of sacrifice the individual makes is in fact, the value or the valuation for the service or the product, especially healthcare service.

In the context of healthcare, this involves estimating what an individual is willing to pay for certain benefits, consequently estimating the value of the health benefits of an intervention in monetary terms for that individual. The advantage is that the individual takes into account all the attributes of the service that are important to them, not just the health gains. The estimation ways in WTP are like i) stated preference and ii) revealed preference

methods. In the case of stated one, we use survey questionnaire where responses are taken, whereas in the case of revealed, we are going to takeindirect approach, as here we indirectly infer to the non-market outcomes (i.e., observed prices of relative market goods).

Valuing productivity gains, which is the next approach. This refers to placing a monetary value on the estimated productivity losses associated with a disease that are avoided due to a health intervention. Within valuing productivity gains approach, there are various approaches, like human capital approach and, friction cost approach. In case of human capital, all the potential production not performed by a person because of morbidity or early mortality is counted as a production loss. And in friction cost, production losses are limited to the time needed to replace an ill employee. So, that is basically the valuing productivity gains evaluation. Using these approaches, we monetize the benefits that help carry out CBA analysis.

CBA is estimated by basically using formulas such as the cost benefit ratio and net benefit. In cost benefit ratio, we usually take $\Delta C/\Delta B$, and the requirement for beneficial intervention is having a CB ratio value less than 1. Whereas, in case of net benefit which we just simply compute $C - B$, and the net benefit should be greater than 0, that is the requirement as a measure of CBA. And the CBA is mostly used to make public decisions. Apart from just cost and benefit, we also have to consider social and marginal cost-benefit (which we discuss in lectures of week 5 and week 7). Please note that, CBA decisions are not a particular point of decisions. So, to implement a decision we must also consider the time component.

Taking time component into consideration, we can formulate the CBA analysis as follows-

$$NPV = \sum_{t} \frac{FV_t}{(1+r)^t}$$

Where,

NPV= net present value, FV= future value of benefit, r = discount rate, and t= time period

So, the net present value is important to mention that is considering the future value of the benefit as a ratio or divided by the discounted rate that is r. ris called discount rate and time period of the discounting that means $(1+r)^t$. So, future value in t^{th} period, divided by $(1+r)^t$ and their summation is nothing but called net present value. Let us understand the use of this formula with the help of some appropriate examples.

In the example 1, we consider implementing two different preventive measures in a community (Here we say, alternative A and alternative B). Alternative A, we are considering mass testing and alternative B is social distancing. Starting with the mass testing, the cost is 1 million, and the benefits (those are like life saved, reduced healthcare cost and economic gains) total is 1.2 million. So, the benefit is higher than that of the cost, whereas, in the case social distancing principle, the cost is 8 lakh and the benefits (in terms of life saved, reduced healthcare cost and economic gains etc), if it is around 8 lakh 50,000. So, in that case, our differences are noted. So, to answer the same using different formulas, let us get the

solution and check which one is better. Through the net benefit approach and another one is through the cost benefit ratio approach.

So, in the net benefit approach, alternative A and alternative B cost 1 million As net benefit is calculated as benefit minus cost, the net benefit is actually 2 lakh on the alternative A, whereas in alternative B, the net benefit is actually 50,000.

Whereas, in the cost-benefit ratio approach, we find that alternative A is 0.83 and alternative B is 0.94. By absolute difference, yes, we have noted. But, the reverse is noted in case of cost benefit ratio. In the conclusion, for the net benefit approach- both alternatives have a positive net benefit. This indicates that they are economically justified. However, alternative A has a higher net benefit and may be more cost effective. So, its' net benefit is actually effective.

In the case of the cost-benefit ratio approach, in terms of conclusion, we just find the difference. B has a relatively higher value (i.e., 0.94) in the cost benefit ratio. Both alternative ratio values less than 1. If it is there as per our limit, which you mentioned in the table earlier, that is really justified. However, since the cost is there as a ratio to that of benefit, A is lesser cost that is 0.83. Hence, alternative A is preferred. So, in both the cases, we just see that A is preferred.

If the time component is considered, we must also modify our example. Consider the COVID-19 program over 3 years for mass testing and social distancing. Now, we are including year wise - first year, second year and third year. For the first year, the benefit is 4 lakh, cost is 3 lakh, then second year it is 6 lakhs and 4 lakhs and accordingly other years we have mentioned. Similarly for social distancing also, the figures are mentioned before you-

Mass Testing (Alternative A)	Social Distancing (Alternative B)
Year 1:	**Year 1:**
•FV of Benefit : ₹400,000	•FV of Benefit: ₹350,000
•Cost: ₹300,000	•Cost: ₹200,000
Year 2:	**Year 2:**
•FV of Benefit : ₹600,000	•FV of Benefit: ₹500,000
•Cost: ₹400,000	•Cost: ₹250,000
Year 3:	**Year 3:**
•FV of Benefit : ₹800,000	•FV of Benefit: ₹700,000
•Cost: ₹600,000	•Cost: ₹300,000

We can calculate by their net present value, for programs A and B that are mass testing and social distancing. So, you can just see by NPV formula (net present value). With its' future

value divided by 1 plus r with its respective year, we will find that the net present value in the first case is given here and the second case. So, net present value of program A is of rupees 1616240 (that is 16 lakh plus or 16.16240) and for B, it is 13 lakh plus (13.92 around). It is quite clearly observed that program 1 has a higher net present value (even if we have counted the year discounting). Net present value wise, in conclusion what we just find, that the program with higher NPV is more financially beneficial over the 3 years. In this case, program A (i.e., mass testing) has a higher NPV as compared to program B. This indicates program A is financially advantageous.

Even though CBA is more widely used, it has both advantages and disadvantages. By advantages, we have just seen that it is more consistent with how other public interventions are evaluated and facilitated across sectoral basis. And potential to value a wider range of benefits. Monetary output is desirable to a range of stakeholders. Whereas for disadvantages, methodological difficulties are attached regarding placing a monetary value on health benefit and between the studies. And also, it is difficult to capture non-fatal health outcomes. Potential misinterpretations and difficulties regarding the practical interpretations are there. And last one disadvantage of CBA is that, equity and distribution concerns are not yet covered.

So, after looking at all those five methods. Out of the first three, we have carefully observed the CBA approach and discussed the last two. So, in total, we discussed three types of full economic evaluation: CCA, CMA and CBA (in detail with examples). The first two are the least preferred and, whereas the CBA is the most preferred (That is, least preferred means CCA and CMA are least preferred as we already mentioned). Each of these has different ways of estimating policies and interpreting results. Both advantages and disadvantages are part and parcel of these evaluation principles and can be applied in different contexts.

So, what we are targeting for the next lecture? It is the cost-effective and cost-utility analysis. Their features, with examples, as well as their advantages and disadvantages, are going to be discussed. These references will be very useful if you are targeting higher study and applying for your assignment and calculations, appearing for the exam. I think you need to go through. With this, I think it is time to close. Any queries will be welcoming for discussion. Thank you. you