Lecture 5: Cost-Benefit Analysis

The last of the five strategies for comparison of investment strategies is *benefit/cost ratio*. This method is commonly used for public planning, by national or local governments, rather than by individual companies. Although there are significant differences between planning in the public and private sectors, the benefit/cost ratio is neutral with respect to these differences, giving the same result as would the present worth or rate of return methods.

Formally, the benefit/cost ratio is defined as the fraction

Present worth of benefits/Present worth of costs

If this ratio is greater than unity, the project should go ahead, otherwise not.

One apparent pitfall in this method is some ambiguity in what should be considered a cost and what a benefit. For example, a project with startup costs **C** which generates annual revenue **R** and which must meet annual costs **K** could be described as having equivalent costs **C + K(P/A,i,N)** and equivalent benefits **R(P/A,i,N)**. So the B/C ratio would be

R(P/A,i,N)/(C+K(P/A,i,N))

On the other hand, the same project could be considered as yielding an annual profit of **P = R-K**. This annual profit is certainly a benefit, so we could argue that the benefit/cost ratio should be

(R-K)(P/A,i,N)/C

But these two ratios are different, so how can we decide which to use?

Fortunately, we don't need to decide. The only thing we care about is whether the ratio is greater than 1, and it can be shown that when one of these fractions meets that criterion, so does the other.

This means that the benefit/cost ratio *cannot* be used to rank alternative strategies in order of preference. However, it *can* be used to rank *incremental* strategies in order of preference. This is just the same approach as we used with the rate of return methods: we tabulate the cash-flows of each mutually exclusive option, in increasing order of initial investment, then construct the additional options of upgrading from each viable alternative to its more expensive neighbours. We upgrade whenever the benefit/cost ratio of spending the extra money is greater than unity.

Differences between the Public and Private Sectors

Public sector decisions are in general more difficult than those in the private sector. This is for several reasons: the time horizon is often more distant, the projects may be larger, and many of the benefits for which the government is striving may be intangible. An example of these difficulties would be the nuclear-waste repository problem in Unit 2.

Some of the factors which can be ignored in a private-sector analysis become the responsibility of government by default. For example, the effect on public health of dioxin emissions from a pulp mill can be ignored by the mill owners, since it isn't the job of the pulp industry to look after people's health. If the

government does not take responsibility for these factors, known as `externalities', then they will be invisible to the economy -- that is, the economy will act as though clean air and water are of no value.

Such externalities can also occur within government, as, for example, when the Ministry of Transport fulfills its mandate to provide efficient transportation by planning a highway through a forest defined by the Ministry of the Environment as an area of outstanding natural beauty.

On the plus side, governments can usually obtain very favourable interest rates for borrowing money, since it is rare for entire nations to declare bankruptcy.

The economic analysis methods we have discussed here are only a small part of the considerations that should be taken into account in public decision making. It may be desirable to poll public opinion on a controversial project, and the public's wishes may take precedence over the results of analysis. Some of the broader issues are discussed in ``How to Use Cost-Benefit Analysis in Project Appraisal", M.J. Frost, John Wiley and Sons, 1971 [TA 177.7 F76] and ``The Economics of Environmental Protection", D. N. Thompson, Winthrop Publishers, 1973 [TD 180 T49].

Other Methods of Comparison

In addition to the five methods we have reviewed, various other methods are also found in industry. Some of these are equivalent to what we've seen, others are actually invalid. One example of the latter is *payback time*. In its crudest form, this method divides the initial cost of a project by its estimated annual saving to get a figure for the number of years it will take for the investment to pay for itself. The figure so obtained will be unduly optimistic, as the method takes no account of the time value of money. However, even if we adjust the annual income to take interest rates into account, comparisons made using this method may be misleading. For example, we may find that of two machines under consideration to perform the same task, one has a payback period of two years, while the other, more expensive machine has a payback period of three. This is not sufficient evidence to select the cheaper machine, though, since it takes no account of what may happen in the fourth or fifth years. It may be, for example, that the cheaper machine must be replaced in its fourth year, with no salvage value, while the more expensive machine will give years of trouble-free operation and a high salvage value.

Despite these very sensible criticisms of the payback-period method, I have noticed that many of the successful entrepreneurs who have given guest lectures in the Wednesday evening slot of this class have, when asked how they evaluate competing proposals, replied that they use the payback-period method. And I have been reluctant to point out their foolishness, since they have often made two or three orders of magnitude more money than I have. Possibly the explanation lies in the field of risk management, which we haven't discussed yet: the reliability of our estimates of future cashflows is lower the further we look into the future, so investors like to know that they'll have recouped their investment by a definite date in the near future.

Sunk Costs

Although we have discussed formulae for moving money from the future to the present, and vice-versa, we have never discussed how to assess the present value of money we've spent in the past. The reason for this is simply that past expenditures are irrelevant to present decisions. Thus, having invested large sums of money in a particular option in the recent past is no reason for sticking with that option if better options are now available. Admittedly, having to send $25,000 of Betamax tapes to the scrap heap can cause you some mental anguish, and lead to embarrassing questions from your stockholders; but from an economic viewpoint, it's the best thing to do.

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