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CHICAGO LAKEFRONT DEMONSTRATION PROJECT

BENEFIT-COST ANALYSIS

PREPARED
BY
LEE G. ANDERSON
RUSSELL F. SETTLE
UNIVERSITY OF DELAWARE

ROY F. WESTON, INC
WESTON
ENVIRONMENTAL CONSULTANTS-DESIGNERS

Illinois. City of Chicago. Dept. of Development and Planning
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DEPARTMENT OF DEVELOPMENT
AND PLANNING
LEWIS W. HILL
COMMISSIONER

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Illinois

CITY OF CHICAGO
MICHAEL A. BILANDIC
MAYOR

DEPARTMENT OF DEVELOPMENT
AND PLANNING
LEWIS W. HILL
COMMISSIONER

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SECTION 1

INTRODUCTION

The purpose of this handbook is to provide concise, step by step procedures for undertaking a benefit-cost analysis. It is hoped, that by reading it the personnel of the City of Chicago will better understand how to read, interpret, and evaluate a benefit-cost analysis; and how to actually do one. Benefit-cost analysis is an evaluative process derived directly from advanced theoretical welfare economics, and cannot be explained in detail in this report. The fundamentals of benefit-cost analysis are quite easy to grasp (although they may at first seem counterintuitive) and if applied with care, can provide extremely useful information on the efficiency aspects of projects to decision makers. Using the procedures described may not result in a report that is rigorous and complete enough for a Ph.D. dissertation in economics, but it will provide numerical results that are of a correct order of magnitude.

While it is certainly possible for a willing learner to be able to assimilate and apply the fundamentals of benefit-cost analysis in a relatively short time, it would be naive to think he would be able to perform all kinds and all aspects of benefit-cost analysis without assistance. It would also be naive of the City of Chicago to think that a relatively short handbook will instantly make their staff experts in the field. The derivation of demand and supply curves, undertaking certain surveys and other such activities are best handled by individuals who have had specific training in those fields. Concerning such problems, the goal of this handbook will be to alert the reader to the possible need for professional help, while familiarizing him with the basics of the analysis so he can easily communicate with the professional. In some cases this familiarity will enable him to locate related studies that may preclude the need for professionals.

In order to get a better overview of the subject, the following is a hypothetical example. The City is considering redeveloping a certain tract of lakefront property into a recreational complex with a marina, public beaches, picnic grounds, indoor swimming pool, and several play fields suitable for baseball, football, soccer, and other sports.

To complete the marina, it will be necessary to perform dredge and fill operations, the results of which will be increased flood protection at the site and other nearby areas, as well as some ecological damage. Current use of the land includes several retail establishments, a few private homes, some privately owned vacant lots, and a few parcels of land that the City already owns. The people who will ultimately have to make the final decision on whether or not to carry out this redevelopment will have to consider the pros and cons from many possible angles. They will have to know if sufficient funds can be allocated to the

project. They may be concerned with the political ramifications of doing the redevelopment at this spot rather than some other, or not at all. They may be concerned with the physical effects the redevelopment will have on the environment and perhaps the political and social ramifications that will result. They may be concerned with such income redistributional effects as what will happen to the profit potential of private firms that deal in competing or complementary products in the locale of the proposed park, or of the income range of the individuals that will use the park. They may also be concerned with whether the expenditures for the park are well spent.

All of these things can be very important and all are, to one degree or another, used as background information for making a final decision. Benefit-cost analysis is designed to provide information on the pure economic efficiency aspects of a project in terms of the value of goods and services given up in order to build it, and the gain as a result of its operation. It is obvious then, that if other types of information will be necessary or useful to decisionmakers, other types of analysis besides benefit-cost analysis will be necessary. If these points are kept in mind they will aid in the understanding and application of what is to follow. The first point is worth stressing because of the misuse of the term benefit-cost analysis. The way the term is thrown around, novices contemplating benefit-cost analysis think that all they have to do is to list everything that looks good and call it a benefit and then list every thing that looks bad and call it a cost. However, in order to provide information on pure economic efficiency, economists have compiled some very specific rules as to what can and cannot be included as benefits or costs, and exactly how to go about measuring them. This handbook will describe these rules in some detail. In doing so, it is hoped that the incorrect interpretation of benefit-cost analysis will not be used. To re-emphasize the second point, just because benefit-cost analysis and, hence this report, concentrate only on the economic efficiency aspects of a project, does not mean that other aspects are not important from a decision making point of view. Information on these aspects is much more useful when separated from the efficiency information.

Economics is the study of the allocation of resources so as to maximize welfare. More specifically it is the study of the allocation of a nation's resources so as to maximize the value of the goods and services produced.

Value is measured using the common denominator of dollars and assignments of value are based on what people are willing to pay. For example, if people are willing to pay $5,000 for an automobile and $600 for a color television, and demonstrate this willingness by purchasing them at these prices, then the production of three cars and six televisions has a value of $18,600. And more important to the point of this report, if it is possible to reallocate resources such that the production of one car is foregone but nine more televisions can be made, there has been a net increase in the value of goods and services produced. Five thousand dollars worth will be lost by not producing the car, but $5,400 worth will be gained by making the nine televisions.

This is basically what benefit-cost analysis is all about; the study of reallocations of resources to see if there has been an increase in the value of goods and services produced. Of course benefit-cost analysis is not this easy. Often it is difficult to determine precisely what types and amounts of goods and services are being gained and lost, and what people would be willing to pay for them. This is certainly the case when evaluating alternative lakefront designs.

Therefore, a benefit-cost analysis of a specific lakefront design would attempt to determine if the value of the goods and services produced is greater than those given up in order to build it. Benefit-cost analysis is a method for studying reallocations of a nation's (or region's) resources to make sure only those reallocations that increase the value of goods and services produced are undertaken. It is a decision making tool, not to be confused with financial reports, or profit and loss statements prepared by a private firm. As the following discussion demonstrates, there are many differences between them as far as both including and excluding items because benefit-cost analysis takes a much wider social view of things than a private firm.

Regarding the hypothetical redevelopment project discussed previously, the benefits of the project would be the value of the services provided by its many components. That is, in order to measure the benefits it would be necessary to determine the numbers of boaters, beach users, picnickers, etc. who would use the project each period and what is the value provided by doing so. The costs would be the value of goods and services foregone by using the land, labor, and capital in the land redevelopment rather than in its next best use. How this is done will be explained but note that when this information is derived it will not provide all of the information that may be required by our hypothetical decision makers. It does not show if sufficient funds for the project are in the budget; that is a political or legislative matter. Benefit-cost analysis of a given project only suggests whether or not the project is an efficient use of funds. Another point worth mentioning is that the cost figure derived in a benefit-cost study may vary greatly from the actual financial cost that must be budgeted. This is because certain items, e.g., using unemployed labor, while involving a financial

cost, do not involve a cost in terms of foregone production. Benefit-cost analysis will not report on how physical effects on the environment affect the value of services produced. That is, if as a result of dredging for the marina, a certain fish population is diminished, then one of the costs of the project will be the net reduction in the value from any commercial fishery involved and any decrease in the value of the recreational services provided by the stock.

It is important to make three things perfectly clear at this point. Although there may be many criteria for determining if a certain lake-front project should be adopted (i.e., income redistribution, strongly felt needs of leaders and other individuals or groups in the community, etc.) benefit-cost analysis uses the criteria of economic efficiency. It should not be judged incomplete or wrong because of this; it has a certain goal and if properly used, it can fulfill that goal. If other criteria are important to decision makers, then other types of studies will have to be done. Efficiency is an important criteria for government decision makers to use in judging the adequacy of a project. Even if other criteria are used, the decision makers should know what they are giving up in terms of lost efficiency.

Secondly, using willingness to pay as the measure of value is sometimes faulted because of its dependence on distribution of income. Willingness to pay is essentially consumer needs backed up with dollars to make the necessary purchases. A change in the distribution of income will likely mean that a different set of needs will have sufficient backing to be registered as willingness to pay, and so the values of different goods and services may change. Economists have chosen to accept the existing distribution of income as the basis for willingness to pay on the grounds that (1) they have no criteria for selecting any other, and (2) the existence of redistribution policies such as welfare, graduated income taxes, etc., indicates that the current distribution is somewhat socially determined.

The third point is that although a project that increases the value of goods and services produced, and hence would be approved by a benefit-cost analysis, may in fact make certain individuals worse off. An increase in the value of production only provides for the potential for increasing the welfare of society. By redistributing the gains, at least one person can be made better off without making anyone else worse off, which seems a useful way of measuring such things, and is in fact the way used in formal economic analysis. Because a project provides this potential does not mean that it will be achieved. For example, using a beach area to build a marina may be an efficient project because the value of its services are greater than those formerly provided to bathers at the beach, but the individuals who used the beach will be worse off unless there is some way to transfer some of the gains to them. In many cases, of course, such transfers are not

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possible for practical as well as institutional reasons. It is useful, therefore, to provide distributional information along with the efficiency information in the written report of a benefit-cost analysis. This point will be covered in some detail later.

Section 2 will provide a set of rules that if followed will result in a useful and theoretically correct benefit-cost analysis. It will also contain a rather brief explanation of the whys and hows of each rule. The following sections will provide more detailed descriptions of some of the important rules and will include practical methodological tips. Section 3 contains an example of using the rules on a hypothetical lakefront development project.

At this point, a word is in order about how to best utilize this handbook. In one sense, perhaps the brief introduction into the background of benefit-cost analysis and what follows in the next section are the most important part. The former provides the basis and underlying foundations for doing benefit-cost analysis, and the latter presents a step-by-step overview of performing one. Together they provide a frame of reference to put the analyst on the proper track for doing a study. A common error in performing benefit-cost analyses is the inclusion of incorrect things and the exclusion of others. Often these mistakes are much more important than imperfect measurements of things that actually should be there. If a person will follow the steps as set out bearing in mind the basic notion of pure economic efficiency, these types of errors can be avoided.

The last section showing how to prepare a report with an example related to Lakefront development, is very important. The material in the other sections describes how to make the actual measurements, and how to handle such things as risk and uncertainty. It will not be necessary to use every one of the tools discussed in every benefit-cost analysis. Therefore, it is not necessary to memorize every aspect of the methodologies. It is sufficient to become familiar with their strengths and weaknesses, the data that they require, the ease with which they are applied, and the degree to which their results can be generalized. One can then pick and choose the methodologies and the procedures that apply, either doing them himself or obtaining the help of an experienced researcher, if necessary.

The goal of this handbook is to provide the fundamentals of performing or reviewing benefit-cost analyses. This can be defined as knowing the basics, knowing how to outline a study, how to actually do the measurements in fundamental areas, and the ability to know when additional help is necessary in order to obtain meaningful results.

SECTION 2

BASIC STEPS FOR UNDERTAKING A BENEFIT-COST ANALYSIS

2.1 BASIC STEPS — OUTLINE

The basic steps for performing a benefit-cost analysis are as follows:

1. Define the project.
2. List the benefits of the project.
3. List the costs of the project.
4. Determine which of the benefits and costs can be measured theoretically.
5. Determine which of the benefits and costs can actually be measured given time, budget, and data constraints.
6. Determine exactly what will be measured and how.
7. Demonstrate how the things not measured could possibly affect the results.
8. Select the proper way to display the information derived so that it will be most useful to decision makers.

When planning a benefit-cost analysis, the analyst should make sure to use each of these steps in order to insure a complete and meaningful analysis. When reviewing a study that a consultant has done for the City, this checklist can be very useful as an evaluation guide. If the results do not show that these steps were followed, the City will not be getting as useful a report as it might have.

The remainder of this section will explain in some detail the whys and hows of each of these steps.

2.2 STEP 1—DEFINE THE PROJECT

This step will specify the exact nature of the project including its purpose, objectives, and its relation to existing and potentially related projects, and the appropriate accounting stance to use while undertaking the analysis. It is necessary to ensure that the study will focus on those things most important to decision makers, but a benefit-cost analysis can be very expensive and it is important to frame the study so that the proper information can be obtained as efficiently as possible. Determining exactly what the decision maker is likely to need is a necessary part of an efficient analysis.

The first two parts of this step, specifying the purpose and the objectives, are included to explicitly state the what and the why of the project. The what should include a detailed description of the project or the program to be undertaken. The why should include a statement of the reason for doing it.

In most cases, specification of the purposes is quite elementary, being spelled out in the charge to the analyst. With multipurpose projects, however, only one or two may be listed, but it is important that all be studied. This will insure that the decision-maker is apprised of all of the consequences of the project. Determining the objective should pose little difficulty. The purpose of benefit-cost analysis is to determine the efficiency aspects of various projects; therefore, for purposes of the study the main objective should be to increase the value of the goods and services produced. In some cases decision makers may have other objectives such as income redistribution, or regional development. These other objectives are most frequently used in developing countries, but the City of Chicago may consider them in lakefront development planning. In this case, the analyst should structure his work so that the report will indicate to what degree these objectives have been met.

If other similar projects or programs are being undertaken or contemplated by other levels of government or in the private sector, an exact statement of the relationship between them should be included in this introduction. For example, if the state government is planning to open a new park with easy access for city dwellers, or if a well-kept vacant lot that is often used as a playground is going to be used for a construction site, they would have important ramifications on the usefulness of a planned lakefront park developed by the City.

The accounting stance is the frame of reference for looking at the project to be studied. Benefits have been defined as people's willingness to pay for the outputs of the project; and costs as the value, as measured by willingness to pay, of the foregone opportunities of doing the project. Before implementing these definitions, it must be specified exactly who will be included in the calculations. That is, should the willingness to pay be included only for the residents of the City of Chicago or expanded to county, state, regional, or national levels.

If a completely general accounting stance is adopted, the rule is to count all benefits and costs to whomever they accrue, where benefits and costs are as defined above. As the accounting stance is narrowed, the rule is to count only those benefits and costs that accrue to individuals specified in the frame of reference. It should be obvious that the accounting stance should be stated very explicitly, so that it is easy to determine just whose benefits and costs are to be counted.

Selection of the accounting stance is quite important, both in determining the cost of doing the project and in the type of decision that is ultimately reached. If the City of Chicago takes the position that it will count benefits and costs that accrue to or are borne only by its citizens, this will confine the analysis and make it easier and less expensive to perform. From a narrow maximization point of view, the City may be quite wise in considering only the gains and losses to its citizens when making decisions on how to spend its tax revenue and its land and water resources. There is basis for the argument that unless the benefits to the people who are paying for the project are greater than the cost, the project should not be approved. Nonetheless, because the effect of lake front projects can be felt state and even areawide, a narrowly defined accounting stance may lead to inefficiency as far as the nation is concerned. For instance, in the process of using landfill to obtain new beach area, the lake may be ecologically affected in such a way that the value of services it provides is decreased. If decrease is primarily to nonresidents, then a narrow accounting stance may approve a project actually leading to a net decrease in the value of goods and services produced as far as the whole area is concerned. While the analyst cannot always determine which accounting stance to use, he must make it known if the only reason a certain project is approved is because a narrow view has been taken.

For lakefront development a narrow accounting stance should be sufficient, especially with regard to measuring benefits. The great majority of the benefits of a local park will be to city residents. Using such a stance will save money, make the workload more manageable, and yet should not significantly alter the basic results. This approach should be used with caution, however. In those instances where significant benefits or costs occur to nonresidents, a wider frame of reference will be necessary to get a true picture of the efficiency of the project. Even so the ultimate decision maker may decide to look only at the local benefits and costs. This is a political decision that may result in bad economics from a national point of view, but as long as the decision maker is aware of these ramifications, the analyst should use the accounting stance that is requested.

Although project definition is a very important step in undertaking a benefit-cost analysis, it is one that the novice can perform with little difficulty.

2.3 STEP 2--LIST PROJECT BENEFITS

A project may have many effects, but for a strictly defined benefit-cost analysis only those that will affect economic efficiency need be considered. A good rule is to define benefits as the amount that people are willing to pay for the direct outputs of the project. The key phrases are: "willingness to pay" and "direct output." According to economic theory, willingness to pay is the proper measure of value to use when ascertaining the worth of something (see Section 1).

Direct outputs are those things actually produced in the construction and operation of the project. It is at the same time narrower in one way than one might expect but broader in another. It is broader because it includes all outputs, not just those for which the project was planned. For example, a marina outputs dockage and storage facilities for boats, potential environmental damage as a result of dredging and boat operations, reduced visual enjoyment of the lakefront, etc. Obviously, the marina was built to provide the boat storage and dockage services, but as a direct result of the other outputs, which are negative, benefits occur. To be complete, they must be counted in a benefit-cost analysis. In many cases, these outputs can be larger than the ones for which the project was designed, meaning that ignoring them will lead to approval of a project that actually provides net efficiency losses. It is quite difficult, sometimes almost impossible, to get a perfect measure of willingness to pay for these nonmarket outputs, but as the next discussion will show, methodologies to do so exist. In spite of these difficulties, the nonmarket outputs must be included in a benefit-cost analysis. Their inclusion helps differentiate benefit-cost analysis from normal business profitability analysis.

The definition of benefits as willingness to pay for the direct outputs of the project is narrower because it does not count such things as the extra services provided by motels that locate next to the marina, nor the revenue earned by a hot dog salesman working the area, nor the effects of the spending habits of those who construct or operate the facility. These things, called secondary or parochial effects, are not really net benefits in the sense that the value of goods and services is being increased. If the economy is fully employed, the resources and labor to provide these items are pulled out of other areas where they could provide services of equal value. If one is interested in the economic impact of the project, these things should be considered, but for all practical purposes, they are not relevant for a benefit-cost analysis. The phrase "for all practical purposes" is used because there are certain situations where these items will be important. The most important case is the use of unemployed resources. Because they are, by definition, producing nothing, their use does not involve a reduction in goods and services produced; they have a zero opportunity cost as far as benefit-cost analysis is concerned. This concept will be discussed in some detail later. In most cases, the best rule is to ignore them. This is especially true for projects the size of those envisioned for lakefront redevelopment and in situations where the potential analyst has only a rudimentary understanding of advanced economic theory. Therefore, it is recommended that when analyzing potential shorefront designs, benefits be defined as the total amount that people are willing to pay for the direct outputs of the project. All other effects should be ignored. It should be emphasized, however, that when narrow accounting stances are used, direct outputs may include more things.

For example if a local accounting stance is used, an increase in related business activity in the Chicago area can be considered a direct output.

If a national accounting stance is used, this would not be the case because with full employment an increase in business activity in the Chicago area would be possible only with a decrease elsewhere. From this perspective there would be no direct output at all as far as related business activity is concerned, only a change in its relative location (assuming full employment elsewhere).

This step in preparing a taxonomy of the project benefits is an expansion of the first part of step 1. The purpose is to be very explicit about what will be produced as a result of the project. At this stage the analyst should not be concerned with the expected size of any of the benefits or of the ease or difficulty with which they can be measured. Every possible direct output benefit should be listed. This provides a good overview of the benefits of the project and provides a checklist for the analyst to measure his success in completing a full analysis. A novice benefit cost analyst should have no trouble performing this step. It is only necessary to keep the definition concerning direct outputs in mind.

2.4 STEP 3 — LIST PROJECT COSTS

This is the counterpart of step 2. The concept of opportunity cost is most important. What we are looking for is what things are given up in order to undertake the project, and what is the willingness to pay for them. That is, costs are the foregone benefits from not being able to put the resources to their next best use. To be complete, the last of costs should include an evaluation of the resources necessary to plan, construct, and maintain the project as well as any to ensure compliance with its use. The analyst must decide the types and sizes of resource reallocations by both public agencies and private individuals and firms as a direct result of the project. The next section and the hypothetical example will clarify this step.

What is called for is a complete list of the amounts and qualities of the actual inputs (i.e., land, labor, and capital equipment) that will be used in the construction and operation. Also costs of the project, in the sense that some good or a service will no longer be produced (even if they will not be a part of the financial cost of building or operating the project), should be included as well. In some instances, it will be more appropriate to include the negative benefits described as a cost just as long as they are not included in both lists. Like step 2, the novice analyst will be able to handle this step.

2.5 STEP 4 — DETERMINE WHICH BENEFITS AND COSTS CAN BE MEASURED THEORETICALLY

From the definition of a benefit it should be clear that while it may be possible to conceptualize a proper measure, actual application may be quite difficult. Measures of willingness to pay for items that are freely purchased and sold in the marketplace are quite simple to obtain.

Market price paid is a useful proxy for this -- if an item is not worth the price, people will not purchase it. In some instances, however, adjustments are necessary. For example, if the project will expand the output of a product by a large amount relative to that already sold it will, in all probability, have an effect on the price. In order to measure benefits properly it will be necessary to know the demand curve for the product in order to predict the exact nature of the change in price. It is also important to realize that when a price change occurs, an extra benefit is provided to existing consumers because they can purchase the same product at a lower price. Another case where the market may not provide useful measures of benefits or costs is when there is monopoly or monopsony in the market for inputs or final outputs. To be specific, the real cost of using an input produced by a person with some monopoly power is less than the price he charges. An extra amount of revenue in that price is due to his market power. The measure of cost needed is the value of goods and services that could be produced if the monopolist ceased production and released the resources for other uses in the economy.

The problem of measurement is much more difficult for the goods and services produced or given up that are not traded on markets. For example, the operation of a power plant may produce negative benefits by lowering the air and water quality in an area which may reduce the amount and value of services provided by the environment. The lost services may include everything from lost fisheries productivity to decreased enjoyment from evening walks. On the other hand, the benefits from past scientific investigations into polio control were reduced mortality and morbidity.

The purpose of this step is to take the lists developed in steps 2 and 3, break them into the market and nonmarket categories, and determine which can be measured given existing theory. Some of the important methods used to measure the types of benefits and costs likely to be associated with lakefront development will be discussed in the following sections.

If it appears that the majority of the benefits or the costs are of the type that cannot be measured using existing social science research methodology, several preliminary conclusions may be determined at this point. First, unless one of the measureable benefits is very high and the project appears to be a clear winner even in the presence of all of the nonmeasurable effects, the benefit-cost analysis may not result in a definitive answer. This may mean that the best one can do is to present the results of the steps so far, hoping that they may be of some use to the decision-maker. Alternatively, it may be a signal, that in order to significantly improve the report it will be necessary to bring in a professional consultant.

Familiarity with the next two sections will allow the novice to make a very good start at completing this step. No actual measurement is required, only a notion of whether the benefits and costs are amenable to

measurement. Since the discussion of ways to measure benefits and costs cannot be complete (as far as including all types of measurement or how to apply each of these in every possible way), there may be instances where the novice using this handbook may make an incorrect classification. The effects of this can be minimized by classifying a benefit as potentially measureable if there is some doubt about its relevance to existing methods. If nothing can be found to work later on in the study, then this particular benefit can be reclassified as nonmeasureable.

2.6 STEP 5 — DETERMINE WHICH BENEFITS AND COSTS CAN BE MEASURED

Probably if enough manpower, computer facilities and other related resources were used to evaluate all the benefits and costs of a project (market or nonmarket), a suitable and acceptable measure could be obtained. The problem is, that the cost of doing the analysis if very important. In most cases there are critical time, budget and data constraints. The analyst must plan to provide the most useful information given these constraints. This process involves much more than merely measuring all the things that can be measured until the constraints are met. It should be a process of determining which benefits and costs are likely to be significant and then trying to obtain as precise a measurement of them as possible to determine whether benefits are greater or less than costs.

In some instances the items that are difficult to measure may be so minor that it is of little value to spend time measuring them. In many cases, however, they will be central to the analysis and can be ignored only at the peril of making a wrong decision. Other times it is difficult to determine in advance whether the difficulty of measuring items will have a significant impact. It is here that the integrity of the analyst is critical. To avoid errors it is advised that he should adopt the policy of attempting to make measurements if there is some question about the relative impact.

Essentially, step 5 is a further breakdown of one of the categories derived in step 4. Of all the effects, only a number may be studied in detail because of various constraints on the analyst. The problem is to make sure that the effort spent on measurement is profitable.

2.7 STEP 6 — DETERMINE WHAT WILL BE MEASURED AND HOW

This step is the logical conclusion of steps 4 and 5. The criteria for determining what should be measured are:

- Awareness of relative importance of the items.
- Possibility of obtaining comparison values from other studies.
- Existence and difficulty of applying measurement tools, etc.

As an interrelated decision, selection of the measurement procedure should be based on the exact nature of the items to be measured, and the budget and data constraints.

Depending on the nature of the project to be studied and the speed and degree of accuracy required, a novice analyst may be able to complete this step as well. If most of the effects are fairly straightforward and there are few external or other nonmarket effects, then the methodologies discussed in the following sections will provide an ample basis for performing a very credible report. In some cases, even though there are complex effects to be measured, the problem of actually making measurements can be bypassed by drawing on values found in economics literature or in other credible benefit-cost analyses. In both cases it is important that the analyst review the work to make sure that it is based on proper economic methodology focused on the appropriate variables. In this regard, this handbook will provide a useful frame of reference for making such decisions. Also it is crucial to make sure that the situations being compared are similar enough so that meaningful adaptations can be made. For example, a study on the value of recreational services in Wyoming will be of little use in placing a unit value on a recreation day on the Chicago lakefront.

In some other instances the novice must realize that there are special problems that will require professional consulting help. This does not mean that the novice must completely give up at this point. With his knowledge of the problem and of benefit-cost analysis, he will be able to tell exactly where professional help is needed, and will be able to get the consultant started immediately by making the work already done available to him. It is important that the novice only use the consultant for those things which he is not trained to do. For example, the consultant should be requested to estimate the demand curve for a particular output, but the analyst should be able to utilize the curve to perform the rest of the analysis as described in this handbook.

2.8 STEP 7 — DEMONSTRATE EFFECT OF NONMEASURED ITEMS

In some instances, the things that cannot be measured for theoretical or practicable reasons can affect the results of the study. If so, the analyst must at least specify that certain things have not been measured and indicate whether it is a benefit or a cost and, if possible, the order of magnitude involved. For example, excluding a measure of the recreation services foregone by using an area of beach for a marina facility underestimates the costs, and, will improve the chances of the project being accepted. This is especially important to the decision-maker if the difference between measured benefits and costs is quite small. With a known cost not being measured, he will then have some reservations about making a positive decision concerning the project. On the other hand, if the benefits far outweigh the costs, then the decision-maker will not be so worried about the unmeasured costs.

Obviously, if only a few effects cannot be measured, then this type of analysis will be quite useful, because it will give some idea as to whether the overall evaluation is overly optimistic or pessimistic; i.e., if benefits are overestimated and/or costs are underestimated or the reverse due to the existence of nonmeasureables. If there are many things that cannot be measured, and their cummulative effects could be in either direction, not very much information has been added. It is still a good idea to perform this step so that the general tendencies may be made known to the decision-maker. This step can adequately be performed by a novice.

2.9 STEP 8 — SELECT PROPER METHOD OF DISPLAYING INFORMATION

The final step of a benefit-cost study is actually writing the report. The presentation of the benefit-cost findings is very important since it serves as the primary channel of communication between the analyst and the decision-makers. The report must be carefully written and the findings properly displayed, or valuable information may be overlooked or misunderstood.

The first step is to clearly identify the presumed objectives of the program or project being analyzed and relate those objectives to the accounting stance adopted in the study. It is especially important that the study's viewpoint, or accounting stance (e.g., citywide, regional), be clearly identified as this information is valuable to policymakers in judging the relevance of the study's findings.

Next is identifying every benefit and cost that should be considered and where possible, measured. This taxonomy provides a benchmark against which the analyst's success in quantifying a project's benefits and costs can be assessed. Even though it is clear from a study's outset that certain effects are unmeasureable, they should be included in the benefit-cost taxonomy.

Once the taxonomy of benefits and costs has been developed, the approaches used in measuring those benefits and costs that were susceptible to quantification should be discussed. This section of the report should emphasize the more restrictive and controversial assumptions made in constructing the various benefit-cost measures.

The next recommended step is to display the summary benefit-cost statistics, either net present values (the difference between discounted benefits and discounted costs) or benefit-cost ratios. The information displays should convey concise information about a project's estimated effects (benefits and costs) and present the results of various sensitivity analyses to aid decision-makers in identifying the study's crucial assumptions.

Finally, the presentation of the measured benefits and costs should make clear that there may remain important unmeasured effects and that the

distribution of the project's benefits and costs may have important policy implications. Once the summary benefit-cost measures are presented, they must be carefully qualified to the extent that there are potentially important intangible or distributional effects associated with the project. These issues will be discussed in more detail. The novice can do this quite adequately, even if it is necessary to hire a consultant for one of the particular measurement tasks.

Essentially a concise and well structured report should provide a fairly detailed description of how the first seven steps of performing a benefit-cost analysis were accomplished. The last section of the handbook contains an illustration of a proper benefit-cost report.

SECTION 3

PROBLEMS OF MEASURING BENEFITS

3.1 OVERVIEW

This section will provide a fuller appreciation of the definition of benefits and introduce some of the more common methodologies for obtaining proper measures. Benefits are the total willingness to pay for all goods and services that are direct outputs of projects. Willingness to pay is accepted as the proper way of measuring value because it is the common yardstick used in market economies. To ensure that problems, such as environmental pollution are included (which cannot be adequately handled in an unregulated market economy) and yet to insure that double counting and inclusion of offsetting values are omitted, all of the direct outputs, but only direct outputs, are to be counted. If an analyst can keep these two points constantly in mind as he selects tasks and properly measures the correct benefits, a proper benefit-cost analysis should result. These points should be the basis for evaluating other benefit-cost reports, because it will be possible to dismiss those that err in measuring the wrong things or use an incorrect measuring method.

Listing the direct outputs and then determining which theoretically and practically can be measured are the main steps in a benefit-cost analysis. The last part comes down to determining if a demand curve, or at least a portion of a demand curve, can be established for the output in question. The demand curve is an amazingly useful theoretical concept as well as a very useful tool. It is at once more complex than the uninitiated might suspect and yet easier to apply than might appear. The reader should not become disillusioned at the abstract nature of next discussion and wonder about its place in this handbook. In many cases it will not be possible to obtain precise estimates of demand curves for all of the outputs of lakefront redevelopment programs. Therefore, there will be nothing in this handbook that will teach a novice how to derive a perfect estimate of the demand curve in every instance.

However using the admittedly difficult-to-apply concept of the demand curve allows a firm frame of reference for benefit-cost analysis. If one could be estimated in every case, the problem of doing a benefit-cost analysis might become as simple as adding a column of numbers. But keeping in mind a complete concept of a demand curve and what it is trying to measure will focus research efforts in the right direction. Used properly, it will insure that only proper effects are considered and that there is no double counting.

The remainder of this section will define demand curves and the related concept of consumers' surplus. We will discuss how demand curves are related to existing market prices and under what situations market prices are appropriate as measures of willingness to pay. There will be many times when this is not appropriate, especially for lakefront development projects, and procedures will be described to correct for this. In some cases, these descriptions will serve as actual cookbook-type instructions for performing the procedures. In other cases it will merely be possible to describe their strengths and weaknesses, the type of problem to which they are suited, and then show how the analyst can work with a professional if it is felt that a particular procedure is necessary. It is important to remember that each procedure is nothing more than an attempt to derive a measure of willingness to pay.

Finally, note that the project cost as far as formal benefit-cost analysis is concerned is the benefits foregone by precluding the use of the resources necessary to undertake the project from being allocated to another use. The use of this means the labor and material to produce a specified lakefront development project precludes their use elsewhere in the economy. The value of what these resources could have produced is the opportunity cost of the development. For example, if one of the inputs is cement, then in order to determine which people are willing to pay for cement for another purpose, it is necessary to study the demand curve for cement. Because opportunity costs are the foregone benefits caused by precluding the use of inputs elsewhere, the following discussion can be applied to the measurement of costs as well. It is only necessary to reverse the frame of reference and consider the demand curve for goods and services foregone. Section 4 will describe some of the special cases when measuring costs can be more difficult.

3.2 DEMAND CURVE: MARGINAL AND NONMARGINAL CHANGES IN OUTPUT

The basis for estimating willingness to pay is the demand curve. A demand curve can be defined as the relationship between the price of a product and the number people will purchase per period of time. It shows the maximum amount that can be obtained on the market when various amounts are provided in a given period.

In Figure 3-1, when 500 units are provided each period, the market price is $8. This means that willingness to pay for these 500 units is at least $4,000 because that is the amount paid on the market. The total value is somewhat greater than this because if the price were raised, the quantity demand would fall, but not to zero. Some people would pay more than the $8 market price. This extra amount, called consumers' surplus, can be represented by the area of the triangle ABC. Since the amount actually paid on the market equals the area of rectangle CE, the total willingness to pay for 500 units per period is area ACEO.

The importance of the concept of consumers' surplus can be explained in the this way. If a project will increase output of the hypothetical good from 500 to 700, then market price will fall to $6. How can willingness to pay for these extra 200 units be evaluated? Is the proper price $8 or $6? A useful way to look at the problem is to divide the total willingness to pay into what is actually paid on the market and the increase in consumer surplus. The 200 units sell for $6 each or $1200. Note also that the area of consumers' surplus has increased by BCGI. Of that, BCFI represents the decrease in price to existing consumers ($2 times 500 units or $1000) and CFG represents a bonus to new consumers in the sense that they are paying something less than they actually would be willing to pay. Assuming that the demand curve is a straight line, this amount can be obtained by multiplying 1/2 times $2 times 200 or $100. The total willingness to pay for the extra 200 units is therefore the sum of these three amounts or $2300.

In a different context, assume that there is a lakefront redevelopment project that will, in part, provide 200 new berths to moor pleasure boats. This is a direct output of the project, and so, in order to complete the benefit cost analysis, we must find out exactly what people are willing to pay for it. Assume that the demand curve pictured in Figure 3-1 is the demand curve for berths. Currently, there are 500 available and so the price will be $8. We can tell from the demand curve that when the extra 200 berths are made available, the market price will fall to $6. Therefore, these extra 200 units are worth at least $1200. Note, however, that the users of the original 500 berths now face a price of $6 rather than $8. Therefore they would be willing to pay at least $2 each to see the redevelopment project undertaken. This amounts to a willingness to pay of $1000. This is still not a complete picture because some of the people who rent the new produced berths, at the $6 rate, are paying less than they would pay rather than do without. The individual who would be most eager to rent would be willing to pay something just less than $8 while the marginal consumer is just barely willing to pay the $6 rental fee. The others are willing to pay something in between. This is demonstrated by the shape of the demand curve between points C and G. An estimate of the consumers' surplus for the new consumers can be found by averaging the extra willingness to pay over the 200 units. This is the same as finding the area of triangle CFG, which is 1/2 times $2 times 200 or $100. The grand total of willingness to pay for these extra 200 berths is the sum of these three or $2300.

This is an example of how to measure total willingness to pay when the output of the project is large enough relative to current production to force a reduction in market price. This will not always be the case, of course. If the existing number of berths was 50,000 rather than 500, the extra 200 would probably have very little, if any, effect on the market price. Therefore, after the completion of the project, the price would still be $8. The willingness to pay for the extra 200 units would then be $1600. With no decrease in price, there would be no consumers' surplus, and so the $1600 would be the total willingness to pay.

The practical lesson to remember from this analysis is that market price is a measure of willingness to pay, and for those direct outputs that are sold in markets, it can be a meaningful measure if the extra amount supplied is so small relative to the existing amount that no change in price is expected. In cases like this, the work of the analyst is quite simple. There is no need to know the entire demand curve, but only the existing price. When the extra output is large enough that a change in price will follow, it is necessary to take into account increases in consumer surplus as well as any revenue earned on the market. In these cases it is necessary to have information on the demand curve, and if no estimates can be found in the economic literature, then the services of a qualified econometrician will be necessary.

After discussing the nature of demand curves and consumers' surplus, it is important to see some restrictions on their use, and suggested ways of estimating willingness to pay when a formal demand curve cannot be obtained. A word of caution here is in order. It is not necessary to use every one of the following procedures on every benefit-cost analysis. In some cases, the methods will not be relevant because standard market prices will be appropriate, and in others the problem may be so small that a known deficiency in demand analysis can be safely ignored. For example, if one tenth of one percent of the dollar costs of a project are produced in a market where there are price ceilings (see the next section), it will not be worth the effort to find the difference between the market price and the correct social measure. The following discussion should be considered a list to consult when undertaking steps 4, 5 and 6 and a source of information if any of the methodologies are deemed relevant to the project.

3.3 RESTRICTIONS ON DEMAND CURVES

In cases of institutional interference in the market, the use of observed prices is not the proper measure to use in benefit-cost analysis, even when there is only a very small change in output. Price ceilings, price floors, and output controls are the most notable examples. It is possible to correct for this in a relatively straightforward manner.

3.3.1 Price Ceilings

Price ceilings are government decrees that the price of a certain product cannot go above a specified limit. Rent control is a prime example. A generally accepted maxim directly related to lakefront development is that access to lakefront recreational facilities should be free. In essence the price ceiling is set at zero. A further example would be the case of a fixed price for mooring spaces below the price that would exist in an unrestricted market. Whatever the product, if a price ceiling is binding (i.e., if the price would tend to be higher without the ceiling), the visible market price is not a reliable estimate of willingness to pay. Because people do not have to pay for the use of beaches does not mean that no value is being provided. Extra apartments

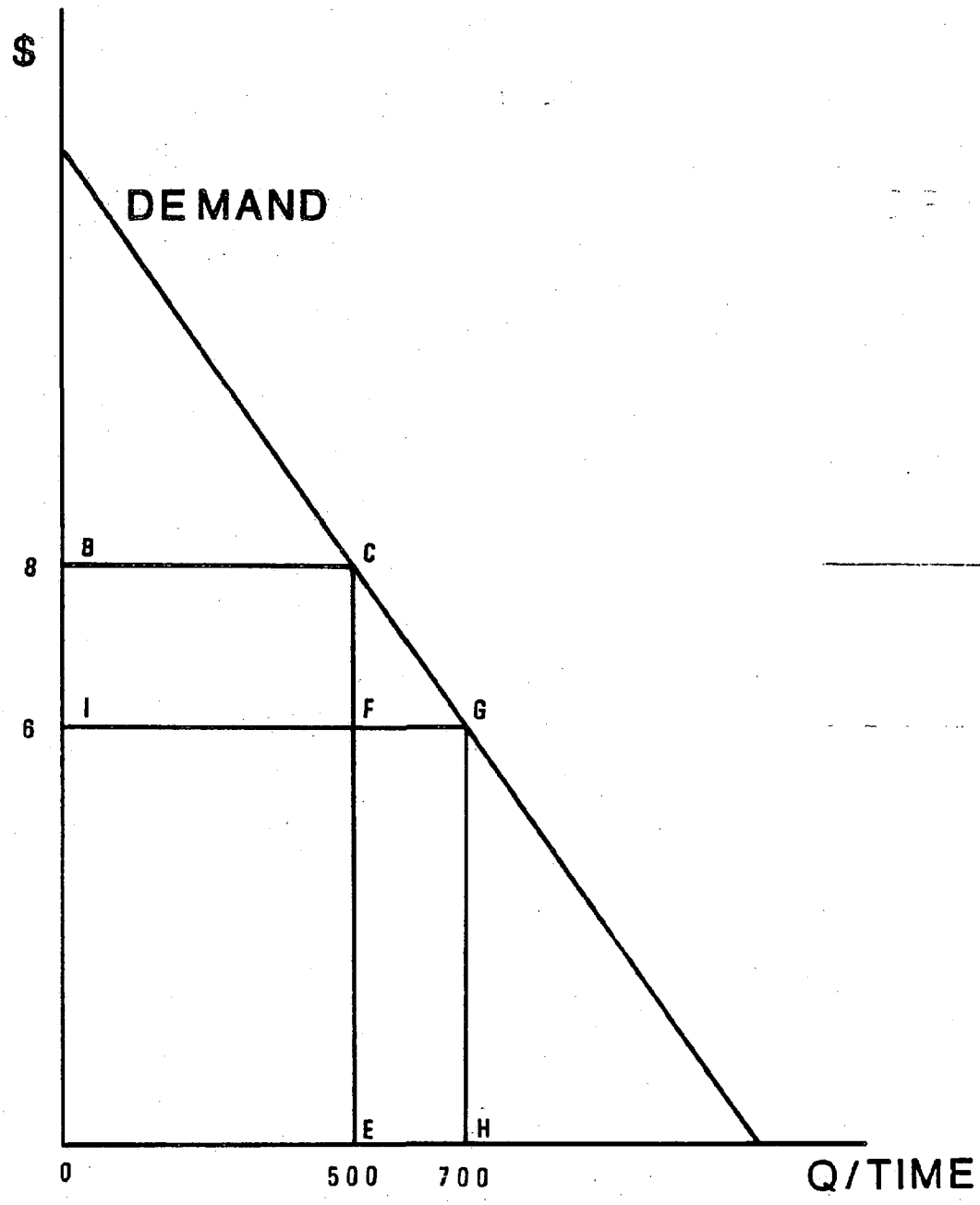

FIGURE 1 DEMAND CURVE

built in an area with rent controls will provide a value to consumers greater than the amount they pay in rent. In these instances, the analyst should strive to obtain an estimate of the true willingness to pay. An example of how to do this for recreation project follows.

Price ceilings also have an effect on the measurement of costs. When an input is produced in a market with a price ceiling, then as long as the amount used will be the result of new production and if the new production will not significantly affect total market output, the price ceiling is an adequate measure of cost. Producers will not produce it unless the regulated price at least covers the cost of production. The price ceiling merely separates the amount that people are willing to pay from the regulated market price; it does not affect the amounts people will sell at different prices. Where the inputs are taken from current production, then the willingness to pay rather than the regulated market price is the proper measure. It should be noted that in most cases any inputs from a market subject to price control used on a project will result in a decrease to current users because suppliers will be producing all they care to at the fixed price.

The reasoning behind this somewhat paradoxical rule is the basic definition of opportunity cost. If the output is from new production, the market price is the correct measure because it measures the cost of extra production (which is, of course, lower than willingness to pay because of the price ceiling). If the output is taken from current users, the willingness to pay is a measure of the value given up.

As an example, suppose that a lakefront project will use 1000 gallons of gasoline to operate heavy earthmoving equipment and that as part of a conservation-inflation program the government has fixed the price at 50¢ a gallon. At this low price the fuel companies cut back on their production, yet consumers want to purchase more. Therefore, in order to make the program work, rationing will be necessary. In the presence of the rationing system a black market in gasoline develops where the fuel sells for 75¢. If the City of Chicago is able to get the 1000 gallons it needs, how should the cost be measured? Although the budget cost of purchasing the gas will only be $500, the actual social opportunity cost will be $750 because that is the amount other people would be willing to pay for the gas if they had the opportunity.

The main point to remember when dealing with price ceilings is that the artificial price is not a real measure of what people are willing to pay. It is incorrect to use the fixed price as a unit value of outputs of the project or for the inputs used to undertake it; another measure is necessary. The existence of black markets is a good way to obtain a proper estimate, as is the method for estimating recreation demand which follows.

3.3.2 Price Floors

Price floors are the reverse of price ceilings. They are prohibitions that prevent the price of a particular good from falling below a set minimum. Agricultural price supports and minimum wage laws are common examples. If the price support is binding (i.e., it keeps the price higher than it would otherwise be), then the regulated price is not a suitable measure of willingness to pay. This point can be clearly seen by using the example of price supports in agriculture. In order to maintain a price above that which can be reached without intervention, the government must buy the "surplus" or the difference between what consumers will purchase at that price and the amount farmers are willing to produce. In this instance, it is easy to see that extra production by a proposed project surely should not be valued at the regulated price because there is more than consumers want at that price. The problem is to find out what use is made of extra goods produced and then obtain a measure of what people are willing to pay for it in that use. In the case of government storage of farm surplus, the value is negative because resources must be spent to store or destroy it.

To measure that cost of using inputs produced in a market subject to price floors, the source of the inputs must be determined. If they only reduce the surplus, the cost is negative because no extra resources are used and storage costs are eliminated. If they reduce the amount available to consumers or if they come from new production, the cost can be measured by the regulated market price. In the former case the regulated market price is the correct measure because it is what the people who do buy the goods are willing to pay (i.e., it is the amount they would lose if they could no longer consume it). In the latter, the regulated price is a proper measure of cost because it is the amount necessary to entice producers to expand production. (See example at end of next section.)

3.3.3 Output Controls

Output controls are regulations prohibiting production of a certain product beyond a certain point. They are quite similar to price floors except that the limit is on output rather than price. With price floors the price is held up by government purchase of any surplus beyond what consumers want at that price. Output controls accomplish the same thing by preventing the growth of output beyond the amount consumers want at that price. Output controls have no surpluses with which to deal. While the regulated price is a correct measure of what people are willing to pay for extra units of this good, if the output control is binding upon the project, it is obvious that the benefits will be zero because extra output will not be permitted. The cost of an input produced in a market with output controls is the market price because any units on the project will have to be transferred from other uses as long as the controls remain in effect. If the amount used on the project is large relative to the total market output, then losses in consumer surplus will have to be included as well.

It is doubtful that price floors or output controls will ever be a problem in estimating benefits from lakefront development. They may, however, raise difficulties in measuring costs. Assume that Q in the demand curve in Figure 3-1 represents an input for a project. If production is limited by government order to 700 units, then the price will be $6. This is the measure that should be used for cost when the project will take only a small percent of total production, regardless of how much it actually costs to produce the item. This is the amount that people are willing to pay for each unit, and is the measure of what they will lose if the inputs are reallocated to the project. In the case where the project will use a large portion of the amount supplied, then the losses in consumer surplus must be considered. For example, assume that the project will use 200 units of Q, and in doing so it will reduce the amount available to other consumers to 500. Therefore, the total loss to consumers will be area BCGHFI, which is equivalent to $2300 as was explained in the discussion of consumers' surplus. It should be obvious that this is just the reverse of providing 200 units of Q because as a result of project production, 200 units of Q will no longer be available to the public. Therefore, the net result is a $2300 cost rather than a $2300 benefit.

3.4 OTHER MEASURES OF BENEFITS

In those cases where the direct outputs of the project are goods and services not normally sold on the market, such as recreation or pollution causing waste products, other methods must be used to estimate willingness to pay. This section will review many of them. A reference supplied by the planning department entitled "A Preliminary Guide for Benefit Considerations in Economic Impact Studies" has a short section on this subject.[1] Since it is assumed that this work will be available to city workers undertaking or studying benefit-cost analysis, it was felt that it would provide a useful framework for this discussion. The book discusses methods but we will discuss only those that are directly relevant to lakefront development. A quotation from some of the relevant sections will be presented, with a brief discussion of how the method fits into our analysis, and to emphasize important points or add new material if necessary. Another method not described in the IIEQ study will be discussed. It should be remembered that it is not necessary to use each of the following methods in every benefit-cost analysis. The importance of each method depends upon the exact nature of the problem under study.

This material is intended to help measure benefits, and methods will have direct application to lakefront redevelopment, but in many instances it will be in terms of costs. That is, a certain project may not reduce environmental pollution but its construction may lead to some. The following quotes will have to be interpreted with this in mind.

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[1] "A Preliminary Guide for Benefit Considerations in Economic Impact Studies," Governors State University, Park Forest South, Ill., IIEQ Document No. 76/12, June 1976.

3.4.1 Monetization of Value of Materials Deterioration Resulting from Exposure to Pollutants

After adjusting the economic value of the material with respect to economic life and the percentage exposed to pollutants, the "value of interaction" is calculated by estimating the difference between the rate of materials deterioration in a polluted versus unpolluted environment. The adjusted economic value is then multiplied by the value of interaction to yield the value of materials deterioration.

Data on the effects of pollutants on many materials is unfortunately non-existent, and the sources and types of pollutants with which the materials are in contact at various times are in most cases difficult to identify.

This general type of approach is directly relevant to studies of changes in the structure and formation of the lakefront. Pollutants can often cause changes in wave patterns. In addition increased moorage spaces will mean increased boat usage on the lake. This will be accompanied by an increased amount of waste products, from the cooling systems, bilges, etc., being dumped into the water. Both the change in wave patterns and the increased waste products can affect the useful life of buildings and other structures. The costs of the project must include the value of output foregone because of the damage, or the costs of protection made necessary, whichever is smaller.

3.4.2 Monetization of Value of Materials Soiling Resulting from Exposure to Pollutants

Costs of increased supplies and manpower in maintenance of households and the environment over those which would be required at a lower level of pollutant are calculated.

This method probably does not measure the total impact of materials soiling, i.e., the aesthetic effect of viewing soiled properties whose owners will not or cannot afford to pay the cost of maintenance.

The same points discussed in subsection 3.4.1 apply here as well.

3.4.3 Monetization of Effects on Vegetation

Economic estimates are made of losses caused by specific pollutants on yield, quality, and marketability of agricultural products. Loss estimates usually concern visible, direct effects on values of agricultural, commercial horticultural and commercial forest crops.

Effects on wild and domestic vegetation are typically neglected because of difficulties inherent in measurement of the quantities affected. (Resource: Stanford Research Institute, 1970.)

It is expected that there will be minimal disruption of agriculture due to lakefront development, but the points raised here apply equally well to fauna, most notably fish. It is important to separate fish caught for commercial purposes from that obtained by recreationalists. The loss of the former can be measured by the decrease in profits of the commercial fisherman after they have had a chance to adjust to the biological disruption of the lake and if necessary, to other lines of work. To do this it will be necessary to measure the current profits of commercial fisherman and then determine how the disruption caused by lakefront development will affect the quality and quantity of their catch and their revenues. It will also be necessary to determine how the costs of operation will be affected, if at all. Using this information the decrease in profits can be determined. The measurement of recreational fishery losses is more difficult to determine.

3.4.4 Effects on Residential Property Values

The relationship between property value and various factors related to influences on that value (percentage of homes in the area recently built, houses per mile, accessibility to business district, etc.) is established through standard multiple regression analysis. One of the contributory factors is assumed to be the mean concentration value of some pollutant. From this, an estimate can be calculated for the monetary property value of an incremental change in pollutant.

Given that conventional sources of statistical inaccuracy are controlled for, a question arises. "What is being measured?" — at best, it is the economic value of the purchaser's perception of deviations from environmental quality. Deviations which were not manifested before the purchase, or which senses cannot perceive, cannot be measured by this method. Thus, the value of the benefits is understated. (Resource: Plager et al., 1976.)

Environmental quality parameters that can be important in these analyses include turbidity of the water, noise and congestion of people using a park near residences and other negative influences; as well as such positive aspects such as increased flood and erosion protection and easy access to recreational facilities. Therefore lakefront development can have either a positive or a negative effect on land values, depending upon which influences are more powerful.

This is a useful measurement procedure if used and interpreted correctly. Several points should be made, however. First, these are studies that novice analysts should not undertake. They require a qualified econometrician who can properly set up and run the multi-variate regressions. It is easy to misstate the equation by omitting relevant variables, placing too much emphasis on the difference between pollutant levels. It is also possible that there will be a great deal of multicollinearity present which will require extra work on data selection.

Also, if certain things such as increased housing protection activities are included, using this measure can result in double counting. It is obvious that house protection activities are part of the reason for decreased property values in high pollution areas; therefore, counting them as a financial loss and then again as part of a reduction in property value will result in an overestimate of the cost. In those instances where most of the disruption results in the necessity of protective action, the most useful way to identify this cost will be to measure directly the protection costs involved and ignore the econometric analysis. Although this method may underestimate the true cost (i.e., property values may fall further because the protective devices are not completely effective), it can provide reliable lower bound estimates of this cost. It will also mean that the services of an econometrician will not be required.

3.4.5 Willingness to Pay Survey

A representative sample of the population is asked what they would be willing to pay for a particular (descriptive) increase in environmental quality. An alternative is polling a representative sample to discover what they would be willing to pay to forestall environmental deterioration in some respect.

The pattern of responses in such a survey may be biased by many factors such as respondents' ignorance of pollution costs. Extreme care must be exercised in formulation and administration of the questionnaire and in interpretation of results. (Resource: Fischer, 1975.)

The section briefly covers a method that can be more useful than indicated. The problem is getting people to reveal their true feelings. They will most likely underestimate their willingness to pay if they believe that as a result of the questionnaire they may be taxed to pay for the services they use. If they feel they will not be taxed and the results could have an effect on future provision of services, they may overestimate it. It is hard to predict which of these biases will be stronger. To correct for this it is necessary to phrase the questions properly and attempt to ask for the same information in different ways in different parts of the questionnaire. Hammack and Brown[1] provide a useful illustration in their study of the value of waterfowl and wet lands. In one part of their questionnaire, they ask the respondent to estimate the smallest amount he would take in exchange for his right to hunt waterfowl for a season. Later they ask by how much his costs would have to increase before he would stop hunting voluntarily. Both answers give estimates of willingness to pay. These estimates were then regressed against such things as income, seasons hunted,

[1] Judd Hammack and Gardner Mallard Brown, Jr., Waterfowl and Wetlands: Toward Bioeconomic Analysis, Resources for the Future, Inc., Washington, D.C., 1974.

success rates, etc. The regression equation provides a relationship between willingness to pay and various attributes of a given population.

It is beyond the scope of this report to give a detailed description of how to construct a survey instrument that will obtain unbiased information. Adequate treatment of the topic would require a manual as large as the present volume. The Hammack and Brown illustration does show one way to approach the problem. It is recommended that anyone attempting to try this technique on his own read very carefully the Hammack and Brown book, as well as some of the references contained therein to become more aware of the theory and methods involved. Other useful sources may be found in the reference section of the report; especially useful is the National Academy of Sciences report, Assessing Demand for Outdoor Recreation. It should be remembered that this technique is very exacting and expensive, and in most cases should only be used with the help of a qualified individual.

3.4.6 Impact on Recreation Site Demand as a Function of Travel Cost

The recreation site becomes the focus of concentric geographic zones of visitor origin, defined by round trip travel cost between zone and site. The frequency of visitor origin from each zone is estimated by sampling visitors at the site. This frequency and population data are used to calculate a visitation rate in days per capita (demand) for each zone of origin. Using socioeconomic data gathered for each zone on factors such as average income, median educational attainment, etc., and travel cost, a regression analysis is used to test the hypothesis that travel cost partially determines visitation rate. Once the functional relationship between travel cost and visitation rate has been determined, it is assumed that changes in admissions cost would have an effect on the visitation rate equivalent to the travel cost function. The cumulative behavior of the zones' demand functions for the recreation site is then estimated by calculating levels of visitation rate for travel cost, plus incremental changes in admission cost. This relationship is then used to monetize the willingness of visitors to pay with the input of estimated changes in demand for a site due to changes in some environmental quality criterion, such as fish caught per angler trip or level of boating activity.

The relationship between environmental quality and recreation site use is generally quite difficult to estimate with confidence. Additionally, assumptions must be made in applying the method as formulated which place limits on its range of application. The primary purpose of the trip is assumed to be the visit to the site. Perhaps an even more limiting assumption is that there are no close substitutes for the site in the area. (Resource: Clawson and Knetsch, 1966; Reiling, Gibbs and Stoerener, 1973.)

An empirical study which addresses problems arising from the latter assumption is Burt and Brewer, 1971.

Perhaps a better grasp of the method can be obtained by reviewing a very simple hypothetical example as presented by Knetsch and Davis:[1] assume a free recreation or park area at varying distances from three centers of population given in the table below.

Visits to a Hypothetical Recreation Area

City	Population	Cost of Visit	Visits Made	Visits/1,000 Population
A	1,000	$1.00	400	400
B	2,000	3.00	400	200
C	4,000	4.00	400	100

The cost of visiting the area is of major concern and would include such items as transportation, lodging, and food cost above those incurred if the trip were not made. Each cost would vary with the distance from the park to the city involved. Consequently, the number of visits, or rather the rate of visits per unit total population of each city, would also vary.

The visits per unit of population, in this case per thousand population, may then be plotted against the cost per visit. A line drawn through the three points of such a plot would have the relationship given by the equation of $C = 5 - V$, or perhaps more conveniently $V = 5 - C$, where C is the cost of a visit and V is the rate of visits in hundreds per thousand population. This information is taken directly from the tabulation of consumer behavior. The linear relationship assumed here is for convenience. Actual data may very well show, for example, that $1.00 change in cost might have only a slight effect on visit rate where the visit is already high in cost, and a large effect on low-cost visits.

The construction of a demand curve of the recreation area, relating number of visits to varying cost, involves a second step. Essentially, it derives the demand curve from the equation relating visit rates to cost, by relating visit rates of each zone to simulated increases in cost and multiplying by the relative populations in each zone. Thus we might first assume a price of $1.00, which is an added cost of $1.00 for visits to the area from each of the three different centers used in our hypothetical example. This would have the expected result of reducing the number of visitors coming from each of the centers. The

[1] "Comparison of Methods for Recreation Evaluation," by Jack L. Knetsch and Robert K. Davis, from Water Research, edited by Allen V. Kneese and Stephen C. Smith. Copyright 1966 by The Johns Hopkins Press for Resources for the Future, Inc.

expected reduction is estimated from the visit-cost relationship. The total visits suggested by these calculations for different prices or differing added cost are given as:

Price (added cost)	Quantity (total visits)
$0.00	1,200
1.00	500
2.00	200
3.00	100
4.00	0

These results may then be taken as the demand curve relating price to visits to the recreation area. While this analysis takes visits as a simple function of cost, in principle there is no difficulty in extending the analysis to other factors important in recreation demand, such as alternative sites available, the inherent attractiveness of the area in question or at least its characteristics in this regard, and possibly even some measure of congestion.

This method is most useful where there are distinctive travel and cost patterns for different users, and, therefore, is often not useful for estimating the value for urban recreational sites, especially if most of the users live within walking distance. If a significant number of the users of improved lakefront recreational sites must use their car or some form of public transportation and if they can be broken into meaningful categories by travel cost, this method can be used.

3.4.7 Reduction in Cost of Avoidance

This method usually involves surveys of private expeditures on items and actions intended as a defense against environmental pollutants. Consideration might be given to purchase of bottled drinking water, air conditioning equipment, outlays for sound deadening, etc. Care must be taken to separate environmental effects caused by human activity from those naturally occurring, over which little or no control may be exercised. Since most defensive expenditures are likely to be less than 100 percent effective, the true benefits of improvement will usually be underestimated. (Resource: Barrett and Waddell, 1973.)

3.4.8 Reduction in Cost of Treatment

When an environmental resource can be considered a public good or as a factor input to a commercial production process, some expenditures for treatment of a pollutant may be required before the resource is usable (i.e., water treatment). An improvement in environmental quality can then be monetized as the resultant amount of reduction in treatment cost. Other interactive effects of the process and result of the environmental improvement should be noted and accounted for. Other

production costs and consumer reactions could substantially affect the analysis. (Resource: Federal Water Pollution Control Administration, 1966, pp. 71-74.)

A discussion of the intricacies of this and other production cost savings and producer/consumer surplus oriented analyses can be found in Freeman, 1975.

These two methods will likely be very relevant for lakefront development, but in the cost rather than the benefit column. The construction of parks may have a serious effect on the supply of drinking water and the increase in cost to avoid this or to treat the water, must be measured and included as a cost of the project.

3.4.9 Damages Awarded as a Result of Litigation

A survey is conducted of monetary awards and the reasons for the awards in an effort to discover the dollar value of an environmental impact as decided in the courts of the area under consideration. An indicator is also obtained of the frequency of instances in which injured parties in the area seek redress in the courts. With this information, monetary awards can be defined as a function of pollutant level.

Difficulties arise when an attempt is made to apply this method. Residents of urban areas appear less likely to seek private legal action than those in rural areas in the case of air (and perhaps other types of) pollutants. It has been suggested that urbanites are conditioned to relatively higher concentrations of some pollutants, or that metropolitan congestion masks the identity of specific polluters. At any rate, the small number of cases to consider may cause the method to falter from lack of data. (Resource: Havighurst, 1969.)

This method has a lot of problems, the most important of which is that there is no reason to believe that courts use willingness to pay as a criterion in assessing damages. Unless the judge or jury are clairvoyant, they must make an estimate in much the same way as discussed here if they are going to be correct. If they do, then it would be more useful to fall back on the original estimates. If they do not, the values assessed really have no meaning as far as benefit-cost analysis is concerned. Unless it is clear that willingness to pay is the standard used by the court, this method should not be used except for illustrative purposes.

Other ways of measuring benefits not mentioned in the IIEQ study follow.

3.4.10 Value of Time

Certain lakefront redevelopment plans may necessitate a change in traffic patterns and the change in commuting time should be included in the analysis for accuracy. The benefit of decreases in travel time (or cost in the case of increases) is what people are willing to pay for it. There are two ways of looking at this. The first is to measure the net value of goods and services that can be produced in the time that is saved. The second is to attempt to measure the valuations that individuals place on time. The first is subject to many pitfalls, the strongest of which as it relates to types of projects we are dealing with, is that it is unlikely that any extra output could in fact be produced in the amounts of time to be saved. The people affected may all be on leisure time, and even those who are going to work will not be able to convert the extra time into output because of union contracts and other institutional restrictions.

The second approach can be more useful and some of the particular methods are quite simple to handle. The basis for most of them are the actions of individuals who have a choice of several means of transportation where they can reveal their preference for time savings versus extra cost. By noting the differences in travel time and costs between a chosen method and a relevant alternative for a group of individuals making a similar trip, (i.e., an alternative where all factors such as comfort, service, etc. are reasonably similar) it is possible to estimate the trade-off between the two. For example, one very simple method is to plot these differences on a standard four quadrant diagram. See Figure 3-2. Each point represents the combination of cost and time difference for one person. Those in the fourth quadrant represent individuals who are willing to give up money to save time, while the opposite holds true for points in the second quadrant. Individuals represented in the third quadrant are somewhat irrelevant to the analysis because the method they use is the cheapest and fastest available. It is unlikely that there will be any points in the first quadrant because that would represent a travel mode that is more expensive and yet slower than any alternative.

A rough but workable estimate of the relationship between time and willingness to pay can be found by drawing a straight line through the origin such that the minimum possible number of points lie to the northeast of it. The slope of this line can then be used as an estimate of how people value travel time. In our hypothetical example, the trade-off is $.35 for every 15 minutes. The justification price is that it will minimize the number of people who are made to appear irrational. Note that at point B, the individual gives up something less than 15 minutes in order to save $.35, and given the $.35 for 15 minute price he has made a correct choice. Individual A, however, gives up more than 15 minutes to save the $.35 and given the price he should have chosen the alternative method. Obviously, this is not a perfect

method but it can provide a useful approximation with little formal analysis. Using this method of British data, it was estimated that the trade-off was somewhere between 30 percent and 50 percent of the wage rate for a comparable time period.

3.5 COMPARISON OF MEASUREMENT METHODS

In all a total of 10 methods of estimating willingness to pay for certain types of benefits have been presented. It will prove useful to compare and contrast their relative usefulness. This can be done by combining them into several different types of categories. To begin with, subsection 3.3.9 would be best ignored. For the reasons stated, the only time it will be of any use is when professional social scientists have been used by the court to ascertain willingness to pay. And if this is the case, this method should be more properly called a literature review where all research done in the area, not just court cases, is studied to determine if appropriate measures have been obtained.

Subsections 3.4.4, 3.4.5 and 3.4.6 and the value-of-time method are quite useful for their stated purpose but will in general require professional assistance. Subsection 3.4.6, the so-called travel cost method for estimating recreation benefits is a possible exception if the analyst is familiar with basic regression techniques so that he can find the relationship between visits per thousand population and travel cost.

The problem of measuring the value of time as discussed can be a very useful method. For all practical purposes it may not be necessary to use it, because the results of many different studies have been quite similar. In almost all cases where this method was used, it was found that the trade-off value of money for time was between 30 percent and 50 percent of the hourly wage rate. Unless there is reason to believe that individuals in Chicago who will be affected by the lakefront redevelopment are significantly different than people studied in other research, it makes sense to use these figures. That is, if one of the direct outputs of a lakefront development project is 4,000 total hours of decreased travel time per year, then a suitable estimate of the benefits would be 30 percent to 50 percent of the average wage rate times 4,000.

The other methods can be undertaken by the diligent novice, keeping in mind that the object of the research is to find the willingness to pay for direct outputs of the project. This provides the basic framework for proceeding with any of these methods. The exact use of each method will vary with every project and with each case within a project, so it will not be possible to show a step by step procedure, but some general guidelines are possible. All of the methods are similar in that they can be broken into two steps. First, it is necessary to specify the exact effects of the project and second, determine the cost savings or actual expenditures associated with them. For example,

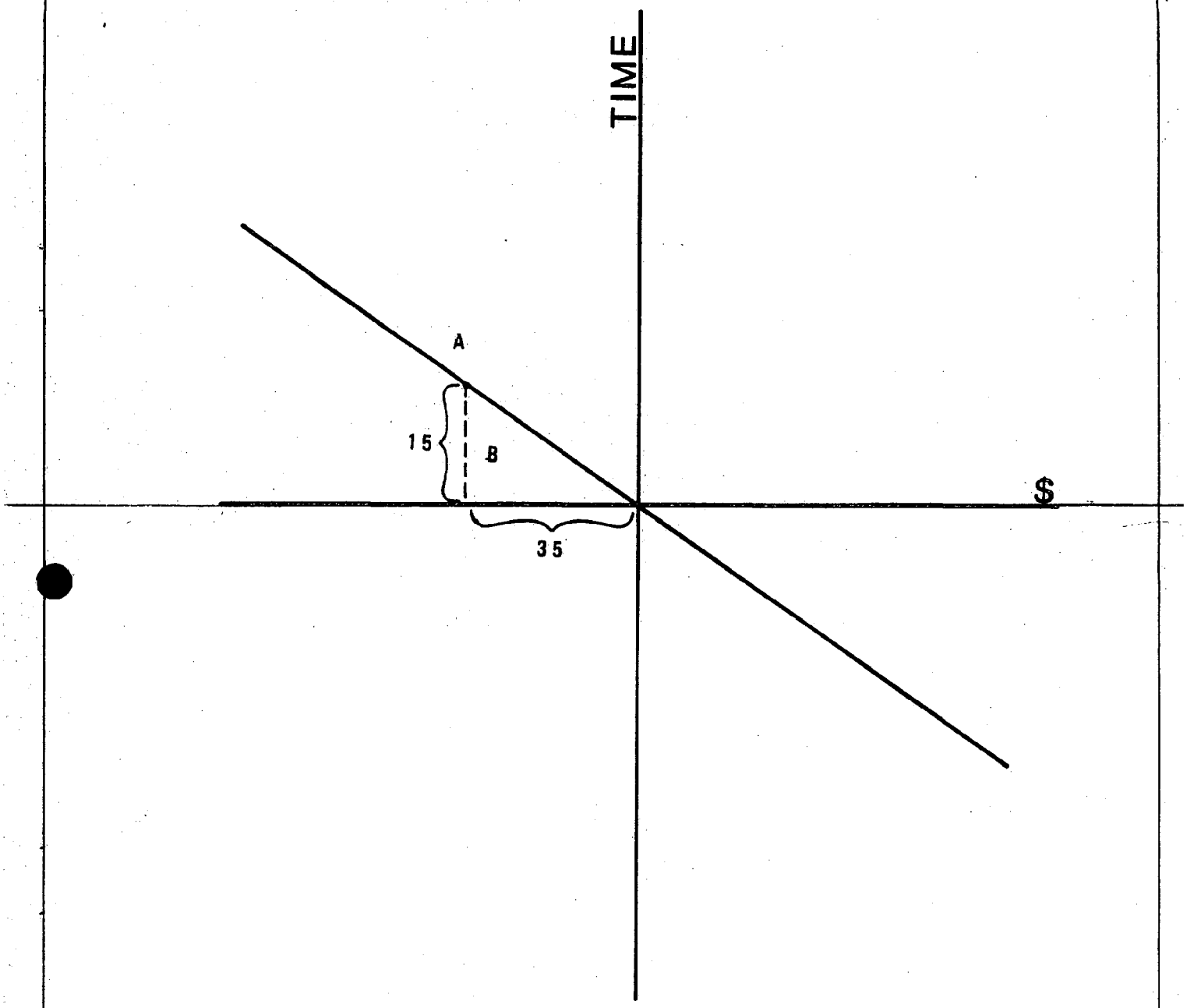

FIGURE 2 VALUE OF TIME

consider the case of materials soiling or deterioration, or of vegetation destruction. It is necessary to determine (1) how much soiling or deterioration will be prevented (or caused) and (2) how much money will be saved (or spent) as a result. A conscientious novice, familiar with the project, should have no trouble in digging up enough data from the industries involved to come up with very reliable estimates of both the physical amounts and the dollar savings.

It should be stressed again the appropriate role these methods play in a benefit-cost analysis. Willingness to pay can be measured by the market price in many instances. When there is a non-marginal change in output, it will be necessary to have some idea of the relevant portion of the demand curve in order to determine consumers' surplus. For much of the work this is all that is necessary. In some cases, many of the outputs of a project will not be sold on a market. In these cases, other ways of determining willingness to pay must be used. This is the purpose of the methods described in this section.

SECTION 4

PROBLEMS OF MEASURING COST

4.1 GENERAL

The costs of a project as far as benefit-cost analyses are concerned are the benefits of the foregone alternatives. Therefore the discussion of benefits in Section 3 applies to costs if interpreted correctly. There are several special problems areas with the measurement of costs, however, that merit special attention. Three of these, unemployment, taxes and subsidies, and monopoly, will be discussed below.

4.2 UNEMPLOYMENT

If a project will employ resources otherwise unemployed, the social cost of doing so is zero. The resources were producing nothing and so there are no losses from transferring them to the project. For purposes of lakefront redevelopment, labor and perhaps some shorefront land may be unemployed and as such must be given careful consideration.

The project may also employ productive factors that would have otherwise been under-employed (rather than unemployed). The social cost of utilizing under-employed resources is not zero, but equal to the value of output they would have produced in their alternative jobs. Unfortunately, it will generally be very difficult to determine the extent to which a productive factor is under-employed, so it is recommended that this particular distinction be ignored, unless the availability of appropriate data warrants otherwise.

Several points should be made clear. The actual financial cost of hiring or purchasing unemployed resources will definitely not be zero, only the social cost of using them. This is an important difference between a benefit-cost analysis and the financial statement of a project. The former is a decision-making tool used to decide whether the project should be built or not, while the latter provides information on what the dollar cost of the project will be.

Another important point is the reason for the use of the resource. If workers are unemployed because of the national economic situation, that is one thing, but if a piece of land sits idle because of local government decree, that is quite another. In the latter case it should be emphasized that the zero opportunity cost is due entirely to the government restriction. If the same governmental organization is going to make the ultimate decision on the project, they should be aware of the actual opportunity cost if their restriction were lifted.

A final point is that it is doubtful that there is either 100 percent employment or unemployment of any labor type, so appropriate percentages

will have to be applied to the labor bill after checking various unemployment rates. Also, if construction is to take many years, care must be taken to correct for predicted changes in employment rates over time.

4.3 TAXES AND SUBSIDIES

When measuring the cost of inputs it is important to consider possible distortions caused by taxes or subsidies. For example, if there is a 15 percent excise tax on a certain item, then the purchase price including tax cannot be used as a proper measure of opportunity cost. The tax is merely a transfer from the consumer to the government; it is not an actual cost of production. Similarly, if an input is produced in markets where there are government subsidies, the market price will be an underestimate of the actual cost of production. If these types of items are a significant part of financial cost, it should be adjusted appropriately to obtain a measure of social opportunity cost. In cases where taxes are directly related to the provision of government services that are inputs to the project, they should be treated as normal costs. For example, if fees for construction permits are used to pay city inspectors for their work on development, then such fees should be treated as a social cost of the project.

Along the same line, if the Federal government provides a subsidy in the construction of a project in an area, this does not lower the actual cost of the project. It merely lowers the cost that the local government undertaking the project has to pay. To be formally correct, the subsidy should be ignored in benefit-cost analysis, unless there are special reasons why a narrow local government accounting stance should be used.

4.4 MONOPOLY

In a similar vein, any items produced in monopolistic markets have a market price that is higher than the true social cost of production. Imperfect competition will, in general, lead to market prices being greater than the marginal social cost of production as long as the imperfectly competitive firms seek to maximize profits. (This conclusion may not hold for firms seeking to attain some other objective, such as maximizing market share subject to earning some minimal profit.) The profit-maximizing monopolist's price includes a monopoly profit as well as the cost of inputs. To be precisely correct in measuring the social cost of inports, their market price should be corrected for the monopoly profit. This is a difficult task. In most cases it can safely be ignored. In instances where a large part of the financial cost is for inputs that are produced by these types of producers, efforts should be made to include this information in the analysis.

SECTION 5

COMPARISON OF BENEFITS AND COSTS IN DIFFERENT PERIODS OF TIME

It is obvious that in most cases the benefits and costs of a project will be provided over a period of years. The existence of a positive rate of interest is evidence of the fact that consumption now is worth more than consumption in the future; else, why is it necessary to pay a premium in order to get consumers to give up the right to consume in the present? This being the case, it is necessary to formulate a method whereby benefits and costs in different periods can be made comparable. The proper way of doing this is by discounting. This section will describe the process of discounting and provide some analysis on selecting the discount rate.

If M_o represents an amount of money (say, $1,000) and i is the interest rate (for instance, 8 percent), then by loaning it out it is possible to obtain M_1 a year from now (in this example, $1,080) where:

$$M_1 = M_o\ (1 + i)$$

Similarly, if it is loaned out for two years it is possible to obtain M_2 in two years, where:

$$M_2 = M_1\ (1 + i) = M_o\ (1 + i)(1 + i) = M_o\ (1 + i)^2$$

In general terms, at the end of n years, it is possible to obtain M_n where:

$$M_n = M_o\ (1 + i)^n \quad .$$

M_n can be called the future value in n years of M_o with an interest rate of i. By simple algebra it follows that the present value of M_n (a specified amount n years in the future) can be represented by:

$$M_o = \frac{M_n}{(1 + i)^n}$$

The benefits and costs in different years can be made comparable by transforming them all to present values. Because they will then be measured in the same units, it is permissible to add them to obtain a total present value of all benefits or costs. In order to obtain a single measure of value of a project that provides benefits B_1, B_2, B_3,...B_n, in years 1, 2, 3,...n, respectively the following equation can be used.

$$\text{Total discounted present value of benefits} = \frac{B_1}{1+i} + \frac{B_2}{(1+i)^2} + \frac{B_3}{(1+i)^3} + \ldots \frac{B_n}{(1+i)^n}$$

The analysis is exactly analogous for comparing costs of a project that occur in different years.

$$\text{Total discounted present value of costs} = \frac{C_1}{1+i} + \frac{C_2}{(1+i)^2} + \ldots \frac{C_n}{(1+i)^n}$$

To illustrate the use of these formulas, consider the following example. Suppose that a city project is expected to yield annual benefits over a three-year period worth $100,000 in the first year, $50,000 in the second, and $200,000 in the third. The anticipated costs of the project are $175,000 in the first year, $140,000 in the second year, and zero thereafter.

What is the present value of these benefits and costs? According to the above formula, the discounted present values are (assuming a discount rate of 10 percent):

$$\text{Discounted benefits} = \$282,400 = \frac{\$100,000}{(1.10)} + \frac{\$50,000}{(1.10)^2} + \frac{\$200,000}{(1.10)^3}$$

$$\text{Discounted costs} = \$274,715 = \frac{\$175,000}{(1.10)} + \frac{\$140,000}{(1.10)2}$$

Using a discount rate of 10 percent, the discounted benefits in this example exceed the discounted costs, suggesting that this particular project is worthwhile on economic efficiency grounds.

The importance of the discount rate is easily illustrated within the context of this example. Suppose that we have discounted the stream of benefits and costs with a 20 percent discount rate rather than a 10 percent rate. With this one change, the discounted benefits would fall to $233,800, whereas the discounted costs fall only to $242,935. At this higher discount rate, it now appears that this hypothetical project is no longer desirable on economic efficiency grounds. Clearly, whether this particular project enhances economic efficiency depends upon the opportunity cost of the funds and resources committed to it. This opportunity cost is reflected by the discount rate.

A further illustration of the importance of the discount rate is provided by Table 5-1. This table indicates the present value of $1,000 discounted over various time periods at selected discount rates. When the discount rate is zero, the present value and future values are identical, since a discount rate of zero implies an indifference between equal amounts in the present and the future: $1,000 now is the same as

$1,000 30 years from now. However, as the discount rate is increased, future effects begin to diminish in relative importance. For example, $1,000 to be received 30 years from today is worth only about $2 today when discounted at 15 percent.

Table 5-1

Present Value of $1,000 for Various Time Periods and Discount Rates

Number of Years Until $1,000 Benefit Received	Discount Rate				
	0%	3%	7%	10%	1
5%					
1	$1,000	$971	$935	$909	$870
5	1,000	863	713	621	497
10	1,000	744	508	386	247
20	1,000	554	258	149	61
30	1,000	412	131	57	2

While there is controversy over what constitutes the appropriate procedure for calculating a discount rate, in many instances this controversy need not concern the benefit-cost analyst. It will often be the case that the exact value selected for the discount rate will not affect the outcome of the benefit-cost study. For example, some projects offer such a high rate of return that they would appear desirable according to benefit-cost criteria regardless of the discount rate used. However, the exact value of the discount rate is important in situations involving mutually exclusive projects, budget-constrained agencies, or projects that appear efficient for some discount rates, but inefficient for others.

The conventional method for identifying those instances in which the value of the discount rate is important is to perform a sensitivity analysis, that is, to calculate the present value of benefits and costs for some alternative discount rates. The analyst should select a relatively low discount rate (e.g., 5 percent) and a relatively high rate (e.g., 20 percent) to test the sensitivity of the benefit-cost estimates to the discount rate. If it is determined that the benefit-cost measures are relatively insensitive to changes in the discount rate, the matter essentially ends there; however, if the study's findings are sensitive to the discount rate selected, the analyst must make that fact known to policymakers so that they can make their own judgments about the appropriate magnitude for the discount rate.

During periods of inflation, the analyst must take care to avoid having inflationary effects influence the findings of the benefit-cost study. To illustrate how inflation can affect a benefit-cost analysis and how inflationary influences can be eliminated, consider the following simple example.

Suppose a proposed project offers an estimated annual net benefit stream (assuming no inflation) of $100,000 over three years for an immediate outlay of $249,000 -- an implicit rate-of-return of 10 percent. Supposing further that the cost of funds to the City is 8 percent, the proposed project would appear desirable according to benefit-cost criteria since discounting the future benefits at 8 percent yields a present value of benefits equal to $258,000.

Suppose, however, that an annual 5 percent inflation is anticipated for the foreseeable future. If this expected inflation is incorporated into the estimated future benefits, the benefit stream (rather than being $100,000 annually) would be $105,000, $110,000, and $116,000, respectively, for each of the three years. Obviously, discounting this benefit stream at 8 percent would yield an even higher present value of benefits than $258,000, apparently suggesting that anticipated inflation enhances the efficiency value of a project. However, this suggestion should be rejected on the grounds that the 8 percent discount rate (assumed appropriate for a non-inflationary period) is no longer appropriate in this situation. If financial markets have fully adjusted to the anticipated 5 percent inflation, we would expect the private opportunity cost of funds to rise in tandem with the rate of inflation. In the absence of inflation, a $100,000, one-year investment in the private sector would, on the average, return $108,000 after one year (an 8 percent return). With a 5 percent inflation expected, the payoff at the end of the one year would presumably be $113,400 ($108,000 x 1.05), for a nominal rate-of-return of 13.4 percent. Thus, a 5 percent fully anticipated inflation can be expected to increase the private opportunity cost of funds from 8 percent to 13.4 percent (in the present example).

Using a discount rate of 13.4 percent to calculate the present value of the three-year time stream of inflated benefits ($105,000, $110,000, and $116,000) yields exactly $258,000, which is the same estimate obtained for the non-inflationary situation.

The conclusion one can draw from this analysis is that inflation can be appropriately handled by either of two methods: 1) estimate all future benefits and costs in constant prices (that is, simply assume no inflation in the estimation of future effects) and use as the discount rate an estimate of the private opportunity cost of funds in the absence of anticipated inflation, or 2) estimate all future effects in inflated prices and use as the discount rate an estimate of the private opportunity cost of funds in the presence of anticipated inflation.

Unfortunately, regardless of the approach taken, the analyst will encounter difficulties that are not easily resolved. The first approach requires the analyst to make some judgment about the private opportunity cost of funds in an inflationless setting. When inflation is anticipated, the perceived or nominal return to private investment contains an inflation premium that may be very difficult to estimate. If the current rate of inflation is used as an estimate of the inflation premium, it will

sometimes be the case that the implied "real" return to private expenditures will be negative. On the other hand, if the second approach is used, the analyst must contend with the problem of predicting the rate of inflation for many years into the future.

In practice, it appears to be the case that most analysts estimate future benefits and costs in constant prices, that is, they ignore inflation in the estimation of benefits and costs. As an approximation to the private opportunity cost of funds in an inflation-free setting, it is common practice to arbitrarily select a "plausible" rate of return (e.g., 10 percent) for discounting the benefits and costs of public sector projects.

There is a great amount of literature on the proper discount rate to use but it is too long and complex to review here. In keeping with our concept of opportunity cost, there is agreement among many economists that the rate chosen should be no lower than the rate of return to capital in the private sector. With existing income tax laws, it is likely that this rate is somewhere around 20 percent. Because the discount rate can be so critical, it is wise to use a sensitivity analysis to see how the results vary with different rates, say between 5 percent and 20 percent.

For city (or regional) projects with narrowly defined accounting stances, the rate at which the governmental unit can borrow can be used as a discount rate for city projects. If a city can borrow funds at, say, 8 percent, then city officials can increase local welfare by undertaking all projects yielding implicit rates of return in excess of 8 percent. Consequently, the cost of borrowed funds (8 percent in this example) would be the appropriate rate to use in discounting future benefits and costs of city projects. (For further discussion of these and related issues, see R. Musgrave and P. Musgrave, Public Finance in Theory and Practive, 2nd Edition, New York: McGraw-Hill, 1976; and E.J. Misham, Cost-Benefit Analysis, 2nd Edition, London: George Allen and Unwin, 1975.)

SECTION 6

ALTERNATIVE BENEFIT-COST CRITERIA

There are a number of alternative criteria for accepting or rejecting projects. These various criteria and their associated decision rules (which account for efficiency effects only) are:

Criteria	Decision Rule
1. Benefit-cost ratio, B/C (the ratio of the present value of benefits and costs).	Accept if B/C is greater than 1; reject if B/C is less than 1.
2. Net present value, B-C (the difference between the present value of benefits and the present value of costs).	Accept if B-C is greater than 0;
3. Internal rate of return (the implicit rate of return offered by the project).	Accept if the internal rate of return exceeds the private opportunity cost of capital, otherwise reject.

As an illustration of these criteria, consider a project costing $249,000 and providing $100,000 in annual benefits for three years. Assuming an 8 percent discount rate, we obtain the following:

B/C = $258,000/$249,000 = 1.04

B-C = $9,000

Internal rate of return = 10 percent.

All three decision criteria reveal that, on efficiency grounds, the project should be undertaken.

If only one project is under considerations, or if there is no budgetary constraint so that all acceptable projects can be undertaken and all of the projects under consideration are independent of one another (ruling out mutally exclusive projects), then the analyst can use either benefit-cost ratios or net present values. Under these circumstances, the two criteria will agree as to the efficiency implications of a project.

Usually the internal rate of return criteria will yield results identical to the other two criteria. Unfortunately, it is sometimes possible for

a time stream of benefits and costs to imply more than one internal rate of return. For instance, consider a project involving an initial cost of $100,000, net benefit of $220,000 at the end of the first year, and a net second-year cost of $120,000. This time stream will yield internal rates of return of 0 and 20 percent, obtained by solving the equation

$$-\$1 + \$2.2/(1 + r) - \$1.2/(1 + r)^2 = 0$$

for r, the internal rate of return.

Suppose that the private opportunity cost of funds is to be 10 percent. Should such a project be undertaken? Is it a good investment yielding a return of 20 percent, or is it a poor one offering a zero return?

The best way to resolve this difficulty is to discount all future effects back to the present, using the private opportunity cost of funds as the discount rate. This approach yields $199,980 as the present value of the benefits and $199,125 as the present value of the costs, suggesting that at a 10 percent discount rate the project would be marginally beneficial. In fact, in this example, any discount rate between 0 and 20 percent would reveal that the project should be undertaken on efficiency grounds.

One might infer from this example that the two internal rates of return provide information about the maximum and minimum discount rates (0 and 20 percent) that would yield positive discounted net benefits. Under some circumstances such an inference would be correct, but under other circumstances it would be seriously misleading. To illustrate, let us simply alter the preceding example slightly, so that the time stream is $100,000; - $220,000; $120,000 (rather than -$100,000; +$222,000 -$120,000). This flow of benefits and costs also implies internal rates of return of 0 and 20 percent.

However, discounting these effects with rates between 0 and 20 percent yields discounted costs in excess of discounted benefits. Only if this time stream of benefits and costs is discounted with rates less than zero or greater than 20 percent would the projects appear acceptable on efficiency grounds.

While in some instances it may prove pedagogically useful to calculate and refer to internal (or implicit) rates of return, it is normally advisable for the benefit-cost analyst to rely upon the less ambiguous benefit-cost criteria, either net present values, or benefit-cost ratios.

Let us turn now to a situation involving mutally exclusive projects. (this analysis also applies to situations in which a budget constraint prevents an agency from undertaking all projects justified on benefit-cost grounds.) Consider two mutually exclusive projects with the following characteristics:

Project	Discounted benefits	Discounted costs	B/C	Net Present value
A	$ 2.0 mil.	$ 1.0 mil.	2.0	$ 1.0 mil.
B	$15.0 mil.	$10.0 mil.	1.5	$ 5.0 mil.

Using the benefit-cost ratios criterion, project A appears better than project B, whereas application of the net present value criterion suggests the opposite conclusion. Since only one of these projects can be undertaken (by assumption), which project should it be? This question is easily answered as soon as the discounted costs and benefits of the projects are made comparable.

If project A is undertaken, the agency would have an additional $9.0 million (the difference between the cost of projects B and A) to invest in other projects or perhaps to return to the taxpayers. The issue of whether project A is preferred to B on efficiency grounds depends on how the agency uses the funds it would save by undertaking A rather than B. Suppose that the $9.0 million could be employed in the next best alternative investment to yield discounted net benefits of $10.0 million. We now have the data needed to make the projects comparable. Taking into account the auxiliary $9.0 million investment if project A is adopted, we otain the following amended set of characteristics:

Project	Discounted benefits	Discounted costs	B/C	Net Present value
A (amended)	$12.0 mil.	$10.0 mil.	1.2	$ 2.0 mil.
B	$15.0 mil.	$10.0 mil.	1.5	$5.0 mil.

Both criteria now agree as to which project is more efficient. Once the projects have been made comparable, it becomes clear that project B in this example is the more efficient of the two.

As a general rule, the analyst should keep in mind that economic efficiency considerations in principle require an agency to expand its funds so as to maximize discounted net benefits. While it is common practice for agencies like the Corps of Engineers to rely upon the benefit-cost ratio criterion, we would nevertheless recommend that the net present value criterion be employed as the basic decision rule for benefit-cost studies. Unless the benefit-cost patterns of alternative projects have been made comparable (in the fashion outlined), use of the benefit-cost ratio criterion tends to undesirably bias the decision in favor of low-cost projects that, while yielding a high return per dollar expended, may fail to maximize the net benefits from an agency's activities when mutually exclusive projects are involved.

SECTION 7

RISK AND UNCERTAINTY

7.1 INTRODUCTION

The essence of benefit-cost analysis is the identification and measurement of a program's benefits and costs. Normally, a program's effects are experienced over some period of time, rather than immediately, so there are naturally some uncertainties or risks in attempting to predict the precise nature of these effects. The measurement of benefit and cost time streams in effect requires the analyst to predict--perhaps over very long periods of time--such things as changes in consumption patterns, population movements and trends, technological discoveries, and perhaps even weather patterns. Estimates of the longer-term benefits from lakefront development, may be of questionable reliability because of uncertainty over such things as future air and water quality, availability of alternative recreational opportunities, or long-term population trends in the area.

In this section some alternative approaches to handling the problems posed by risky or uncertain outcomes are discussed. Economists commonly draw a distinction between risk and uncertainty. "Risk" refers to situations in which information is available regarding the probability of an outcome's occurrence: "Uncertainty" refers to situations in which no such information is available. In this discussion, these terms will be used interchangeably to refer to all less-than-certain outcomes. It should be made clear that while the following methods provide the analyst with some alternative means of coping with risk and uncertainty, it is often the case that none of these methods are explicitly employed in benefit-cost studies. Frequently, problems of risk or uncertainty are handled rather subjectively with the analyst relying more upon "judgment" than any formal technique.

7.2 CUT-OFF PERIOD

One approach to dealing with uncertainty is to adopt some arbitrary cutoff (or payback) period. This is a time period past which all project effects are simply ignored. In the case of extremely risky projects the cutoff period might be as short as two or three years; in other cases it might be as long as 30 to 50 years. This strategy would result in the adoption (on efficiency grounds) of only those projects capable of generating sufficient (discounted) benefits prior to the cutoff to more than cover (discounted) project costs. This decision rule is analogous to the "payback" criteria commonly employed by businessmen in judging the desirability of investments.

Extremely short cutoff periods (e.g., two or three years) would seldom appear justified in evaluating public projects. Normally, public sector

investments are simply not risky enough to warrant such a limited time horizon. In addition, analyses conducted with short cutoff periods ignore all information related to periods past the cutoff. Even when there is considerable uncertainity about future outcomes, the analyst would probably be well-advised to avoid discarding or ignoring potentially useful information simply because it applies to periods past the cutoff.

Relatively long cutoff periods such as 50 or 100 years are more justifiable. The longer the period of time involved (other things equal), the greater is the presumed degree of uncertainity. The analyst can be more confident in predicting consumption or recreational patterns 5 years hence than in predicting such patterns 50 years hence. Moreover, as noted in Section 5, discounting tends to render effects occurring so far in the future relatively unimportant, so ignoring them seems justifiable in most circumstances.

An advantage of this approach is its simplicity: it is only necessary to select the cutoff point. The selection of any particular cutoff point is arbitrary, however, so few guidelines can be provided to assist the analyst in this particular task. Using cutoff periods shorter than 30 or 40 years is discouraged to avoid discarding potentially useful information.

7.3 DISCOUNT RATE ADJUSTMENTS

An alternative approach to coping with the problem of uncertainity about the magnitudes of future benefits or costs involves arbitrary adjustments to the discount rate (that is, the opportunity cost of funds). In order to err on the conservative side, if this approach is used, the adjustments should entail increases in the discount rate used to discount future costs. (Erring on the conservative side is desirable if policymakers are risk-averse; if they are risk-neutral or risk-takers, the conservative adjustments of this sort may not be beneficial.) This alteration will tend to reduce the magnitude of discounted net benefits by simultaneously reducing the magnitude of discounted benefits and increasing the magnitude of discounted costs. Consequently, this approach will result in fewer projects being adopted on efficiency grounds.

This procedure is probably preferable to the adoption of a cutoff period since it discounts, rather than completely discards, information about future effects. Nevertheless, it too involves some arbitrary decisions. The analyst must decide not only which portion of the time stream of benefits and costs should be discounted with the adjusted rates, but also what the magnitudes of the adjustments should be.

One way of reducing the arbitrariness in the selection of the adjustment magnitude has been suggested by Arrow and Lind. They recommend examining the rates of return being earned on similar investments in the private sector to determine the appropriate adjustment magnitude. If private lakefront developments were yielding a 13 percent before-tax rate of return whereas relatively riskless private investments were offering a 10

percent before-tax rate of return, then the appropriate adjustment magnitude would be 3 percent (the difference between the two rates). In accordance with these suggestions and in the context of this example, it would appear natural to discount future benefits from public lakefront developments with a rate of 13 percent. (That is, the before-tax rate of return being earned on similar private sector investments.) If the City can borrow funds at less than the 10 percent used in this example, the conclusion would be somewhat different. For instance, if the City could borrow funds at 8 percent, this adjustment would suggest that perhaps 11 percent (8 percent plus 3 percent) is the appropriate discount rate.

This approach helps to partially resolve the problem of uncertainty about future benefits and costs; however, as it tends to involve highly arbitrary decisions its attractiveness is reduced. The following is recommended. If it is possible to obtain estimates of before-tax rates of return to private investments in lakefront developments, discount rate adjustments may reasonably be made. If such estimates cannot be obtained, some other approach to coping with risk and uncertainty should be employed.

7.4 EXPECTED VALUES

Another method of explicitly introducing risk or uncertainty considerations into a benefit-cost analysis is to treat estimated benefits and costs as random variables that can be described by some probability distribution. Suppose that an analysis of historical weather patterns suggests that (other things equal) to average annual (discounted) benefits from a lakefront development project will range from $1 million (extremely poor weather conditions for the year) to $10 million (extremely good weather conditions). Suppose that we can identify only four possible outcomes and the probability that any given outcome will occur. (in practice the number of alternative outcomes would be much larger.) This information could then be summarized as follows:

Value of discounted benefits	Probability of occurrence
$ 1 million	0.3
$ 3 million	0.4
$ 5 million	0.2
$10 million	0.1

Which of these discounted values, or which combination of values, should be used in calculating the project's benefit-cost ratio (or net present value)? The conventional method of determining one unique value when this type of information is available is to calculate the project's expected value, a weighted average of the alternative outcomes:

$$\text{Expected value of benefits} = (\$1 \text{ million} \times 0.3) + (\$3 \text{ million} \times 0.4) + (\$5 \text{ million} \times 0.2) + (\$10 \text{ million} \times 0.1) = \$3.5 \text{ million}$$

Suppose that the average annual discounted cost of the flood control project is $3.1 million. Should the project be undertaken? An examination of the probability distribution of benefits reveals a 70 percent chance the actual average benefits in any one year will be less than the $3.1 million average annual project cost. The project should probably be undertaken because the expected value calculation indicates that the average benefit from such a project will be $3.5 million.

Over a period of 10 years one could, on the average, expect $1 million in benefits in three of them, $3 million in benefits during four of the years, $5 million in two of the years, and $10 million in one year for an average annual (discounted) benefit of $3.5 million.

It is likely that each estimated annual benefit and cost may be a random variable, suggesting that the appropriate discounting procedure (when information about probability distributions is available) is to translate expected future benefits, E(b), and costs, E(c), into an expected present value, E(PV): for instance:

$$E(\text{PV of benefits}) = E(B_o) + \frac{E(B_1)}{1 + r} + \frac{E(B_2)}{(1 + r)^2} + \ldots + \frac{E(B_n)}{(1 + r)^n}$$

One serious problem with these expected value calculations is that they take into account only the mean of the distribution, ignoring other potentially important characteristics of a distribution (e.g., the variance). For instance, consider two mutually exclusive, equal-cost projects, each offering expected (discounted) benefits of $1 million. Should the analyst suggest that these projects are equally desirable on efficiency grounds? Probably not, unless the benefit distributions of the two projects are similar. Suppose the two projects (A and B) have benefit distributions such as:

Project A		Project B	
Benefit distribution	Probability of occurrence	Benefit distribution	Probability of occurrence
$1 million	1.0	$0	0.9
		$10 million	0.1

Both projects have the same expected value of $1 million, but have very different benefit distributions. In this case, as long as policymakers are at all risk-averse, they will prefer project A (other things equal) with its certain gain of $1 million to project B. However, if policymakers tend to be risk-takers, it is no longer obvious that project A is preferable to project B--at least from the viewpoint of the policymaker.

Another difficulty in using this approach is the problem (and cost) of discovering the nature of the necessary probability distributions. Probabilities of some events (e.g., floods, tornadoes) may be easily obtained from historical records, but the probability distributions for many variables (e.g., input and output prices) may be very difficult and costly to obtain. When the relevant probability distributions are known, this approach is the conventional one for incorporating risk elements into the analysis. This approach is highly recommended when the necessary information is available. When data on the relevant probability distributions is not available, another technique must be employed.

7.5 GAME THEORY: MAXIMIN STRATEGY

Lacking information about probability distributions, it is sometimes useful to apply game theory techniques in evaluating alternative projects. One technique is the "maximin" strategy, referring to "maximizing the minimum." This approach is extremely conservative, implicitly assuming that the worst possible outcomes always occur.

To illustrate, assume the analyst is evaluating three mutually exclusive, equal-cost lakefront development projects (A, B, and C) that would generate total discounted benefits of $100 million, $120 million, and $150 million, respectively under the most optimistic assumptions (regarding such things as weather conditions, pollution problems, etc.). Under the most pessimistic assumptions, the projects still yield (discounted) benefits in the respective amounts of $30 million, $60 million, and $20 million. (For simplicity only two situations are examined: the best and worst possible cases.) Assuming that no information is available regarding the probability of flood occurrence, the expected value approach cannot be used.

The various possible outcomes can be illustrated in a simple matrix:

	Best possible outcome	Worst possible outcome
Project A	$100 million	$30 million
Project B	$120 million	$60 million
Project C	$150 million	$20 million

The maximin strategy suggests that project B is preferable to projects A and C because B offers a minimum benefit of $60 million versus $30 million and $20 million for projects A and C, respectively. That is, the selection of B would maximize the minimum benefits offered by the alternative projects.

In many instances this conservative maximin criteria could lead to the rejection of the more preferable projects. Suppose the previous benefit matrix were altered in the following fashion:

	Best possible outcome	Worst possible outcome
Project A	$800 million	$59 million
Project B	$120 million	$60 million
Project C	$900 million	$58 million

Under these circumstances the maximin criteria still recommends project B even though it is now almost certainly inferior to either project A or C. The problem with the maximin strategy is essentially the same as the problem with the cutoff period criteria: it ignores potentially useful information, namely, all gains other than the minimum. This approach is extremely conservative. Reliance on it is not recommended unless the analyst had been directed to seek out the most risk-averse strategy.

An obvious advantage of the maximin approach is that it requires relatively little data. The analyst only needs estimates of net benefits under the worst possible scenario in order to implement this approach.

7.6 GAME THEORY: MINIMAX-REGRET

An alternative game-theory approach to the maximin strategy is the minimax-regret criteria; that is, minimizing the maximum regret (or loss) that might be suffered. The minimax-regret strategy more fully utilizes the available infomation about possible outcomes than does the maximin approach, and thus is less subject to the criticism that the approach is too conservative and risk-averse to be useful to the benefit-cost analyst.

The minimax-regret criteria can be illustrated using the example summarized in the previous benefit matrix. Suppose that the more optimistic outcome does occur. In that event, project C would have provided the greatest advantage ($900 million in benefits). Had project A been undertaken, rather than project C, the foregone benefits would be $100 million (= $900 million - $800 million). Had project B been undertaken, rather than project C, the foregone benefits would be $780 million (= $900 million - $120 million). If it is supposed that the worst possible outcome occurs, project B generated the most benefits, namely, $60 million. If project A or C is selected, the foregone benefits from failing to undertake project B would be $1 million and $2 million, respectively. This information can also be presented in matrix form:

	Best possible outcome	Worst possible outcome	Row maximum
Project A	$100 million	$ 1 million	$100 million
Project B	$780 million	$ 0 million	$780 million
Project C	$ 0 million	$ 2 million	$ 2 million

Examination of the various row maximums indicates that selection of project A might cause $100 million in benefits to be foregone, selection of project B entails a potential opportunity cost of $780 million. The minimax-regret strategy would lead the analyst to recommend project C, since the worst the policymaker could do by selecting C would be to forego (in the event of the worst possible outcome occurring) an extra $2 million offered by project B.

This approach to handling uncertainity can be useful if the number of variables under consideration is small. If the analyst attempts to use these game-theory techniques where there is uncertainty about several variables (such as future prices, consumer tastes, technology, and weather patterns), the number of different outcomes the analyst would have to consider increases geometrically with increases in the number of such variables. Consequently, these game-theory techniques are of limited usefulness in most practical benefit-cost analyses.

7.7 SENSITIVITY ANALYSIS

Another approach to coping with risk and uncertainty (one that can easily be used in conjunction with any of the preceding methods) is the application of sensitivity analysis. The analyst can be more confident in predicting that some variable (e.g., benefit or cost) will fall within a certain range (e.g., between $1 million to $10 million) than in predicting a precise value from that variable. Consequently, whenever there is considerable uncertainty about the reliability of a predicted value, the analyst could recalculate the benefit-cost ratios (or net present values) for some alternative values, presumably upper and lower bound estimates of the variable in question. An advantage of this approach is that it allows the analyst to identify those (uncertain) estimates that are crucial to the analysis. An additional advantage is that this approach does not require additional data (e.g., probability distributions). The sensitivity analyses are simply performed with whatever data has been obtained for other aspects of the benefit-cost study. If the sensitivity analysis reveals that even relatively large changes in a particular estimate do not alter the general outcome of the study, the fact that some uncertainty may surround that estimate is unimportant. However, as suggested in Section 5, the amount of information generated by an additional sensitivity analysis increases at a geometric rate, so this approach can quickly lose the advantages it has to offer.

SECTION 8

ALLOWANCE FOR INTANGIBLE EFFECTS

In some instances certain efficiency or distributional effects, though quite important, must remain unmeasured (or measured very imperfectly) because of incomplete data or the absence of commonly accepted measurement techniques (e.g., aesthetic benefits from a lakeshore development). In other instances, an environmental assessment or impact analysis may reveal information about the physical magnitudes of a problem (for instance, anticipated increases in traffic congestion) but it may not be feasible to place a dollar value on such effects. Such unmeasured and unvalued effects we refer to as intangible benefits or costs.

When confronted with the problem of intangible benefits or costs, the analyst should, at least, clearly identify them for policymakers. The unmeasured effects can be far more important in some circumstances than the quantified effects and, consequently, must not be overlooked by the analyst or the policymakers.

One way to incorporate intangible effects into a benefit-cost study (other than merely identifying them), is to answer the following question: Does it appear likely that in any particular instance the intangible effects could have been large enough, had they in fact been quantified, to have substantially altered the findings of the benefit-cost study? To illustrate this approach, consider a hypothetical project yielding measured discounted benefits of $10 million for a cost of $15 million (all costs are assumed to be accurately measured). The measured social costs of this program clearly exceed the measured social benefits. Should the analyst recommend, on efficiency grounds, that the program be rejected? The project should be rejected on these grounds only if the intangible (unmeasured) benefits of the project are presumed to be less than $5 million, the difference between the measured costs and the measured benefits.

The analyst's role is not to determine whether, in this example, the intangible benefits of the project exceed $5 million, but rather to inform the policymakers: 1) as to which effects have not been measured, and 2) the magnitudes that would have to be attained by the intangible effects ($5 million in this example) before they could alter the conclusion implied by the measured effects.

This approach highlights one interesting aspect, namely, that intangible effects, regardless of their true magnitude, may be relatively unimportant to the benefit-cost analyst or the policymaker under certain circumstances. Suppose that in the preceding example the estimated discounted benefits of the project exceeded the discounted fully measured costs, and that the only issue involved was whether to

undertake a project of a given size. In this instance since the measured benefits exceed the costs, the fact that there may be substantial unmeasured benefits associated with the program is irrelevant, unless a budget constraint prevents the agency from undertaking all efficiency-enhancing projects. If the size of the project was in questiou, the intangible effects would still be relevant, since economic efficiency suggests that projects should be expanded until the social marginal benefits just equal to the project's social marginal costs.

SECTION 9

DISTRIBUTION OF BENEFITS AND COSTS

Benefit-cost analysts tend to emphasize the economic efficiency aspects of a project; that is, the identification and measurement of a project's "real" benefits and costs. A decision maker may be concerned not only with the relative magnitudes of the benefits and costs, but also with the distribution of the benefits and costs. In some instances the distributional considerations may be of overriding importance to a policymaker. Consequently, it is useful for the analyst to indicate, to the extent feasible, how the benefits and costs of a project are likely to be distributed among various groups of people.

Many classifications could be used in discussing a project's distributional effects. The more familiar categories would include income, race, sex, age, region (or neighborhood), religion, family size, occupation, and educational background. These characteristics could themselves be further divided into various subcategories.

In addition to the difficulties and costs of determining how the benefits and costs are distributed, presentation of this type of information can be difficult to accomplish, even for a relatively few classifications. For instance, distributing a project's benefits and costs across 10 income groups, 8 age classes, 4 racial categories, and 6 regions (or neighborhoods) requires a table containing approximately 2,000 separate cells. Unless many of the cells were empty, most individuals would probably find it very difficult to assimilate and digest that much information. Consequently, while the distributional effects may be of considerable interest, the cost of identifying and measuring such effects and the problems of transmitting such detailed information suggest that the analyst should normally work with a few broad classifications.

Most policymakers will indicate a need for specific types of distributional information, so that the analyst only need be concerned with estimating the distribution of benefits and costs. Sometimes the analyst will be given considerable discretion over what, if any, distributional information is presented.

One approach to organizing some reasonably detailed information about the distribution of a project's benefits and costs is presented in Table 9-1. This table presents information about a project's distributional consequences in terms of income, age, race, and residence. This table is easily altered to allow for the inclusion of additional variables (e.g., sex) or for the substitution of one variable for another.

Ideally, distributional measures should reflect all income or wealth changes occasioned by a project, not just those changes associated with the "real" (efficiency) benefits and costs. Alterations in a family's income or wealth position can be caused as easily through purely pecuniary effects (which should be ignored in assessing a project's efficiency) as through real effects, and, where feasible, such effects should consequently be taken into account when assessing a project's distributional impact.

Usually the benefit-cost analyst's contribution in this area is limited to the identification and (where feasible) measurement of a project's distributional effects. This statement should not suggest that this identification and measurement task is easily accomplished. In many instances it is very difficult and costly to obtain reasonably accurate estimates of a project's distributional effects. It is not uncommon for distributional assessments to be limited to merely identifying whether particular groups are gainers or losers, with no serious effort made to measure the magnitude of a project's distributional impact.

In principle, if policymakers have revealed which distributional effects are desirable and which are undesirable, the desirable effects can be treated as a social benefit, the same as a project's desirable efficiency effects. The undesirable distributional effects can be similarly viewed as social costs. The analyst could assign weights (determined perhaps by a legislative body or some official) to distributional gains and losses to make them comparable across groups of people and also with efficiency gains and losses. To illustrate this point, consider a project that confers real discounted benefits of $100,000 to group A while imposing $200,000 in real discounted costs on group B. (For simplicity all income or wealth changes associated with secondary or pecuniary effects are ignored). According to strict benefit-cost criteria, this project should be rejected since its net present value (discounted benefits minus disounted costs) is less than zero. This decision rule assumes that a dollar gain, or loss, is the same regardless of the group involved. Suppose, that the city's policy objectives indicate that a dollar gain (or loss) to group A should receive three times the weight received by a similar gain (or loss) to group B. With this information, the gains to group A would have to be revalued at $300,000, thereby making the project desirable on benefit-cost grounds once the distributional gains are explicitly taken into account. The analyst will rarely, if ever, have such explicit distributional weights available and, thus, is likely to be restricted to simply presenting estimates of a project's distributional effects to decision makers and letting them assign implicit weights to the effects.

Clearly, this issue of distributional gains and losses can be very sensitive politically. The extent to which this sensitivity will (or should) affect a benefit-cost study will vary from project to project and from agency to agency. Consequently, not much guidance can be offered the analyst regarding this issue.

Table 9-1

Distribution of Net Benefits by Income, Age
Race, and Residence of Beneficiary

Area of Residence and Age Group	Income Class					
	$0 - $4,999		$5,000 - $14,000		$15,000 and Above	
	White	Nonwhite	White	Nonwhite	White	Nonwhite
Chicago						
0 to 18 years						
19 to 64 years						
65 years and above						
Chicago Suburbs						
0 to 18 years						
19 to 64 years						
65 years and above						
Illinois (other than Chicago and suburbs)						
0 to 18 years						
19 to 64 years						
65 years and above						
United States (other than Illinois)						
0 to 18 years						
19 to 64 years						
65 years and above						

SECTION 10

BENEFIT-COST ANALYSIS AND LAKEFRONT DEVELOPMENT: AN ILLUSTRATION

10.1 INTRODUCTION

This section discusses the application of benefit-cost principles and writing a benefit-cost report within the framework of a lakefront development project. The form of the benefit-cost report and the presentation of the results are very important since this report serves as the primary, if not the only means of conveying a study's findings to policymakers. Care must be taken in preparing the benefit-cost report, so that valuable information or crucial assumptions to the study are not overlooked or misunderstood by decision-makers. The format discussed below is a useful one for conveying the relevant information generated by the benefit-cost study.

In this section steps will be outlined that should be taken in a benefit-cost analysis and guidelines provided for performing a benefit-cost study of the development of Chicago's lakefront. These guidelines will provide City employees and/or officials with the information they need to perform at least certain parts of a benefit-cost study of the development of the lakefront. These guidelines are not substitutes for the judgment and skills of an economist trained in the uses of benefit-cost principles. Also indicated are which aspects of a benefit-cost study of Chicago's lakefront development should be undertaken in consultation with well-trained benefit-cost analysts.

The approach presented here is illustrative, and individual analysts may choose to modify it somewhat to meet their own needs. The necessary elements of a benefit-cost report will be outlined in general terms, (refer back to Section 2) and the recommended approach within the context of a hypothetical lakefront development study will be presented.

10.2 PROGRAM OBJECTIVES AND ACCOUNTING STANCE

As noted in Section 2, the first step in writing a benefit-cost report is to identify the objectives of the program being analyzed and relate those objectives to the accounting stance employed in the study. The relationship between the program objectives and a study's accounting stance becomes extremely important if there is some divergence between the two. For instance, in the case of Chicago's lakefront development project, presumably city officials (and local taxpayers) are primarily interested in whether the local benefits of the project exceed the local costs, and perhaps only secondarily interested in the project's regional or nationwide efficiency implications. Thus, the analyst should clearly define whether the study's accounting stance is local, regional, or

nationwide in nature. (It is indicated in more detail below how changes in the accounting stance can affect the benefit-cost estimates; also see Section 2.)

It will not always be possible to identify with certainty the project objectives because policymakers themselves may not have clearly identified a project's objectives, or those objectives may be seen differently by different policymakers. With respect to Chicago's lakefront development project, the objectives appear to be clearly stated (see the Lakefront Plan of Chicago). Even if the objectives are not clearly defined, the analyst will always be able to, and should specify the viewpoint, or accounting stance, taken in the benefit-cost study. The policymakers will, therefore, have the information necessary to judge the relevance of the study's findings.

In this discussion it is assumed that the accounting stance will be designed to focus only on the local (city) effects of the project. It will be shown, however, that those effects may have to be viewed differently under alternative accounting stances.

10.3 TAXONOMY OF (EFFICIENCY) BENEFITS AND COSTS

The next step in the construction of a benefit-cost report is the identification of the various benefits and costs that should, on efficiency grounds, be taken into account and, where feasible, quantified. (See subsections 2.3 and 2.4 of Section 2) The purpose of this exhaustive taxonomy is to provide a benchmark for assessing the analyst's success in measuring the program's benefits and costs. Not all of the benefits and costs will be amenable to quantification, given the present state of benefit-cost analysis. Still, it is very important to at least identify all the benefits and costs so as to place those that are quantifiable into perspective. Ideally, the various measures of a project's gross benefits should capture all of those elements which, in combination, equal the sum of all individual willingnesses to pay for the project's advantages (representing the efficiency benefits of the project). Similarly, the taxonomy of social costs should include all those elements which, in combination, equal the sum of all individual willingnesses to pay to avoid the project's disadvantages (that is, the efficiency costs of the project).

Consider the application of these points to Chicago's proposed lakefront development project. What are the social (economic efficiency) benefits and costs of such a project? In addressing this question and developing the taxonomy, first the benefits and then costs will be considered. In the development of these taxonomies, take considerable care to avoid any double-counting of benefits or costs. In the following paragraphs there are specific instances where double-counting could easily occur if careful consideration were not given to the development of these taxonomies.

10.3.1 Taxonomy of Benefits from Chicago's Lakefront Development

One obvious form that the efficiency gains from lakefront development would take is the saving associated with reduced flooding or erosion (assuming that the development project would provide for improved flood or erosion protection along the shore) to the extent that flood and erosion damage is reduced. A resource savings is realized and, the value of these savings should be accounted for in an approximation of a social willingness to pay for lakefront development. Reduced flooding may result in an increase in property values along the lakefront. The value of this benefit could be measured by estimating the reduction in damage costs or the increase in property value. If both of these measures are included as a benefit, the analyst will be double-counting the benefit of reduced flooding or erosion.

Flood and erosion problems necessitate protective expenditures by both public and private lakefront property owners to protect against such hazards. Lakefront development that reduces the likelihood of flooding and erosion would allow property owners to reduce such protective expenditures and thereby free additional valuable resources for alternative uses. The value of any such savings should be counted as a real social benefit of lakefront development because the lakefront property owners would certainly have a willingness to pay for such an advantage.

Reductions in the danger of water damage may lead to a reduction in the need for insurance against such hazards. A lessened demand for insurance may release resources (e.g., manpower) from the administration of insurance policies and claims. The value of such freed resources in their next best alternative use should be included as a real social benefit. As the amount of insurance-related resources released as a result of lakefront development may be quite small, this effect could probably be safely overlooked in the benefit-cost study. The saving in insurance premiums (as a result of improved flood and erosion control) should not be included as a real social benefit (i.e., resource savings). Insurance premiums and payments are financial transfers (similar to taxes) and should not be included in an evaluation of the efficiency effects of the project. Any savings in insurance premiums (unless they are subsidized) should be approximately offset by reductions in the insurance payments made to lakefront property owners, so these two effects will more or less cancel each other.

If those who are presently running the risk of incurring flood or erosion-related losses dislike accepting risks, they will also have willingness to pay for lakefront development simply because it offers a means of reducing those risks. This willingness to pay arising out of risk-aversion should, in principle, be measured and included as a real social benefit of lakefront development. In practice it is often not feasible to quantify this particular benefit. Moreover, this effect may not be of sufficient magnitude to justify the time and expense associated with gathering the data necessary to measure it.

One of the objectives of the lakefront plan is the development of natural areas for wildlife habitats along the Chicago lakefront. The willingness to pay of individuals for such natural habitats should be estimated and included as a real benefit of the project.

Another form of real benefits from lakefront development is the increase in recreational opportunities afforded by such a project. Individuals' willingness to pay for enhanced opportunities for such things as swimming, boating, biking, and picnicking constitutes a real social benefit of lakefront development and should be taken into account.

Lakefront development may have a beneficial impact upon employment and income in Chicago. The project may provide more jobs, thereby directly lowering unemployment in the city. This direct effect is categorized as a reduction in the social cost of the project (see Section 10.3.2), and should not be counted as a social benefit in order to avoid double-counting this effect. As long as this direct employment effect is included, it doesn't matter whether it is categorized as a gain in social benefits or a reduction in social costs; it is merely conventional to classify this effect as the latter.

Lakefront development may also indirectly enhance income and employment opportunities in the area by attracting new business into Chicago and adjoining communities. To the extent that the project does indirectly generate additional jobs for city residents, the City will enjoy a real benefit (not elsewhere counted) that should be included in assessing the benefits of the project. Note, that these "additional jobs" represent a true social benefit only if their existence implies a lowering of the unemployment rate (other things equal). Thus, the appropriate procedure for measuring these indirect multiplier effects requires that the analyst estimate (a) the number of unemployed people that will become employed as an indirect result of the lakefront development, and (b) the average annual income these people will earn. Multiplying these two estimates together provides, an estimate of the aggregate annual value of this particular benefit. For a precise estimate of this indirect employment effect, the analyst must use either an input-output model or an econometric model of the Chicago region. A qualified economist should be consulted on this point if such estimates are desired. Less precise estimates of this employment effect could be obtained by using "employment multipliers" derived in other studies.

If the accounting stance is regional or national rather than local, these indirect employment and income effects must be examined from a regional or national viewpoint, respectively. The analyst must try to determine the extent to which the project lowers the regional, or national unemployment rate. In this connection, different accounting stances can lead to significantly different estimates of the indirect employment effect because increased business activity and employment in one area may develop at the expense of business activity and employment in another area. A local accounting stance may reveal some indirect

employment benefits from the project, whereas a regional or national accounting stance might indicate the existence of offsetting employment and business reductions (outside the Chicago region).

10.3.2 Taxonomy of Social Costs from Chicago's Lakefront Development

In this section efficiency costs likely to accompany a lakefront development project are identified. These real social costs, in principle, must be offset against the social benefits noted previously to determine whether the project is desirable on efficiency grounds. (See subsection 2.4 of Section 2.)

One social cost created by lakefront development is the variety of construction costs associated with implementing the lakefront plan. The costs of creating such things as new beaches, offshore islands, new marinas, tennis courts, or bikeways are all costs that must be included as a real social cost of the project. This category includes construction expenditures by both the city government (or other governments) and by private parties.

Lakefront development will also create operating and maintenance expenditures (e.g., of the new parks and marinas). Also, the development may increase operating and maintenance costs for existing facilities. These outlays all constitute real resource expenditures and must be included in an accounting of the social costs of lakefront development.

Further lakefront development may entail some adverse environmental or ecological consequences—or cause expenditures to avoid such consequences. In either event, these undesirable effects would represent real social costs that should be quantified as one of the undesirable effects of lakefront development.

Another potential cost of lakefront development is the value of the opportunities foregone by not employing the lakefront areas in their next-best use (e.g., for high-rise apartments or office buildings). The analyst must be careful, however, with this particular effect to avoid a double counting of social costs. The market value of a piece of land is a measure of the (discounted) benefits that can be expected from that land. To the extent that land purchases (if any) are included in the construction cost category, these foregone benefits are already included in the assessment of the project's social costs. For those areas acquired at less than full market value (e.g., areas already owned by the city), the analyst must endeavor to estimate this particular social cost of development.

This completes the illustrative taxonomy of benefits and costs likely to be caused by the lakefront development project. In an actual benefit-cost study, the analyst may want to explain the economic rationale for each benefit and cost in greater detail.

10.4 BENEFIT-COST MEASUREMENTS

After the taxonomy of benefits and costs has been developed, the approach used in measuring those effects that were quantifiable should be discussed in detail (refer back to subsections 2.5, 2.6 and 2.7 of Section 2). Emphasis should be given in this section of the report to justifying, highlighting the more restrictive and controversial assumptions made in constructing the benefit-cost measures. Any divergence between the operational measures and theoretically appropriate benefits and costs should also be clearly indicated. For each effect measured, there should be a separate section where the measurement techniques and data sources are carefully explained.

An example of the type of information that might be presented in this section of the report might be the recreational benefits that could be expected from such a project. In connection with the construction of a measure for this benefit, the type of information that should be presented includes:

The method used in identifying the types of people that will benefit from the recreational opportunities.

The approach and data employed in estimating these individuals' willingnesses to pay for the types of recreational opportunities offered by the development plan.

The method of accounting for any anticipated future changes (e.g., growth) in the demand for such recreational opportunities.

The discount rate (or rates) used in translating future benefits into present values.

The time period employed in the analysis.

In connection with the most important assumptions, the analyst should undertake sensitivity analyses to determine how crucial a particular assumption is to the benefit-cost estimates. A large number of crucial assumptions will necessitate some judgment in selecting the number of sensitivity analyses because the amount of information generated by additional analyses increases at a geometric rate. If, for every key assumption or variable (e.g., the discount rate), the implications of only two alternative values (e.g., 4 percent and 10 percent) are analyzed, the number of cells needed to display the resultant information is 2^n where n is the number of key assumptions or variables examined. The presentation of the results of a sensitivity analysis involving 10 variables (with two values for each variable) would require over 1000 cells. If each of the 10 variables takes on three alternative values, the number of separate pieces of information skyrockets to almost 60,000 (or to precisely 3^{10}). Sensitivity analysis can be a very powerful instrument, but caution must be exercised to avoid carrying its use too far to provide comprehensible and useful information.

In the remainder of this subsection are outlined some approaches to operationalizing measures of the various social benefits and costs just identified. Benefit-cost analysis is too complex and requires too many study-specific judgmental decisions to be able to provide the detailed, step-by-step directions necessary for a novice to successfully undertake a benefit-cost study. A skilled benefit-cost analyst will probably need to be consulted on various aspects, in order to conduct the study correctly.

10.4.1 Measurement of Social Benefits

The measurement of benefits associated with the development of Chicago's lakefront will be discussed in this subsection.

10.4.1.1 Reduced Flood and Erosion Damage. The development should reduce the amount of damage caused by flooding and soil erosion. The reduction in such damages should be valued and included as a real social benefit of the project. The estimated value of this benefit involves: (1) determining the extent of the damage without the development, and (2) determining the extent of the anticipated damage with the development (the with/without methodology).

Historical records should contain information useful in estimating the extent of damage without the project. Such records should be used to obtain an estimate of the value of the average annual flood and erosion damage under present circumstances. Since this estimate is to be used to approximate the probable annual damage (without the development) for many years (perhaps decades) into the future, the analyst may wish to adjust the estimate to allow for future population growth, more intensive use of lakefront property, rising property values, etc. Once this annual time-stream is estimated, it must be discounted back to the present with the appropriate discount rate (or rates). (See the previous discussion on discounting.)

Estimates of flood and erosion damage that is likely to occur with the project completed may be more difficult to obtain. It would be wise to consult with marine scientists and engineers to obtain some idea of the extent of flood and erosion damage in the presence of the development. If it is estimated that a 75 percent reduction in physical damage is likely, it would be reasonable to assume that the reduction in the value of the damage would also be 75 percent. Thus, if estimated annual damage without the development is $2 million, and marine scientists and engineers anticipate a 75 percent reduction in physical damage from flooding and erosion, then $1.5 million can be used as an estimate of the annual value of this particular benefit. These annual amounts would have to be discounted before they could be included in the calculation of a net present value or benefit-cost ratio.)

These points must be qualified to allow for the following possibility. The development may encourage more intensive use of the lakefront so

that in the event of a flood (less likely because of the development), more damage occurs than would have been the case without the development. In this instance, a 75 percent reduction (for example) in the probability of flooding does not translate into a 75 percent savings in the damage caused by flooding. Floods occur less frequently, but are more damaging when they do occur. It may not be feasible to incorporate this qualification in estimating the annual reduction in flood and erosion damage because of the difficulty of predicting how the lakefront will develop (both with and without the project). The analyst should keep this qualification in mind, though, and note that it introduces an additional element of uncertainty into this phase of the analysis. If this qualification cannot be implemented, the analyst should recognize that the resultant estimated benefits from reduced flood and erosion damage represent upper bound estimates of benefits, that is, they probably overstate the true benefits of the development.

10.4.1.2 Reductions in Protective Expenditures. Improved flood and erosion control associated with the development may allow private and public lakefront landowners to reduce the amounts spent on flood and erosion protection. These reductions would represent a social benefit over and above the benefit associated with reduced flooding and erosion damage. Improved flood control may allow substantial savings in building construction costs along the lakefront, since (with the project), the buildings could be built to withstand fewer and less powerful floods. These cost savings constitute a real social benefit of the development.

In quantifying this benefit, the analyst should consult construction contractors and architects to gauge the amount by which construction costs might be lowered if flooding and erosion were less of a problem. It might be possible to obtain measures of protective expenditures by property owners along other shore lines, where flooding and erosion risk is comparable to that expected along the Chicago shoreline once the development is complete. Then such estimates could be compared to current expenditures by Chicago lakefront property owners to gain an idea of the possible savings that might result from the development.

10.4.1.3 Savings in Insurance Administration Costs. The extent to which flooding and erosion reduction along Chicago's lakefront reduces the overall cost of insurance administration on lakefront property is likely to be negligible compared to other project benefits and costs. For practical measurement purposes, this particular effect can be ignored, although it should certainly be included in the taxonomy of benefits.

10.4.1.4 Benefits Related to Risk-Aversion. As noted in the benefit taxonomy, if lakefront property owners are risk-averse (dislike accepting risks), they would have a willingness to pay for lakefront development because it would reduce the risk of flood or erosion damage. In principle, this benefit should be taken into account, but in practice it is usually quite difficult to estimate the magnitude of benefits

related to risk-aversion. It is recommended that Chicago analysts treat this particular benefit as an intangible effect, and not worry about quantifying it.

10.4.1.5 Wildlife Habitats. Creation of natural wildlife habitats along the lakefront is another potentially beneficial effect of the project. In attempting to quantify this particular benefit, the analyst is confronted with approximating an individual's willingness to pay for wildlife preservation along portions of the lakefront. This is difficult and complex since there is no wildlife preservation market to reveal people's willingness to pay for such a service. Opinion-poll techniques might give a rough approximation of the value people would place on such wildlife habitats. If this approach is chosen, it will be necessary to consult with individuals skilled in the survey techniques. Alternatively, it may be advisable to simply treat this benefit as an intangible effect (see the discussion below). If city analysts choose to try to quantify this particular benefit, they should consult with a qualified economist about the various avenues open to them.

10.4.1.6 Improved Recreational Opportunities. One of the main objectives of the proposed lakefront development is improved recreational opportunities for Chicago area residents. The appropriate measure of this efficiency benefit is the residents' willingness to pay for these opportunities. There is no commonly accepted methodology for estimating this willingness to pay for urban recreational opportunities provided by park-like developments. The conventional method of approximating willingness to pay for suburban or rural park visits involves surveying visitors to determine what travel expenses they actually incurred to make the visit. This information, along with personal data (age, income, education, etc.), is then analyzed with econometric techniques to find a rough estimate of willingness to pay. This technique is not very useful for urban settings because many visitors to urban parks travel to the urban area for a variety of reasons (e.g., shopping, business), besides visiting the park. Consequently, it is extremely difficult to determine what portion of an individual's total travel costs were specifically for visiting the park or development.

One alternative is to survey individuals (potential users of the development) to determine their willingness to pay for the recreational opportunities offered by the lakefront development. Using this approach, it would be necessary to consult with experts in the field of opinion polling and economists to be sure the relevant data were being collected.

It is also possible to estimate willingness to pay for those components of the development where information exists about market price. It would be possible to approximate willingness to pay for an additional public swimming pool by using the fees that people presently pay at existing (public or perhaps private) pools, along with an estimate of the number of users of the new pool. Suppose that public pools are charging $2 per visit and the existing pools are relatively crowded all summer. Suppose

that an additional pool would experience 10,000 visits a year. Willingness to pay for this pool could be estimated to be $20,000 per year. If the existing pools are highly congested, this amount would probably understate true willingness to pay for an additional pool. On the other hand, if the existing pools were relatively uncongested, this estimate would be an overstatement of true willingness to pay. There are a number of subtleties associated with the use of this particular technique, so it should be used only in consultation with a qualified economist.

These benefits could also be treated as intangible effects (see below). This approach should only be used as a last resort since these benefits are so important to the success of the project.

10.4.1.7 Income and Employment Effects. Employment provided directly by the development should not be classified as a social benefit of the project. If people employed by the development would have been employed elsewhere without the development project, employment by the project represents a social cost (either a construction or an operating and maintenance cost), not a benefit. If development employment provides jobs for people who would otherwise have been unemployed, then budgeted construction costs or operating and maintenance costs should be reduced.

If a citywide accounting stance is adopted, a real employment and income benefit arises from the development if it stimulates additional business activity and employment in the city. Suppose that lakefront development attracts additional visitors to Chicago, stimulating economic activity in the area, and assume that this additional business activity creates a net expansion of 25,000 jobs for Chicago area residents. Assuming that average income provided by these new jobs is $10,000 before taxes, the social benefit attributable to the development would be $250 million annually ($10,000 times 25,000). Development-related income gains to people in existing jobs should be added to this amount to arrive at an estimate of the aggregate employment and income gains arising from the project.

Of course, these annual benefits would have to be discounted before they could be used in the calculation of a net present value or benefit-cost ratio. If a national accounting stance were used, these would not be considered as benefits because assuming full employment, the increase in business activity in Chicago would have to be matched by a decrease in activity elsewhere in the nation. Estimation of these benefits requires the analyst to forecast both the indirect employment effects of the development project and the average income generated by these new jobs. Forecasting the employment and income effects is especially difficult and requires an economist skilled in forecasting techniques and econometric analysis.

10.4.2 Measurement of Social Costs

Presented in this subsection are some rules-of-thumb applicable to measuring the social costs associated with the development of Chicago's lakefront.

10.4.2.1 Construction Costs. The measurement of this particular social cost is relatively straightforward. In principle, the figure sought is the discounted value of the productive resources that will be used in the construction of the development components (the marinas, parks, bikeways, swimming pools). Construction cost estimates are readily available, once the contractors have bid on the project.

To illustrate, if the project contractor agrees to complete the entire development within 5 years for, say, a present value of $100 million, then the $100 million figure would provide a good approximation of the real resource costs of the construction activity. However, the analyst may be presented with estimates of construction costs that have not been discounted; in that case these estimates will have to be converted to present value equivalents. As mentioned in the discussion of the discount rate, the city should use the (percent) cost of borrowed funds as the discount rate for the project.

If the benefit-cost study is being undertaken prior to the contract bidding, the analyst may experience some difficulty in obtaining an estimate of construction costs. In this case, the analyst might try consulting with potential contractors to obtain the information. In addition, construction costs for developments in other cities may provide some useful information.

Wages of construction workers who would have otherwise been unemployed should not be included as part of the construction costs. Such payments do not reflect the true opportunity cost of using unemployed workers and should be ignored in quantifying the efficiency benefits and costs. (See the discussion about the treatment of unemployed resources.)

10.4.2.2 Operating and Maintenance Costs. Annual operating and maintenance costs will recur throughout the life of the project, and the discounted present value of these costs should be included in the calculation of the project's net present value or benefit-cost ratio. These operating and maintenance costs should include wages and salaries paid to workers engaged in the operation and/or maintenance of the facility, and the cost of material required to maintain the equipment. Estimates of these annual costs can be obtained from the operating and maintenance costs of other city facilities (e.g., parks), from facilities in other cities, and from private facilities (e.g., private marinas, tennis courts).

Once again, regarding the employees who would have otherwise been unemployed, wage payments should be excluded from the estimate of annual operating and maintenance costs. Also, it should be remembered that

annual effects must be discounted before arriving at an overall estimate of their magnitude in present value terms.

10.4.2.3 Environmental or Ecological Costs. Development of the lakefront may entail some adverse environmental or ecological consequences. For instance, dredge and fill operations in the lake may harm the breeding grounds of some aquatic life, thereby diminishing the population of a species, and perhaps even leading to its extinction. Presumably, there will be some willingness to pay the cost of avoiding such adverse consequences, so they represent a social cost that should be quantified and included in the analysis. Unfortunately, it may not be possible to attach an economic value to many environmental and ecological effects.

The first step toward measuring these effects is an environmental assessment designed to identify the physical impacts of the development. In principle, the environmental assessment would reveal the exact nature of the environmental and ecological consequences of the lakefront development. After these physical effects have been identified, economic analysis can be used to evaluate some of the effects.

The valuation of environmental and ecological effects is often quite difficult and sometimes simply infeasible. For instance, it may not be possible to obtain a reliable estimate of the value of preserving the breeding grounds of an aquatic species that has no commercial use. As a result, few guidelines can be provided in this area other than to suggest that qualified economists be consulted.

If the environmental or ecological effects impact upon a commercial activity, it may be possible for the novice benefit-cost analyst to derive a value for those effects, at least in part. For instance, if a dredge and fill operation results in depopulation of a fish caught commercially, a reasonable estimate of the social cost of this effect would be the resultant decline in revenues to the local fishing industry.

This estimate must be modified if the diminished catch results in higher prices for the fish, or if the reduced fishing activity frees productive resources (e.g., workers, boats) for other uses. To illustrate the first point, suppose that the catch of a particular type of fish falls by 100,000 pounds per year, thereby increasing the price from $1 per pound retail to $2 per pound. If the catch reduction is valued at the initial price of $1, we obtain $100,000 as a measure of the annual social cost of this effect. However, if we value the reduction at the new price of $2, we obtain $200,000 as the estimate of annual social cost. In this type of price-change situation, the best approximation to the true social cost would be the average of these two estimates, that is, the value of the catch reduction would be $150,000 annually. (This estimation procedure assumes that the demand curve for fish is approximately linear in the relevant range).

Prior to completion of the project it may not be possible to predict what impact the project will have on the price of commercially caught fish. Consequently, the analyst may have little choice other than to use the existing market price in valuing these effects.

Next, consider the situation in which reduced fishing activity releases productive resources for other types of productive undertakings. Suppose, for example, that the 100,000 pound reduction in annual fish catch results in some workers moving to other types of employment, reducing annual wage payments in this segment of the local fishing industry by $75,000. This resource savings (valued at $75,000 annually) must be subtracted from the estimated social cost associated with the reduced catch ($150,000 annually, in the preceding example) to arrive at a measure of the net social cost.

In many cases, it will not be feasible to value environmental and ecological effects. Such unquantified (in dollar terms) effects are referred to as intangible effects. The treatment of intangible effects is discussed at greater length in a following subsection.

10.4.2.4 Opportunity Cost of Lakefront Land. As we noted above, another potential cost of lakefront development is the value of the opportunities foregone by not employing the lakefront land for other uses, such as apartment complexes. The market value of a piece of land will normally reflect the discounted present value of the opportunities that would be foregone. If all of the land to be used in the development is to be acquired on the open market, then the market price of the land, which will be included as part of the development's construction cost provides a reasonable estimate of the value of these foregone opportunities. In this instance the opportunity costs have already been counted once (as construction costs) so it would be incorrect to count them again.

If the city presently owns some of the land that will be used in the development, however, and it is contributed free-of-charge or at a below-market price to the development, then true construction costs will be understated. Consequently, if city-owned land is to be used in the lakefront development, the analyst must determine the market value of that land. This market value should be used as a measure of the social cost of using city-owned land in the development of the lakefront.

10.5 DISPLAY OF SUMMARY BENEFIT-COST MEASURES

The next step in the writing of a benefit-cost report is the preparation of a display summarizing the benefit-cost measures, either benefit-cost ratios or net present values. The purpose of this display is to convey to the reader (the policymaker) the concise information regarding the project's benefits and costs, and perhaps information about the distribution of those benefits and costs. The display should also contain the results of the more important sensitivity analyses, to aid policymakers in understanding the study's more crucial assumptions.

Table 10-1 is an example of such a display. This table lists the summary benefit-cost measures resulting from sensitivity analyses involving: (a) the estimated number of beneficiaries (denoted here simply by x, y, and z), (b) the benefits per beneficiary (represented by B and B'), (c) the discount rate (4 percent and 10 percent are used in this illustration), and (d) the time period (50 and 100 years are merely illustrative).

Completing such a table quickly reveals the more important assumptions. For instance, it may indicate that the benefit-cost estimates are highly sensitive to the choice of the discount rate, but relatively insensitive to changes in the time period. This would suggest that policymakers spend more time determining which discount rate best suits the needs of the City. The table may also highlight the need for more precise estimates.

One problem posed by a table such as Table 10-1 is how to interpret a conflicting set of benefit-cost statistics, some suggesting that the project is efficient and some suggesting it is inefficient. One approach to this problem is to ignore the conflicting implications and select that set of assumptions that appear most reasonable or appropriate. For instance, if a policymaker feels that public projects of this sort should be evaluated with low discount rates, the fact that, say, relatively high discount rates tend to make the project appear inefficient is of little importance. While the analyst is free to select the assumptions that appear the most appropriate, he should also present the results of the sensitivity analyses to provide policymakers the data for making their own judgments and recommendations.

10.6 INTANGIBLE EFFECTS

Presentation of the measured benefits and costs should not be allowed to obscure the fact that there may be substantial unmeasured or intangible effects. The presentation should be carefully qualified with the information that some benefits or costs are unmeasured.

One method for bringing these omitted factors into the evaluation, aside from merely mentioning them, is to ask the following question: Could the unmeasured benefits (costs) plausibly be large enough to make an unfavorable benefit-cost ratio favorable (or vice versa)? In the lakefront development project, the relevant question would be: Could the unmeasured net benefits of the project (per beneficiary) change the favorability of net cost (where net cost is the difference between the measured social benefits of the project and the measured social costs)?

Table 10-2 shows how the estimates could be displayed to allow for alternative assumptions regarding, say, the anticipated number of beneficiaries, discount rates, time periods, and average measured benefits per beneficiary. This table would have to be completed only for those assumptions that yielded benefit-cost ratios less than unity (assuming that all costs had

Table 10-1

Alternative Benefit-Cost Rating for Chicago's Lakefront Development Plan

Discount rate and time period	Number of beneficiaries and benefit measures used: "x" Beneficiaries, Average benefits per beneficiary B	"x" Beneficiaries, Average benefits per beneficiary B'	"y" Beneficiaries, Average benefits per beneficiary B	"y" Beneficiaries, Average benefits per beneficiary B'	"z" Beneficiaries, Average benefits per beneficiary B	"z" Beneficiaries, Average benefits per beneficiary B'
4 percent rate						
50 years						
100 years						
10 percent rate						
50 years						
100 years						

Table 10-2

Estimate of the New Measured Cost Per Beneficiary Provided by Lakefront Development

Discount rate and time period	Number of beneficiaries and benefit measures used: "x" Beneficiaries, Average benefits per beneficiary B	"x" Beneficiaries, Average benefits per beneficiary B'	"y" Beneficiaries, Average benefits per beneficiary B	"y" Beneficiaries, Average benefits per beneficiary B'	"z" Beneficiaries, Average benefits per beneficiary B	"z" Beneficiaries, Average benefits per beneficiary B'
4 percent rate						
50 years						
100 years						
10 percent rate						
50 years						
100 years						

been measured with an acceptable degree of accuracy). If this analysis reveals, for instance, that intangible benefits would only have to be $5 to $25 per beneficiary in order to alter all the unfavorable benefit-cost ratios, policymakers could feel confident in approving the project on efficiency grounds; on the other hand, if the intangible benefits would have to be as large as $1,000 to $10,000 per beneficiary before the project would appear efficient, policymakers would be much more skeptical about the project's desirability. With information of this sort, policymakers should find it easier to come to grips with the problems created by intangibles.

10.7 DISTRIBUTION OF BENEFITS AND COSTS

In addition to the efficiency considerations, policymakers may find it useful to have information about how the project's benefits and costs are distributed across different groups of people. In some instances, the distributional considerations may be of overriding importance from a policy standpoint and the analyst is reminded that this information may be needed in the display. (See Section 9.)

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SECTION 11

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