6. Return to Question 5. Indicate how you would measure the *efficiency* of efforts to achieve these goals.
7. Many economists argue that equality and efficiency are competing objectives. For this reason, the relation between equality and efficiency is one that requires a trade-off whereby gains in equality are sacrificed for gains in efficiency, and vice versa [see Arthur M. Okun, *Equality and Efficiency: The Big Trade-Off* (Washington, DC: Brookings Institution, 1975)]. Other economists [see Jaroslav Vanek, *The Participatory Economy* (Ithaca, NY: Cornell University Press, 1970)] and political scientists [see Carole Pateman, *Participation and Democratic Theory* (Cambridge, MA: Cambridge University Press, 1970)] argue that the trade-off between equality and efficiency is a consequence of the limited forms of democratic participation in politics and work. Equality and efficiency, they argue, do not have to be "traded" when politics and economics are fully democratic. Why would this be true? What does it suggest about the appropriateness of economic concepts such as *opportunity costs* and *net efficiency* versus *redistributional benefits*?
8. Return to Figure 5.2 and consider the following criteria for prescription:
   a. Maximize effectiveness at least cost [*Note:* Be careful—this is a tricky question].
   b. Maximize effectiveness at a fixed cost of $10,000.
   c. Minimize costs at a fixed-effectiveness level of 4,000 units of service.
   d. Achieve a fixed-effectiveness level of 6,000 units of service at a fixed cost of $20,000.
   e. Assuming that each unit of service has a market price of $10, maximize net benefits.
   f. Again assuming that each unit of service has a market price of $10, maximize the ratio of benefits to costs.

   Indicate which of the two main programs (program I and program II) should be selected under each of these criteria, and describe the conditions under which each criterion may be an adequate measure of the achievement of objectives.
9. The estimation of risk and uncertainty is an essential aspect of the policy-analytic methodology of prescription. Although it seems obvious that the best way to obtain valid estimates of uncertainty is to use the most highly qualified experts, there is evidence that "people who know the most about various topics are not consistently the best at expressing the likelihood that they are correct" [Baruch Fischoff, "Cost-Benefit Analysis and the Art of Motorcycle Maintenance," *Policy Sciences* 8 (1977): 184]. Discuss.
10. Use procedures of value clarification and value critique to analyze value premises that underlie the following claim: Increased energy production is essential to the continued growth of the economy. The government should therefore make massive investments in research and development on new energy technologies. Treat the first sentence as information (*I*) and the second as the claim (*C*).
12. Calculate the discount factor (DF) at ten years for a 3, 4, and 10 percent discount rate.
13. Calculate the present value (PV) of the following cost and benefit streams (in millions of dollars) for two health programs. Use a discount rate of 4 percent. Which program has the higher present net efficiency benefits? Why?

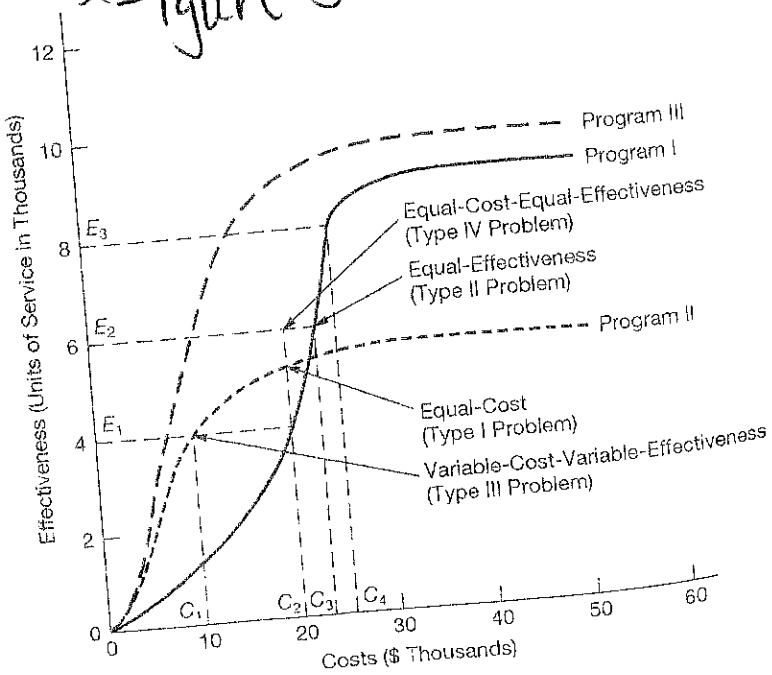
	Year					
Program	*2000*	*2005*	*2010*	*2015*	*2020*	*Total*
I Costs	$60	$10	$10	$10	$10	$100
Benefits	10	20	30	40	50	150
II Costs	20	20	20	20	20	100
Benefits	10	20	30	40	50	150

4. *Type IV problems.* Problems of this type involve EQUAL costs as well as equal effectiveness. Type IV problems, which involve *equal-cost–equal-effectiveness analysis*, are especially difficult to solve. Analysts are not only limited by the requirement that costs not exceed a certain level but are also limited by the constraint that alternatives satisfy a predetermined level of effectiveness. For example, if public transportation facilities must serve a minimum of 100,000 persons annually—yet costs have been fixed at an unrealistic level—then any policy alternative must either satisfy both constraints or be rejected. In such circumstances, the only remaining alternative may be to do nothing.

The different definitions of adequacy contained in these four types of problems point to the complexity of relationships between costs and effectiveness. For example, two programs designed to provide municipal services (measured in units of service to citizens) may differ significantly in terms of both effectiveness and costs (Figure 5.2). Program I achieves a higher overall level of effectiveness than program II, but program II is less costly at lower levels of effectiveness. Should the analyst

1-3

*Figure 5.2



4-9

DEMONSTRATION EXERCISE

Return to Chapter 1 and reread Case 1.1 (Saving Lives and Saving Time). Then read Case 5.1 (Opportunity Costs of Saving Lives—The 55 mph Speed Limit) below. Prepare a short analysis in which you answer these questions:

- What assumptions govern estimates of the value of time lost driving? Are some assumptions more tenable than others? Why?
- What is the best way to estimate the value of time? Justify your answer.
- What is the best way to estimate the cost of a gallon of gasoline? Justify your answer.
- Driving speeds and miles per gallon estimates may be based on official statistics on highway traffic from the Environmental Protection Agency and the Department of Energy or on engineering studies of the efficiency of gasoline engines. Which is the more reliable? Why? What are the consequences of using one source rather than another?
- What is the value of a life saved? Explain.
- Which policy is preferable, the 55 mph speed limit or the 65 mph limit that was abandoned in 1994?

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CASE 5.1 OPPORTUNITY COSTS OF SAVING LIVES—THE 55 MPH SPEED LIMIT[41]

Conducting a benefit-cost analysis is not only a technical matter of economic analysis. It is also a matter of identifying, and if necessary challenging, the assumptions on which benefit-cost analysis is based. This can be seen if we examine

Table 5.11 describes steps in conducting a benefit-cost analysis and a critique of the assumptions underlying the analysis. The case shows, among other things, that all steps in conducting a benefit-cost are sensitive to these assumptions.

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CASE 1.1 THE GOELLER SCORECARD—MONITORING AND FORECASTING TECHNOLOGICAL IMPACTS

When advanced technologies are used to achieve policy goals, sociotechnical systems of considerable complexity is created. Although it is analytically tempting to prepare a comprehensive economic analysis of the costs and benefits of such policies, most practicing analysts do not have the time or the resources to do so. Given the time constraints of policy making, many analyses are completed in a period of several days to a month, and in most cases policy analyses do not involve the collection and analysis of new data. Early on in a project, policy makers and their staffs typically want an

Case 1.1 continued ↓

overview of the problem situation and the potential impacts of alternative policies. Under these circumstances, the scorecard is appropriate.

The Goeller *scorecard*, named after Bruce Goeller of the RAND Corporation, is appropriate for this purpose. Table C1.1 shows the impacts of alternative transportation systems. Some of the impacts involve transportation services used by members of the community, whereas others involve impacts on low-income groups. In this case, as Quade observes, the large number of diverse impacts are difficult to value in dollar terms, making a benefit-cost analysis impractical and even impossible.[50] Other impacts involve financial and economic questions such as investments, jobs created, sales, and tax revenues. Other impacts are distributional because they involve the differential effects of transportation. ■

TABLE C1.1

Scorecard

Social Impacts	CTOL	VTOL	TACV
TRANSPORTATION			
Passengers (million miles)	7	4	9
Per trip time (hours)	2	1.5	2.5
Per trip cost ($)	$17	$28	$20
Reduced congestion (%)	0%	5%	10%
FINANCIAL			
Investment ($ millions)	$150	$200	$200
Annual subsidy ($ millions)	0	0	90
ECONOMIC			
Added jobs (thousands)	20	25	100
Added sales ($millions)	50	88	500
COMMUNITY			
Noise (households)	10	1	20
Added air pollution (%)	3%	9%	1%
Petroleum savings (%)	0%	−20%	30%
Displaced households	0	20	500
Taxes lost ($millions)	0	0.2	2
Landmarks destroyed	None	None	Fort X
DISTRIBUTIONAL			
Low-income trips (%)	7%	1%	20%
Low-income household Noise annoyance (%)	2%	16%	40%

Source: Goeller (1974); Quade, *Analysis for Public Decisions* (1975), p. 60.

Note: Conventional takeoff and landing aircraft (CTOL); vertical takeoff and landing aircraft (VTOL); tracked air-cushion vehicle (TACV).

- What assumptions govern estimates of the [illegible] of time lost driving? Are some assumptions more reliable than others? Why?
- What is the best way to estimate the value of time? Justify your answer.
- What is the best way to estimate the cost of a gallon of gasoline? Justify your answer.

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are the consequences of using one source rather than another?

- What is the value of a life saved? Explain.
- Which policy is preferable, the 55 mph speed limit or the 65 mph limit that was abandoned in 1994?

CASE 5.1 OPPORTUNITY COSTS OF SAVING LIVES—THE 55 MPH SPEED LIMIT[41]

Conducting a benefit-cost analysis is not only a technical matter of economic analysis. It is also a matter of identifying, and if necessary challenging, the assumptions on which benefit-cost analysis is based. This can be seen if we examine the case of the National Maximum Speed Limit

Table 5.11 describes steps in conducting a benefit-cost analysis and a critique of the assumptions underlying the analysis. The case shows, among other things, that all steps in conducting a benefit-cost are sensitive to these assumptions. ■

Case 5.1 continued

TABLE 5.11

Measuring the Costs and Benefits of the 55 mph Speed Limit: A Critical Appraisal

Steps	Critique
Costs	
1. The major cost of the National Maximum Speed Law (NMSL) was the additional time spent driving as a result of slower speeds. To calculate the number of hours spent driving in 1973, divide the total number of vehicle miles traveled on interstate highways by the average highway speed (65 mph) and then multiply by the average occupancy rate per vehicle, which is approximately 1.77 persons.	*Why use 1973 mileage without any adjustment? The average growth rate in travel before 1973 was 4 percent. Therefore, the formula should be*
Next, find the number of hours spent driving in 1974 by dividing total vehicle miles traveled on interstate highways by the average highway speed in 1974 (58 mph). The NMSL caused some people to cancel trips and others to find alternative modes of transportation; as a result, time calculations based on 1974 mileage would be an underestimate. Therefore, we should use the 1973 mileage of 525 million miles.	$H = \left(\frac{VM_{1973}}{S_{1974}} - \frac{VM_{1973}}{S_{1973}} \right) \times R$
Using the following formula, where VM is vehicle miles, S is average speed, R is average occupancy rate, and H is the number of hours lost, $H = \left(\frac{1.04VM_{1973}}{S_{1974}} - \frac{VM_{1973}}{S_{1973}} \right) \times R$	*Using the above formula, the estimated number of hours lost should be 1.95 billion—not 1.72 billion.*
The number of hours lost driving in 1974, based on this equation, is estimated to be 1.72 billion.	
2. To estimate the value of this time, begin with the average wage rate for all members of the labor force in 1974—$5.05. The value of one hour's travel is not $5.05 per hour because very few persons would pay this sum to avoid an hour of travel. We estimate that the people will pay up to 33 percent of their average hourly wage rate to avoid an hour of commuting. The value of time spent traveling is therefore about $1.68 per hour.	*Why take a percentage of the $5.05 figure based on what commuters would pay to avoid an hour of travel? We should avoid reducing the value of people's time for two reasons. First, the value of time in cost to society is equal to what society will pay for productive use of that time. Time's value is not what a commuter will pay to avoid commuting because commuting has other benefits, such as solitude for thinking or the advantages of suburban living. Second, the value of time spent driving for a trucker is many times the industrial wage rate. Discounting would greatly underestimate the value of commercial drivers.*
3. Application of the cost figure ($1.68) to the time lost figure (1.72 billion hours) results in an estimated	*Applying the value of one hour's time to the hours lost as calculated above (1.95 billion) results in an estimated travel*

Case 5.1 continued

4. The NMSL also has some enforcement costs. Total enforcement costs for signs, advertising, and patrolling are about $810,000.

Total enforcement cost should be about $12 millior $810,000.

   a. New signs were posted. Cost estimates from 25 states for modification of speed limit signs totaled $707,000; for 50 states, this results in an estimated $1.23 million. Spread out over the three-year life of traffic signs, we get an estimate of $410,000.

OK.

   b. The federal government engaged in an advertising campaign encouraging compliance. The Federal Highway Administration's advertising budget for 1974 was $2 million. About 10 percent of this, or $200,000, was spent to encourage compliance with the NMSL. Assume that an additional amount of public service advertising time was donated, for a total of $400,000.

Not OK. The Federal Highway Administration dc advertising. Public service advertising estimate a

   c. Compliance costs are difficult to estimate. The cost of highway patrols cannot be used because these persons were patrolling highways before the NMSL. Assume that states did not hire additional personnel solely for enforcement of the NMSL. Therefore, we assume that enforcement of the NMSL will not entail any additional costs above enforcement of previous speed limits.

Compliance costs pose some problems, but they estimated. In 1973, some 5,711,617 traffic cita 1,713,636 to over 7.4 million. Each additional includes an opportunity cost to society. If a law officer were not issuing traffic tickets, he or she other crimes. Assuming that it requires 15 min enforcement officer to issue a speeding ticket, t enforcement is $2.9 million. This figure is base cost of placing a law enforcement officer on th per hour. This figure is clearly an underestima not count time lost waiting to catch speeders. Approximately 10 percent of all speeders wil hearing. Estimating an average of 30 minute and an hourly court cost of $45 results in an society of $3.8 million for 171,000 cases. G court dockets, this opportunity cost may be

Benefits

1. The most apparent benefit of the NMSL is the amount of gasoline saved. The average gasoline economy improves from 14.9 miles per gallon at 65 miles per hour to 16.1 at 58 miles per hour. Use this information to estimate the number of gallons of gasoline saved by traveling at lower [illegible] will be calculated by the

Why estimate gasoline saved by comparin miles-per-gallon figures in relation to vehic The federal figures for average miles per h based on several assumptions. Given the c industry estimates, Environmental Protec estimates, and Energy Department estima per-hour estimate must be considered unr [illegible] is also based on

Case 5.1 continued

$$G = \frac{VM_{1973}}{MPG_{1973}} - \frac{VM_{1973}}{MPG_{1974}}$$

$$= 3.487 \text{ billion gallons}$$

In 1974, the average price of gasoline was 52.8 cents per gallon. This market price, however, does not reflect the social cost of gasoline, due to government price controls on domestic oil. The marginal (or replacement) cost of crude oil is the price of foreign oil. Therefore, the price of gasoline must reflect the higher cost of foreign oil. Use the market price of gasoline in the absence of price controls, which is about 71.8 cents per gallon. This figure yields an estimate of $2.50 billion in benefits through gasoline saved.

Studies of the efficiency of gasoline engines show that the effect of reducing the average speed of free-flow interstate highways would be to save 2.57 percent of the normal gas used. In 1979, American motorists consumed 106.3 billion gallons of gasoline. Saving 2.57 percent would total 2.73 billion gallons.

Why use the market price? There is no way to determine whether a marginal gallon of gasoline will be imported or come from domestic reserves. In addition, the costs and benefits of the NMSL should not be distorted simply because the U.S. government does not have a market-oriented energy policy. In 1974, gasoline cost 52.8 cents per gallon, and therefore, a gallon of gasoline saved was worth 52.8 cents.

2. A major second-order benefit of the 55 mph limit was a large drop in traffic fatalities, from 55,087 in 1973 to 46,049 in 1974. Part of the gain must be attributable to reduction in traffic speeds. Studies by the National Safety Council estimate that up to 59 percent of the decline in fatalities was the result of the speed limit. Applying this proportion to the decline in fatalities provides an estimated 5,332 lives saved. The consensus of several studies is that a traffic fatality costs $240,000 in 1974 dollars. Using this figure, the value of lives saved in 1974 is estimated at $1,279.7 million.

OK.

3. The NMSL also resulted in a reduction of nonfatal injuries. Use the 59 percent figure found in the fatality studies. Between 1973 and 1974, nonfatal traffic injuries declined by 182,626. Applying the estimated percentages results in 107,749 injuries avoided. Generally, three levels of injuries are indentified: (1) permanent total disability, (2) permanent partial disability and permanent disfigurement, and (3) nonpermanent injury. In 1971, the proportion of traffic injuries that accounted for injuries in each category was 0.2 percent, 6.5 percent, and 93.3 percent, respectively. The National Highway Traffic Safety Administration

OK.