**Chapter 2 Exercises**
**Conceptual Foundations of Cost-Benefit Analysis**

**1. Many experts claim that, although VHS came to dominate the video recorder market, Betamax was a superior technology. Assume that these experts are correct, so that, all other things equal, a world in which all video recorders were Betamax technology would be Pareto superior to a world in which all video recorders were VHS technology. Yet it seems implausible that a policy that forced a switch in technologies would be even potentially Pareto improving. Explain.**

**1.** Obviously, the switch itself from Betamax to VHS would be costly: the stocks of existing VHS tapes and equipment would lose their value and equipment for producing them would have to be retired earlier than would otherwise be the case. As the replacement would almost certainly occur gradually, there would be a transition period during which positive "network" externalities, the benefits from having compatible systems, would be reduced.

More generally, it is important to keep in mind the distinction between Pareto efficient outcomes and Pareto efficient moves. If everyone were at least as well off, and some were better off, in some alternative to the status quo, then the alternative would be considered Pareto superior. Yet, if the move to the alternative were sufficiently costly, then it would not be Pareto improving. Only if the move were costless, the common assumption in the comparison of alternative equilibria in economic theory, would the Pareto efficiency of outcomes correspond to the Pareto efficiency of moves. In the real world, moves are rarely costless so that policy alternatives are best thought of as moves rather than as outcomes.

**2. Let's explore the concept of willingness to pay with a thought experiment. Imagine a specific sporting, entertainment, or cultural event that you would very much like to attend-perhaps a World Cup match, the seventh game of the World Series, a Bruce Springsteen concert, or an opera starring Renée Fleming performance.**

**a. What is the most you would be willing to pay for a ticket to the event?**
**b. Imagine that you won a ticket to the event in a lottery. What is the minimum amount of money that you would be willing to accept to give up the ticket?**
**c. Imagine that you had an income 50 percent higher than it is now, but that you didn't win a ticket to the event. What is the most you would be willing to pay for a ticket?**
**d. Do you know anyone who would sufficiently dislike the event that they would not use a free ticket unless they were paid to do so?**
**e. Do your answers suggest any possible generalizations about willingness to pay?**

**2.a.** Students' answers will vary (they should be > or = 0).

**2.b.** Most people would be willing to pay less to obtain something than the amount of compensation they would require to give the same thing up willingly if they already owned it. This difference has been frequently observed and economists refer to it as "the difference between willingness to pay and willingness to accept." Though some of the difference may be attributable to the lower wealth level of the individual in the first case than in the second case, it almost certainly also reflects the way people perceive gains and losses.

**2.c.** Willingness to pay depends on people's wealth. If a person's income rises, then the person is wealthier and is likely to be willing to pay more for goods such as tickets to recreational events. (Recreational events are normal goods.)

**2.d.** Different people can have very different willingness-to-pay amounts for the same good. Indeed, it is quite likely that some people would have a negative willingness to pay for a recreational event that others would be willing to pay large positive amounts to attend – tastes differ. In CBA, it is important to keep in mind that a project effect may simultaneously be viewed by some as a benefit and by others as a cost.

**3. How closely do government expenditures measure opportunity cost for each of the following program inputs?**

a. **Time of jurors in a criminal justice program that requires more trials.**
b. **Land to be used for a nuclear waste storage facility that is owned by the government and located on a military base.**
c. **Labor for a reforestation program in a small rural community with high unemployment.**
d. **Labor of current government employees who are required to administer a new program.**
e. **Concrete that was previously poured as part of a bridge foundation.**

**3.a.** Most jurisdictions pay jurors a small per diem and reimburse them for commuting and meal expenses. For most jurors, these payments fall short of the opportunity costs of their time. For employed workers, a more reasonable estimate of the opportunity cost of their time would be their wage rates. Note that, from the social perspective, it makes no difference whether or not workers continue to receive their wages while on jury duty. Society is forgoing their labor, which the market values at their wage rates. For those not employed, the opportunity cost is the value they place on their forgone leisure.

**3.b.** Assume that the government does not charge itself for the use of land that it owns. As long as the land could be used for something other than a nuclear waste facility, the government's accounting would underestimate the opportunity cost of the land. If the land could be sold to private developers, for example, then its market price would be a better reflection of its opportunity cost. If the fact that the land is on a military base precludes its sale to private developers, then the opportunity cost of the land would depend on the other uses to which it could be put by the government.

**3.c.** Government expenditures on wages would overestimate the opportunity cost if the workers would have otherwise been unemployed. The opportunity cost of the workers is the value they place on the leisure time that they are giving up.

**3.d.** As the employees are already on the government payroll, the diversion of their time to the program would not involve additional expenditures. The opportunity cost of their time depends on how they would have been using it in the absence of the program. If the government efficiently used labor, then the opportunity cost of their time would be measured by their wage rates. If the government inefficiently used labor, so that the value of output given up per hour diverted is less than their wage rate, then the opportunity cost would be less than the wage rate.

**3.e.** Once it is in place, the concrete has zero opportunity cost if it cannot be salvaged and reused, regardless of whether or not the government has yet paid the bill for it. This is the classic case of a "sunk cost." Indeed, imagine that if the bridge project were to be cancelled. Then, for safety reasons, the concrete would have to be removed, requiring the use

labor and equipment. Consequently, with respect to the bridge project, the opportunity cost of the concrete is negative – not having to remove it is a benefit of continuing the project!

**4. Three mutually exclusive projects are being considered for a remote river valley: Project R, a recreational facility, has estimated benefits of $20 million and costs of $16 million; project F, a forest preserve with some recreational facilities, has estimated benefits of $26 million and costs of $20 million; project W, a wilderness area with restricted public access, has estimated benefits of $10 million and costs of $2 million. In addition, a road could be built for a cost of $8 million that would increase the benefits of project R by $16 million, increase the benefits of project F by $10 million, and reduce the benefits of project W by $2 million. Even in the absence of any of the other projects, the road has estimated benefits of $4 million.**

a. **Calculate the benefit-cost ratio and net benefits for each possible alternative to the status quo. Note that there are seven possible alternatives to the status quo: R, F, and W, both with and without the road, and the road alone.**
b. **If only one of the seven alternatives can be selected, which should be selected according to the CBA decision rule?**

**4.a.** The seven possible alternatives to the status quo have the following costs (millions), benefits (millions), benefit/cost ratios, and net benefits (millions):

| **Alternative** | **B** ($) | **C** ($) | **B/C Ratio** | **NB** ($) |
|---|---|---|---|---|
| Project R without road | 20 | 16 | 1.25 | 4 |
| Project R with road | 36 | 24 | 1.50 | 12 |
| Project F without road | 26 | 20 | 1.30 | 6 |
| Project F with road | 36 | 28 | 1.38 | 8 |
| Project W without road | 10 | 2 | 5.00 | 8 |
| Project W with road | 8 | 10 | 0.80 | -2 |
| Road alone | 4 | 8 | 0.50 | -4 |

**4.b.** Even though Project W without the road has the largest benefit/cost ratio, Project R with the road offers the largest net benefits among the possible projects and therefore would be selected by the CBA decision rule.

**5. An analyst for the U.S. Navy was asked to evaluate alternatives for forward-basing a destroyer flotilla. He decided to do the evaluation as a CBA. The major categories of costs were related to obtaining and maintaining the facilities. The major category of benefit was reduced sailing time to patrol routes. The analyst recommended the forward base with the largest net benefits. The admiral, his client, rejected the recommendation because the CBA did not include the risks to the forward bases from surprise attack and the risks of being unexpectedly ejected from the bases because of changes in political regimes of the host countries. Was the analyst's work wasted?**

**5.** The analyst was mistaken in attempting to apply CBA as a decision rule to alternative policies that had impacts that could not easily be monetized. Nevertheless, the analysis could be restructured as a multigoal analysis with three goals: maximize economic efficiency, reduce vulnerability to surprise attack, and reduce risks from political changes in host country. In this analysis, the net benefits estimated in the CBA can be taken as a

criterion for ranking alternatives in terms of maximizing economic efficiency. Thus, CBA is useful in this evaluation not as a decision rule, but rather as a way of systematically measuring progress toward one of several important goals.

**6. Because of a recent wave of jewellery store robberies, a city increases police surveillance of jewellery stores. The increased surveillance costs the city an extra $500,000 per year, but as a result, the amount of jewellery that is stolen falls. Specifically, without the increase in surveillance, jewellery with a retail value of $900,000 would have been stolen. This stolen jewellery would have been fenced by the jewellery thieves for $600,000. What is the net social benefit resulting from the police surveillance program?**

**6.** As a result of the increase in surveillance, the jewellery stores (or their insurance companies) receive benefits of $900,000, taxpayers incur costs of $500,000, and the jewellery robbers incur costs of $600,000.

The answer to this question depends on whether the jewellery robbers are given standing. After all, they are (unfortunately) part of society.

If the robbers are given standing, society suffers a $200,000 net loss:
$900,000 - $500,000 - $600,000 = -$200,000.

If the robbers are not given standing, which would appear to be the more appropriate approach, society enjoys a $500,000 net benefit from the surveillance project:
$900,000 - $500,000 = $400,000.

**7. (Spreadsheet recommended.) Excessive and improper use of antibiotics is contributing to the resistance of many diseases to existing antibiotics. Consider a regulatory program in the United States that would monitor antibiotic prescribing by physicians. Analysts estimate the direct costs of enforcement to be $40 million, the time costs to doctors and health professionals to be $220 million, and the convenience costs to patients to be $180 million (all annually). The annual benefits of the program are estimated to be $350 million in avoided resistance costs in the United States, $70 million in health benefits in the United States from better compliance with prescriptions, and $280 million in avoided resistance costs in the rest of the world. Does the program have positive net benefits from the national perspective? If not, what fraction of benefits accruing in the rest of the world would have to be counted for the program to have positive net benefits?**

**7.** The provided spreadsheet shows the following:

| | | Millions of Dollars |
|---|---|---|
| **Regulatory program to monitor antibiotic prescribing by U.S. physicians to reduce the spread of resistant strains** | Regulatory enforcement | 40 |
| | Time cost to doctors | 220 |
| | Convenience cost to patients | 180 |
| | **Total U.S. Costs** | **440** |
| | | |
| | Avoided U.S. resistance costs | 350 |
| | Better drug compliance | 70 |
| | **Total U.S. Benefits** | **420** |

| | |
|---|---|
| Avoided non-U.S. resistance costs | 280 |
| Fraction counted as U.S. Benefits | 0 |
| **U.S. Net Benefits** | **-20** |

To determine what fraction of benefits to non-U.S. resistance costs would have to be included in the CBA to show zero benefits can be determined by changing the value of cell C13 until U.S. Net Benefits rise to zero. Any larger fraction will then yield positive net benefits. The net benefits are about $20,000 when the fraction equals .0715. This might be a good time to talk to students about rounding –here, $20,000 should be rounded to zero.