B.E. International Program

Faculty of Economics, Thammasat University

EE 465/463 Project Evaluation

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Practice Problem 2 – Suggested Answers

1. Boardman et al., chapter 6 question 2

A government data processing center has been plagued in recent years by complaints from employees of back pain. Consultants have estimated that upgrading office furniture at a net cost of $425,000 would reduce the incidence and severity of back injuries, allowing the center to avoid medical care that currently costs $68,000 each year. They estimate that the new furniture would also provide yearly benefits of avoided losses in work time and employee comfort worth $18,000. The furniture would have a useful life of five years, after which it would have a positive salvage value equal to 10 percent of its initial net cost. The consultants made their estimates of avoided costs assuming that they would be treated as occurring at the beginning of each year.

In its investment decisions, the center uses a nominal discount rate of 9.5 percent and an assumed general inflation rate of 3 percent. It expects the inflation rate for medical care will run between 3 percent and 5 percent but is uncertain as to the exact rate. In other words, it is uncertain as to whether the cost of medical care will inflate at the same rate as other prices or rise 2 percent faster. Should the center purchase the new furniture?

Answer:

First, convert the nominal discount rate to a real discount rate: $d = (.095-.03)/(1+.03) = .063$.

A major benefit is avoided medical care costs. If it is assumed that the price of medical care inflates at the same rate as the general price level, then all the costs and benefits are in real dollars and the present value can be calculated as:

$$\begin{aligned}NPV &= (-\$425{,}000 + \$68{,}000 + \$18{,}000) \\ &\quad + (\$68{,}000 + \$18{,}000)/(1+.063)^1 \\ &\quad + (\$68{,}000 + \$18{,}000)/(1+.063)^2 \\ &\quad + (\$68{,}000 + \$18{,}000)/(1+.063)^3 \\ &\quad + (\$68{,}000 + \$18{,}000)/(1+.063)^4 \\ &\quad + (\$42{,}500)/(1+.063)^5 \\ &\quad = -\$339{,}000 + \$80{,}903 + \$76{,}108 + \$71{,}598 + \$67{,}354 + \$31{,}313 \\ &\quad = -\$11{,}724.\end{aligned}$$

If, instead, it is assumed that the price of medical care inflates 2 percent faster than the general price level, then the net benefits are calculated as follows:

$$\begin{aligned}NPV &= (-\$425{,}000 + \$68{,}000 + \$18{,}000) \\ &\quad + (\$69{,}360 + \$18{,}000)/(1+.063)^1 \\ &\quad + (\$70{,}747 + \$18{,}000)/(1+.063)^2 \\ &\quad + (\$72{,}162 + \$18{,}000)/(1+.063)^3 \\ &\quad + (\$73{,}605 + \$18{,}000)/(1+.063)^4 \\ &\quad + (\$42{,}500)/(1+.063)^5 \\ &\quad = -\$339{,}000 + \$82{,}183 + \$78{,}539 + \$75{,}063 + \$71{,}744 + \$31{,}313 \\ &\quad = -\$158\end{aligned}$$

In this case, the purchase would not pass the net benefits test if it were assumed that medical care prices will rise at the general rate of inflation, or if it were assumed medical care prices will rise 2 percent faster than the general rate of inflation. Though medical care prices have appeared to rise substantially faster than other prices in recent years in the United States, some of the faster increase may result because medical care price indexes do not take full account of improvements in the quality of care.

2. Boardman et al., chapter 6 question 4

The environmental protection agency of a county would like to preserve a piece of land as a wilderness area. The current owner has offered to lease the land to the county for 20 years in return for a lump-sum payment of $1.1 million, which would be paid at the beginning of the 20-year period. The agency has estimated that the land would generate $110,000 per year in benefits to hunters, bird watchers, and hikers. Assume that the lease price represents the social opportunity cost of the land and that the appropriate real discount rate is 4 percent.

a. Assuming that the yearly benefits, which are measured in real dollars, accrue at the end of each of the 20 years, calculate the net benefits of leasing the land.

Answer:

The present value of the real yearly benefits is most easily calculated using the formula for the present value of an annuity presented in Appendix 6a:

PV(benefits) = ($110,000)[1-(1+.04)$^{-20}$]/(.04) = $1,494,936

NPV = $1,494,936 - $1,100,000 = $394,936

b. Some analysts in the agency argue that the annual real benefits are likely to grow at a rate of 2 percent per year due to increasing population and county income. Recalculate the net benefits assuming that they are correct.

Answer:

First, calculate d_g = (.04-.02)/(1+.02) = .01961

PV(benefits) = [($110,000)/(1+.02)][1-(1+$d_g$)$^{-20}$]/$d_g$] = $1,770,045

NPV = $1,770,045-$1,100,000 = $670,045

3. Boardman et al., chapter 6 question 5

Imagine that the current owner of the land in the previous exercise was willing to sell the land for $2 million. Assuming this amount equaled the social opportunity cost of the land, calculate the net benefits if the county were to purchase the land as a permanent wildlife refuge. In making these calculations, first assume a zero annual growth rate in the $110,000 of annual real benefits; then assume that these benefits grow at a rate of 2 percent per year.

Answer:

The benefit stream can now be viewed as a perpetuity. If the growth rate of benefits is assumed to be zero, then

PV(benefits with zero growth rate) = ($110,000)/(.04) = $2,750,000

NPV(zero growth rate) = $2,750,000 - $2,000,000 = $750,000

PV(benefits with 2% growth rate) = ($110,000)/(.04-.02) = $5,500,000

NPV(benefits with 2% growth rate) = $5,500,000 - $2,000,000 = $3,500,000

Thus, the land should be purchased whether the growth rate is zero or 2 percent.

4. [Optional] Boardman et al., chapter 10 question 1

The following table gives cost and benefit estimates in real dollars for dredging a navigable channel from an inland port to the open sea.

Year	Dredging and Patrol Costs ($)	Saving to Shippers ($)	Value of Pleasure Boating ($)
0	2548000	0	0
1	60000	400000	60000
2	60000	440000	175000
3	70000	440000	175000
4	70000	440000	175000
5	80000	440000	175000
6	80000	440000	175000
7	90000	440000	175000

The channel would be navigable for seven years, after which silting would render it un-navigable. Local economists estimate that 75 percent of the savings to shippers would be directly invested by the firms, or their shareholders, and the remaining 25 percent would be used by shareholders for consumption. They also estimate that all government expenditures come at the expense of private investment. The social marginal rate of time preference is assumed to be 1.5 percent, the marginal rate of return on private investment is assumed to be 4.5 percent, and the shadow price of capital is assumed to be 1.33.

Assuming that the costs and benefits accrue at the end of the year they straddle and using the market-based interest rate approach, calculate the present value of net benefits of the project using each of the following methods:

a. Discount at the marginal rate of return on private investment, as suggested by the U.S. Office of Management and Budget.

b. Discount at the social marginal rate of time preference, as suggested by the U.S. Environmental Protection Agency.

c. Discount using the shadow price of capital method.

d. Discount using the shadow price of capital method. However, now assume that the social marginal rate of time preference is 2.0 percent, rather than 1.5 percent.

e. Discount using the shadow price of capital method. However, now assume that the shadow price of capital is 1.1, rather than 1.3. Again assume that the social marginal rate of time preference is 1.5 percent.

f. Discount using the shadow price of capital method. However, now assume that only 50 percent of the saving to shippers would be directly invested by the firms or their shareholders, rather than 75 percent. Again assume that the social marginal rate of time preference is 1.5 percent and that the shadow price of capital is 1.3.

See the spreadsheet provided.