Cost benefit analysis refers to the comparison of costs and benefits of public goods projects to decide if they should be undertaken Carrying out the cost -benefit analysis requires answering hard questions such as: How do we value the benefits to consumers? How do we value the costs of the externalities of projects? And how do we deal with the fact that many of these costs and benefits accrue not today but far into the future?

Measuring the Costs of Public Projects

The Example

Suppose that you are working for the Nyahururu Municipal Council running the highway department. The town’s main street is in poor shape, with large potholes and crumbling shoulders that slow down traffic and pose an accident risk. You have been charged by the mayor with the task of considering whether the council should invest in repairing this road. As shown in Table below, making the improvements will require the following inputs:

* 1 million bags of asphalt
* 1 million hours of construction labor (500 workers for 2,000 hours each)
* Ksh. 10 million per year in the future for maintenance costs

There are two main benefits to these road improvements:

* Driving time for producers (trucks) and consumers will be reduced by 500,000 hours per year.
* The road will be safer, resulting in five fewer accidents per year.

Table 1: Cost Benefit analysis

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Cost-Benefit analysis of a street construction project | | | | |
|  |  | Quantity | Price/ Value | Total |
| Costs | Asphalt | 1 million bags |  |  |
|  | Labor | 1 million hours |  |  |
|  | Maintenance | Ksh. 10 million per year |  |  |
|  |  | First year cost |  |  |
|  |  | Total cost |  |  |
| Benefits | Driving time saved | 500,000 hours per year |  |  |
|  | Lives saved | 5 lives per year |  |  |
|  |  | First year benefit |  |  |
|  |  | Total benefit |  |  |
|  |  | Total costs less benefits |  |  |

Measuring Current Costs

The first goal of the cost -benefit analysis is to measure the cost of this public good. It seems an easy task: add up what the government pays for all the inputs just listed to obtain the cost. This method represents the cash-flow accounting approach to costs that is used by accountants. This does not, however, correspond to the theoretical concept of social marginal cost that we used to determine the optimal level of public goods. The social marginal cost of any resource (e.g., the asphalt, labor, and future maintenance costs) is its opportunity cost: the value of that input in its next best use. Thus, the cost to society of employing any input is determined not by its cash costs, but by the next best use to which society could put that input.

Consider first the asphalt. The next best use for a bag of asphalt, besides using it on this project,

is to sell the bag to someone else. The value of this alternative use is the market price of the bag, so in this case the opportunity cost is the input’s price. This is the first lesson about opportunity costs: if a good is sold in a perfectly competitive market, then the opportunity cost is equal to the price. If the price of a bag of asphalt is Ksh.100, the asphalt costs for the project will be Ksh.100 million; if in a competitive equilibrium, price equals marginal social cost.

If the labor market is perfectly competitive, then the same argument applies to the labor costs of the project. In this case, the value of an hour of labor used on this project is the market wage—that is, what that labor is worth in its next best alternative use. If the market wage for construction workers is Ksh.10 per hour, then the opportunity cost of the labor for the project is Ksh.10 million.

Imperfect Markets

Suppose, however, that for some reason there is unemployment among construction workers—perhaps state law mandates a minimum wage of Ksh.20 for construction workers. If Ksh.20 is above the equilibrium wage in the construction sector, there will be some workers who would happily work at the prevailing Ksh.20 per hour wage but who cannot find jobs at that wage. Instead, they sit at home and watch TV. Because they value leisure, the unemployed workers do get some utility from their unemployment. Suppose that an hour of leisure is worth Ksh.10 to construction workers on average; that is, at a wage below Ksh.10, the typical construction worker would rather stay home than work. What is the opportunity cost of the time of any unemployed workers you bring onto the job? Their alternative activity is not working; it is watching TV, an activity that is valued by the workers at Ksh.10 per hour. Thus, the opportunity cost for unemployed construction workers is only Ksh.10 per hour, not Ksh.20 per hour. If half of the million man -hours that are required for this job come from workers who are unemployed, then the opportunity cost of hiring 1 million worker hours is Ksh.20 x 500,000 + Ksh.10 x 500,000 = Ksh.15 million, even though the government is actually paying out Ksh.20 million in cash.

The cash cost to the government for labor consists of two components: the opportunity cost of the resource (labor) plus the transfer of rents, which are payments to the resource deliverer (the worker) beyond those required to obtain the resource. The opportunity cost of one hour of labor is only Ksh.10 per hour for the unemployed workers, since they would be willing to work for that wage. Thus, by paying them Ksh.20 per hour, we are transferring an extra Ksh.10 per hour to them. This is not a cost to society; it is simply a transfer from one party (the government) to another (unemployed construction workers). So, of the Ksh.20 million paid by the government, Ksh.5 million is a transfer of rents from government to unemployed workers (Ksh.10 \_ 500,000), and is not counted as a true economic cost of the project (despite being a cash accounting cost). Economic costs are only those costs associated with diverting the resource from its next best use, which for these unemployed workers was watching TV at a value of Ksh.10 per hour. Any other costs are transfers.

Similarly, suppose that the asphalt was sold to the government not by a perfectly competitive firm but by a monopoly, which charges a price that is above its marginal cost. In this case, the resource cost of the asphalt is the marginal cost of producing it—the cost of the asphalt in terms of what else could have been done with these resources. The difference between the price paid for the bag of asphalt and the marginal cost of its production is simply a transfer of rents from the government to the monopoly asphalt maker.

Measuring Future Costs

The last cost is maintenance, which involves both materials and labor. The analysis for those materials and labor is the same as we have pursued thus far. But there is a new wrinkle as well, because we need to combine a future stream of costs (maintenance) with the one -time costs associated with construction.

To do this, we compare the present discounted value (PDV ) of these costs, as reviewed in finance. A Ksh. tomorrow is worth less than a Ksh. today because I could put the Ksh. in a bank today, earn interest, and have more money tomorrow. So a Ksh. today is worth (1 + r) times as much as a Ksh. tomorrow, where r is the interest rate I could earn in the bank. As a result, future maintenance costs must be discounted to compare them to today’s construction costs. While applying present discounted value involves simple algebra, there are some important economic issues involved in choosing the right social discount rate to use for these calculations. If a private firm were making an investment decision, the proper discount rate should represent the opportunity cost of what else the firm could accomplish with those same funds. If there is an existing bag of asphalt and the marginal cost of its production is simply a transfer of rents from the government to the monopoly asphalt maker. investment that yields 10% per year with certainty, and the firm pays a tax rate of 50%, then this investment would net the firm a return of 5% per year. The opportunity cost of spending money on any new project, then, is the 5% net return that the firm could earn on the existing investment. Thus, 5% is the rate that should be used to discount the payments associated with any new project.

The government should also base its discount rate on the private –sector opportunity cost. The next best use for any money by the government is its use in the hands of the private sector. Thus, if a private firm could earn a 10% return on their money, then the government counts that full 10% as its opportunity cost. Unlike the private actor, the government does not count solely the after-tax portion of the investment return as its opportunity cost, since the government is the party collecting the taxes. Thus, the social cost of removing the money from the private sector is 10%: the 5% after -tax return to the firm and the 5% in tax revenues to the government. This is the opportunity cost of devoting the funds to the government’s project, so 10% should be used as a discount rate.

Measuring the Benefits of Public Projects

Measuring the benefits associated with this project is more difficult than measuring the costs because it is more difficult to use market values to place a value on the benefits.

Valuing Driving Time Saved

The first benefit associated with this project is that both producers and consumers will save travel time. For producers, we can value the time savings in a straightforward manner. The benefits to producers arise from a reduction in the cost of supplying goods, because it takes less time to transport them. The decreased costs lead to an increase in supply (a rightward shift in the supply curve), which raises the total size of social surplus. This increase in social surplus is the benefit to society from the lower cost of producing goods. It is much trickier to measure the benefits of time saved for consumers: How do we value the benefits of being able to get from point to point more quickly? What we need is some measure of society’s valuation of individuals’ time: What is it worth to me to have to spend fewer minutes in the car? Economists have several approaches to answering this question. None are fully satisfactory, but by putting them together we can draw some general conclusions about the value of time.

Using Market-Based Measures to Value Time: Wages

Suppose we can show that the time that individuals save from driving faster is spent at work. Suppose, moreover, that there is a perfectly competitive labor market that allows individuals to earn their hourly wage for each additional hour spent at work. Under these assumptions, we would use drivers’ wages to value their time savings. Opportunity cost is the value in the next best alternative use, and the next best alternative use in this example is being at work. The value of time at work in a perfectly competitive labor market is the wage rate that could be earned during that hour. The average wage rate for workers in the United States was $19.29 per hour in 2009 (you could obtain similar data for Kenya). What if the time savings is spent partly at work, and partly in leisure? Once again, if we are in a perfectly competitive labor market in which individuals can freely choose how many hours they want to work, then the wage is the right measure even if the time is spent on leisure. This is because, in a competitive model, individuals set the value of their next hour of leisure time equal to their wage. If the marginal utility of leisure time was above the wage, individuals would work less and take more leisure (driving down the marginal utility of leisure by consuming more leisure). If the marginal utility of leisure time was below the wage, individuals would work more and take less leisure (driving up the marginal utility of leisure by consuming less leisure). Thus, in a perfectly competitive labor market with freely adjusting hours, the value of time is always the wage, even if the time is spent on leisure activities. As you might expect, this theoretical proposition runs into some problems in practice:

\_ Individuals can’t freely trade off leisure and hours of work; jobs may come with hours restrictions. Suppose I’d like to work more than 40 hours per week at my current wage, but my employer will not let me because that would involve paying me a higher overtime wage. Inthis case, my value of leisure could be below my wage, but I can’t drive them to equality by working longer hours. So the wage overstates the value to me of saving time.

\_ There may be nonmonetary aspects of the job. For example, during leade, my office at work is air conditioned, while my home is not. This means that I value time at work at more than the wage; I also value the fact that it is more comfortable. Thus, my total compensation at work is higher than my wage. The value of leisure is set equal to total compensation from work, not just the wage, so the wage understates the value to me of saving time. These problems limit the value of the wage as a value of time, leading economists to consider a variety of other approaches to time valuation.

Using Survey -Based Measures to Value Time: Contingent Valuation

Before you took any economics, if I had asked you to figure out the value of time to someone, how would you have proposed to do it? Most likely you would have simply asked individuals what time is worth to them! That is, you could ask, “How much would you pay to save five minutes on your drive?” This approach is labeled by economists as contingent valuation: asking individuals to value an option they are not now choosing (or that is not yet available to them). The advantage of contingent valuation is that, in some circumstances, it is the only feasible method for valuing a public good. Consider the difficulty of valuing efforts to save a rare species of owl. There is no obvious market price that you can use to value that species. But you can survey individuals and ask what it is worth to them to save the species. These preferences can then be aggregated (added up) to form a value of efforts to save the species. The problems with contingent valuation, however, are daunting, as reviewed in the following application.

Using Revealed Preference to Value Time

The natural way for noneconomists to value time is to ask individuals what their time is worth, but this approach runs into the previously noted problems. The natural way for economists to value time is instead to use revealed preference: let the actions of individuals reveal their valuation. The mantra of economics is: people may lie, but their actions, which result from utility maximization, don’t! Suppose we compare two identical houses, one of which is five minutes closer to the central city where most commuters work. If individuals are willing to pay more for the closer home, this implies that they value the time savings. We can therefore use the difference in sales prices between the two homes to assign a value to saving five minutes of commuting. This comparison provides a market -based valuation of their time that truthfully reveals the preferences of individuals. While appealing in theory, this approach also runs into problems in practice. This example works if the two homes are identical. But what if the house that is closer to the city is also nicer? Then we would find that it sells for a lot more, and falsely assume that this implies that individuals value their time very highly. The problem is that the price of any good values the entire set of attributes of that good, but for revealed preference analysis we are only concerned with one particular attribute (in this case, distance to the city). Because other attributes of the good differ, it is difficult to use revealed preference to distill the value of a particular attribute of the good, such as location. The ideal way to value time would be a controlled experiment, where we varied just the attribute of the good that we are trying to value: in this example, we could take the same house and move it five minutes closer to the city. This is clearly not possible in many cases. As reviewed in the Empirical Evidence box, however, a clever attempt to resolve this problem suggests that the value of an hour of time is remarkably consistent with the estimate from market - based measures.

Valuing Saved Lives

Returning to our highway example, the other major benefit of improving the street is that repairing the road will improve safety and save lives. Valuing human lives is the single most difficult issue in cost -benefit analysis. Many would say that human life is priceless, that we should pay any amount of money to save a life. By this argument, valuing life is a reprehensible activity; there is no way to put a value on such a precious commodity. This argument does not recognize that there are many possible uses for the limited government budget, each of which could save some lives. By stating that life should not be valued, we leave ourselves helpless when facing choices of different programs, each of which could save lives. By this logic, we would have to finance any government program that could save lives, at the expense of, say, education or housing expenditures. Alternatively, we could claim that virtually any government expenditure has some odds of saving a life; by improving education, for example, we may reduce crime, which will save victims’ lives. To escape the impotence that would be imposed by the “life is priceless” argument, one needs to be able to place some value on a human life.

Using Wages to Value a Life As with valuing time, the market -based approach to valuing lives is to use wages: life’s value is the present discounted value of the lifetime stream of earnings. While this seems like a logical approach, it faces a number of problems. One major problem is that using wages to value life doesn’t value any time that isn’t spent working. In a competitive markets model, we would want to add up not only the wages that are earned at work but also the leisure time that is valued at that market wage. Keeler (2001) calculated that a worker under 50 in the USAwill spend 10–20% of her future hours working, so that, assuming she values leisure time at her wage rate, the value of her life is about 5–10 times her future lifetime earnings. Using data on employment, wages, and mortality rates, Keeler calculates that the average 20-year -old female will have future earnings of $582,000 (net present value, 2009 $) but will value her life at $3.685 million (2009 $). Men have slightly higher values because of higher earnings, while older people have lower values because they have fewer hours of life remaining. This approach also faces the same problem as using wages to value time, which is that the market wage may not accurately reflect the value of leisure time. Moreover, life may mean more than just wages earned or corresponding leisure. For example, an individual may internalize the enjoyment derived by others from her being alive.

Contingent Valuation The second approach to valuing a life uses contingent valuation. One way to do this is to ask individuals what their lives are worth. This is obviously a difficult question to answer. Thus, a more common approach is to ask about the valuation of things that change the probability of dying. For example, one such survey asked participants how much more they would pay for a ticket on an airline with one fatal crash out of 500,000 flights compared to the same ticket on an airline with two fatal crashes out of 500,000 flights. Another question asked how much less they would be willing to pay for a house in an area with environmental pollution that would reduce their life span by one year compared to a house in an unpolluted area. The problems of contingent valuation just raised will clearly haunt this analysis as well, however. Perhaps for this reason, contingent valuation studies have provided a very wide range of results for life values, ranging from Ksh.963,000 to Ksh.26.0 million per life saved.12

Revealed Preference As with valuing time savings, the method preferred by economists for valuing life is to use revealed preferences. For example, we can value life by estimating how much individuals are willing to pay for something that reduces their odds of dying. Suppose that a passenger air bag could be added to a new car for Ksh.350, and there is a 1 in 10,000 chance that it would save the life of the car passenger. This implies that the value of lives to individuals who buy airbags is at least Ksh.3.5 million.

Discounting Future Benefits

A particularly thorny issue for cost -benefit analysis is that many projects have costs that are mostly immediate and benefits that are mostly long -term. An excellent example of this would be efforts to combat global warming through reducing the use of carbon -intensive products (via a tax on the carbon content of goods, for example). The costs of such efforts would be felt in the near term, as consumers have to pay more for goods (such as gasoline) whose consumption worsens global warming. The benefits of such efforts would be felt in the very distant future, however, as the global temperature in 100 years would be lower with such government intervention than it would be without any such intervention.

These types of examples are problematic for two reasons. First, the choice of discount rate will matter enormously for benefits that are far in the future. For example, a Ksh. benefit in 100 years is worth 13.8¢ if the discount rate is 2% (1/(1.02)100 \_ 0.138), 5.2¢ if the discount rate is 3%, and 2¢ if the discount rate is 4%. This sensitivity of benefit calculations to small changes in the discount rate places enormous importance on getting the discount rate exactly right. Second, long -lived projects provide benefits not only to the generation that pays the costs but to future generations as well. Should we treat benefits to future generations differently than benefits to current generations? Some would argue that we should just weight the benefits to the current generation, who are paying the costs. But what if the current generation cares about its children? Then we should incorporate the children as well.

Cost-Effectiveness Analysis

Despite the list of clever approaches to valuing the benefits of public projects, in some cases society may be unable (or unwilling) to do so. This does not imply that the techniques of cost -benefit analysis are useless. Rather it implies that, instead of comparing costs to benefits, we need to contrast alternative means of providing the public good, and to choose the approach that provides that good most efficiently. This comparison is called cost-effectiveness analysis, the search for the most cost -effective approach to providing a desired public good. For example,

society may decide to combat global warming even if it is impossible to put an estimate on the benefits of doing so (or if the benefit is hugely uncertain because it is so far in the future).

Common Counting Mistakes When analyzing costs and benefits, a number of common mistakes arise, such as:

\_ Counting secondary benefits: If the government improves a highway, there may be an increase in commerce activity along the highway. One might be tempted to count this as a benefit of the project, but this new road may be taking away from commercial activity elsewhere. What matters in determining the benefits is only the total rise in social surplus from the new activity (the net increase in surplus -increasing trades that results from the improved highway).

\_ Counting labor as a benefit: In arguing for projects such as this highway improvement, politicians often talk about the jobs created by the project as a benefit. But wages are part of a project’s costs, not its benefits. If the project lowers unemployment, this lowers the opportunity cost of the workers, but it does not convert these costs to benefits.

\_ Double -counting benefits: Public projects often lead to asset -value increases. For example, the fact that consumers save time driving to work when the highway is improved could lead to higher values for houses farther away from the city. When considering the value of this highway improvement, some may count both the reduction in travel times and the increase in the value of houses as a benefit. Because the rise in house values results from the reduction in travel time, however, both should not be counted as benefits.

Sometimes, these types of mistakes are made because of hasty or uninformed analysis. Other times, however, they are made on purpose by one side or another of a heated cost -benefit debate. The growing role of cost –benefit analysis in public policy making has raised the stakes for avoiding this type of manipulation of what should be an objective exercise.

Distributional Concerns The costs and benefits of a public project do not necessarily accrue to the same individuals; for example, when we expand a highway, commuters benefit, but those living next to the road lose from more traffic and noise. In theory, if the benefits of this project exceed its costs, it is possible to collect money from those who benefit and redistribute it to those who lose, and make everyone better off. In practice, however, such redistribution rarely happens, partly due to economic problems (such as the informational requirements of carrying out such redistribution), and partly due to political problems of the type discussed in the next chapter. In the absence of such redistribution, we may care specifically about the parties gaining and losing from a public project. For example, if a project benefits only the rich and hurts only the poor, we may want to discount benefits and raise costs to account for this. The problem, of course, is: How do we pick the weights?