# Chapter 2

# Health and Health Behaviors

**2.1 A patient with arthritis of the knee is planning to have a knee replacement. He has applied for a loan for this surgery; the loan has an annual interest rate of 6 percent. The artificial knee can function for 10 years before it needs to be replaced. Fees for knee replacement surgery are expected to grow at 5 percent annually.**

**a. Why is an artificial knee a form of health capital?**

An artificial knee could serve as a part of body function for several years, which is similar to capital stock that could yield the flow of return annually in the sense that artificial knee could help a person to work normally every day.

**b. Assume the artificial knee depreciates at a constant rate every year until the time of replacement, which is 10 years hence. What is the cost of this capital?**

As noted in this chapter, cost of capital (COC) = $i+\delta+a$, where $i$ indicates the cost of obtaining a dollar of capital for a period, $\delta$ is the depreciation rate on the capital stock, and $a$ is the appreciate rate of a unit capital. In this case, $i = 0.06$, $\delta = 0.1$, $a = 0.05$. Thus, COC = $0.06+0.1+0.05 = 0.21$.

**c. Suppose that instead of a loan, the patient plans to pay the surgery from his or her own savings. Assume that the bank's interest rate on savings deposits equals its rate on loans. Does this change your answer to (b)? Why or why not?**

COC remains the same in this case because the use of personal saving has its "opportunity cost." That is, this patient needs to give up the return from his or her own saving in order to pay the fees of surgery. This opportunity cost is equal to the bank's interest rate that he or she can learn from saving deposits.

**d. Draw the COC (cost of capital) line on a graph, with health capital on the *x*-axis and the COC rate on the *y*-axis. What is the slope of the COC schedule? Explain why it looks the way it does.**

The COC line is zero slope, that is, a horizontal line because the individual investment on health will not change the market value of i. Also, $\delta$ and a are constant and will not change with respect the amount of health investment.

**2.3 Assume the health production function is *h* = 365 – 1/*H*, where *h* is the number of healthy days a person has in each year and *H* is the person's health capital. Assume this person earns a wage of $100/day, and the marginal cost of health investment π = 25 and is constant over time. The annual interest rate is 5 percent, and health capital depreciates at a rate of 15 percent per annum.**

**a. What does the MEC for this person's health capital look like? Draw the MEC curve on a graph, with health capital on the *x*-axis and the rate of return on the *y*-axis. Explain the shape of this MEC curve.**

MEC = (w × G)/π, where w is wage rate, π is the marginal cost of health investment, and G = dh/dH = $1/H^2$. Given the value given for this question (w = 100, π = 25), MEC = $4/H^2$. Based on this function, MEC is a downward sloping curve as follows:

| MEC (*y*-axis) | 4 | 1 (4/4) | 0.44 (4/9) | 0.25 (4/16) |
|---|---|---|---|---|
| Health (*x*-axis) | 1 | 2 | 3 | 4 |

**b. What is the cost of health capital in this problem?**

As noted in this chapter, the cost of capital (COC) = $i+\delta+a$ . In this case, $i = 0.05$, $\delta = 0.15$ and $a = 0$. Thus, COC = 0.20.

**c. Find the optimal level of health this person demands under the above conditions.**

The optimal level of health capital is solved by MEC = COC.

That is, $4/H^2 = 0.20$. Thus, $H = \sqrt{20} = 4.47$.

**d. Suppose the person acquires a *chronic disease* and his health depreciation rate rises to 35 percent annually. How does this change your answer to part (c)?**

In this case, COC = 0.35+0.15 = 0.5. The optimal level of health capital is solved using $4/H^2 = 0.50$. $H = 2.83$. That is, the optimal level of health capital decreases because the user cost of capital increases.

**e. Suppose instead of having a chronic disease the person experiences a recession and his wage falls to \$50/day. Assume the change in the price of time inputs accounts for 20 percent of the total change in cost of a unit of health investment. Show graphically how this change affects the MEC curve. What is the person's optimal health demand now?**

In this case, w reduces to 50 and $\pi$ reduces to 22.5, then MEC = $50/22.5\text{x}H^2 = 2.22/H^2$. This induces MEC shift to left and the optimal level of health capital reduces to 3.33, which is obtained from $2.22/H^2 = 0.20$.

**f. Now focus on the role of human capital in this model. Suppose a person's educational attainment increases. How does the MEC curve shift in this case? How does this shift affect the person's investment in health capital?**

An increase in a person's educational attainment increases the efficiency in health production and hence reduces the marginal cost of health investment. The MEC schedule shifts to the right and hence increase, the person's optimal health capital stock. However, the increase in education attainment may also increase the supply of health capital given that schooling increases the productivity of health investment. Thus, the effect of increased educational attainment on the person's investment in health's capital (or demand for medical care) is ambiguous a priori.

**2.5 Suppose a person is asked a standard gamble question about three kinds of diseases. For each disease, the person decides to undergo surgery if the expected utility from the operation exceeds or is equal to the patient's utility if he or she does not undergo surgery and continues having the disease. The person's expected utility is therefore $(1 - \Theta)U_a + \Theta U_d$, where $U_a$ is the utility if the operation is successful, $U_d$ is the utility if it fails, and $\Theta$ is the probability of failure. The patient assigns the following probabilities of surgical failure to the diseases:**

| Disease | A | B | C |
|---|---|---|---|
| $\Theta$ | 0.25 | 0.4 | 0.01 |

**a. Assume $U_a = 1$ and $U_d = 0$. Then what is the utility of having each of the diseases if the person is indifferent between having and not having the operation?**

The utilities of being disease states A, B, C are 0.75, 0.6 and 0.99 respectively, which are calculated from 1-$\Theta'$.

**b. If the diseases are liver cancer, glaucoma, and dental caries, which one is most likely to be denoted as A above?**

Disease A is likely to be glaucoma, disease B is likely to be liver cancer, and disease C is likely to be dental caries.

**Viscusi and Evans (1990) took a similar approach to analyzing the loss in utility from being healthy to becoming sick. In the experiment they discussed in their paper, workers were randomly assigned to label four different chemicals: asbestos, TNT, sodium bicarbonate, and chloroacetophenone. The first two chemicals are quite dangerous and could cause death if they exploded. The third is rather harmless, and the fourth will only cause some tearing if proper treatment is not received. The authors asked the workers how much money they would have to receive in compensation if they were reassigned to label another chemical. We will now apply the standard gamble concept to this problem. Assume the workers' utility function is $U(w) = \ln w$, where $w$ is the hourly wage received from the labeling work and $U(\text{death}) = 0$.**

**c. The probability of TNT exploding is $\Theta_{TNT}$, and if it explodes, the worker cannot survive. Also suppose the wage of labeling sodium bicarbonate is $w_S$ per hour. What is the minimum wage a worker must receive if he were reassigned to label TNT as a function of $\Theta_{TNT}$ and $w_S$?**

The minimum wage a worker must receive to label TNT ($w_{TNT}$) must satisfy the following condition:
$\Theta_{TNT}U(\text{death})+(1-\Theta_T)U(w_{TNT}) = U(w_S)$. This equation reduces to $(1-\Theta_{TNT})\ln w_{TNT} = \ln w_S$ by substituting $U(w) = \ln w$ and $U(\text{death}) = 0$ into the equation. Thus, $w_{TNT} = w_S/(1-\Theta_{TNT})$.

**d. Which labeling work must have a higher wage, asbestos or chloroacetophenone?**

Asbestos.

**e. What is the wage function for chloroacetophenone? Use $w_S$ as the benchmark again. Which value(s) do you need to be able to solve this problem?**

Following the same condition shown in question c, the wage function for chloroacetophenone (wc) = $w_S/(1-\Theta c)$, where $\Theta c$ indicates the probability of causing some tearing.

**f. One major implication of Viscusi and Evans's research is that people may have different utility functions when healthy than when sick. Suppose the utility function is $V(w) = 0.5\ln w$ if the worker is sick but alive. How does this change your answer to part (e)?**

The answer is the same as the answer to part (e).