

CHAPTER 2

1. Discuss how health can be classified as a “consumption” good as well as an “investment” good?

As a good, health is desired for consumption and investment purposes. From a consumption perspective, people feel better when they are in a state of good health. The investment element concerns the relation between health and use of time. An individual who is in a state of good health allocates less time to sickness and therefore has more healthy days available to work and enhance her income or to pursue leisure activities.

2. Explain the basic structure of the Grossman model, based on the seven equations that comprise the model.

In Grossman's model, individuals choose their level of health similar to choosing consumption levels of other commodities, and therefore have some control over their health. The main ways in which the demand for health differs from the demand for other goods and services can be encapsulated in the following conditions that set up the basic model:

$$U_t = U(H_t, Z_t);$$

where utility (U) increases with the individual's health status (H) and with other commodities (Z) - such as entertainment, meals and nutrition, and shelter.

$$H_{t+1} = H_t - \delta_t H_t + I_t;$$

where the health stock in the following period (H_{t+1}) equals the current level of health (H_t) less any depreciation ($\delta_t H_t$) plus any investments (I_t).

$$I_t = I(M_t, TH_t; E);$$

where individuals can make investments (I_t) in health by investing medical care or other market inputs (M) and their time devoted to health-producing activities (TH) at each period t .

$$Z_t = Z(X_t, TZ_t; E);$$

where, similar to a production function for health, individuals produce other commodities (Z) using market inputs (X), time inputs (denoted by TZ), and education (E).

$$W \cdot TW = P_M \cdot M + P_X \cdot X;$$

where the income constraint is shown as individual's income, denoted by the product of the wage rate (W) and work time (TW), being expended on market goods M and X at prices P_M and P_X , respectively.

$$TT = TW + TH + TZ + TL;$$

where the individual's time constraint is shown as Total time (TT), measured over some interval such as a day or year, exhausted on work (TW), time spent on health (TH), time spent on other commodities such as meals and socializing (TZ), and time lost due to illness and sick days (TL).

Healthy Days = $(365 - TL) = F(H)$;

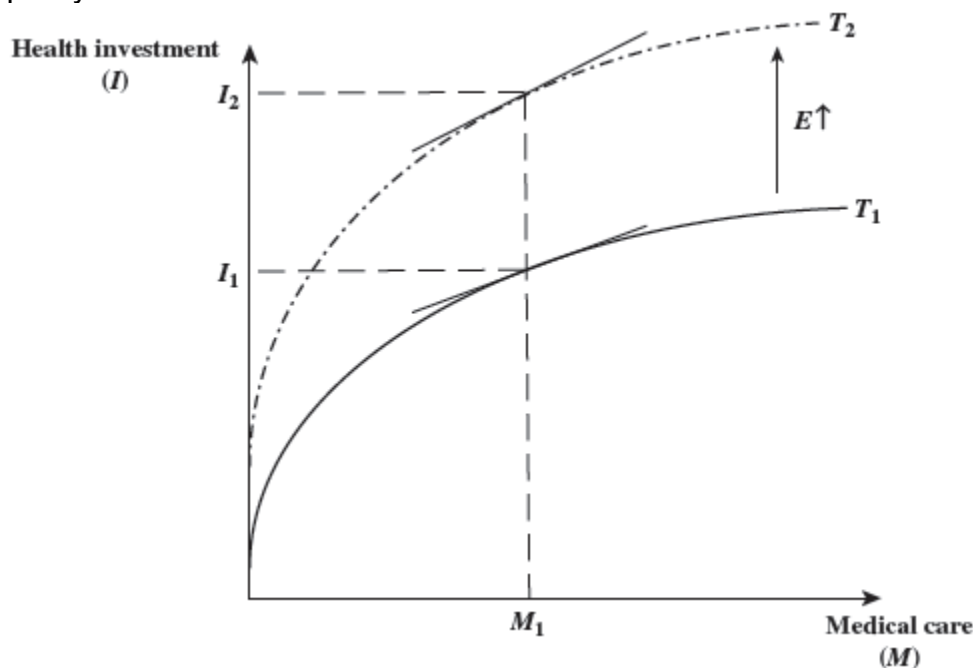
where the number of healthy, productive days $(365 - TL)$ that the individual has is a function of their underlying health stock (H).

3. With the help of a graph, discuss the concept of a health production function. In what sense is the individual considered a “producer” of health in the Grossman model?

A health production function indicates the maximum amount of health that an individual can generate from a specific set of health-related inputs in a given period of time.

Health = $H(\text{Profile, TECH, Environment, SES, Lifestyle, Medical Care})$

where, at a point in time, Health reflects the person's level of health; Profile captures the individual's mental, social, and physical profile at the beginning of the period in addition to uncontrollable factors like age, race, and gender; TECH refers to the state of medical technology; Environment stands for a variety of environmental factors, including air and water quality along with any public health measures; SES reflects the joint effect of social and economic factors, such as education, income, and poverty; Lifestyle represents a set of health-related choices such as diet and exercise; and Medical care equals the quantity and quality of medical care consumed.



A patient often acts as both producer and consumer. Without the patient's active participation, the medical product is likely to be poorly produced.

4. Explain the education-health causality debate in the context of the Grossman model. What does the model say about the education-health relationship—that is, how does education affect the optimal health stock in the model? What are some other explanations of the observed positive relation between education and health?

A higher level of health may cause the intercept term of the health production function and the marginal product of medical care to increase. For example, since education is likely to make the individual a more efficient producer of health independently of the amount of medical care consumed, the total product curve shifts upward. An individual with more education is likely to better understand the positive impact of a healthy diet on health. The total product curve also steepens, or the marginal product of medical care increases, because education allows the person to utilize each unit of medical care consumed more effectively. For example, an educated individual may be more inclined to understand and follow a physician's advice concerning diet and exercise after undergoing a heart bypass operation. In addition, she or he may be able to recognize a medical problem early and seek medical care quickly when the effectiveness of medical treatment is generally at its maximum. However, it may also be possible that health affects education. A chronically ill child is more likely to miss school, learn less while attending school, and in the end acquire less education. Over time, what the researcher may observe is a less healthy adult with only a modest level of education. Some analysts hypothesize that higher levels of education may be associated with better health not because there is a direct link between the two variables but because both variables are directly correlated with a third factor, the degree to which future events are valued.

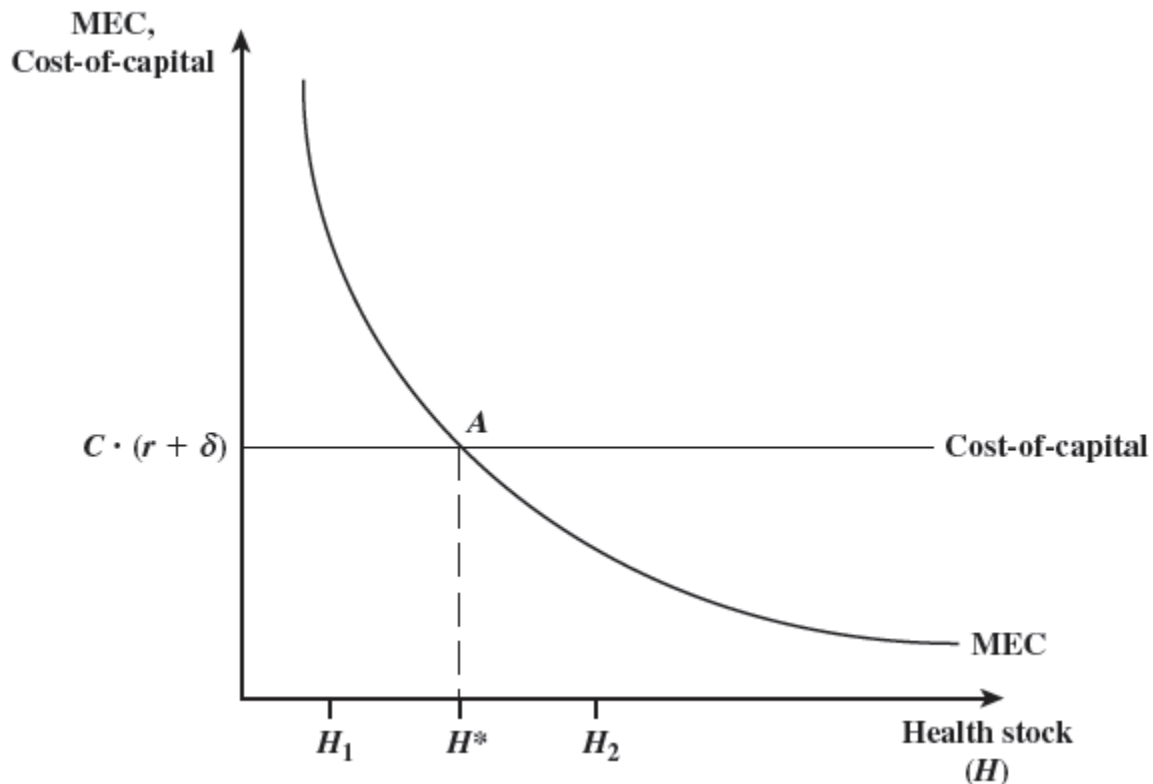
5. Discuss how the optimal demand for health is determined in the Grossman model based on the MEC and cost-of-capital.

$$\text{MEC} = \text{MPH} \cdot \text{Wage}$$

Assume that an individual values wage as the opportunity cost of time. The marginal efficiency of capital is the product of the marginal product of health and the wage rate. The MEC captures the value of the additional healthy days gained from a one-unit increase in the health stock. The downward slope of the MEC is due to the diminishing marginal product of health. The MEC curve can be interpreted as the demand curve for health capital. The cost of an additional unit of health stock is the price of the resources used to invest in health (C) multiplied by the sum of the real interest rate (r) and the depreciation rate (δ).

$$\text{Cost-of-capital} = C \cdot (r + \delta)$$

The cost-of-capital curve can be interpreted as the supply curve of health capital. It is horizontal since the individual typically does not have control over the market prices or the real interest rate.



The rational individual will invest up to the point where the marginal efficiency of capital (MEC) equals the cost-of-capital. In the figure, this occurs at a health stock of H^* .

6. What is the effect of an increase in education on the demand for medical care?

There is a strong positive correlation between education and health. This correlation persists even after controlling for income which on average is higher among educated persons. Education raises the marginal product of health (MPH); this reflects an increase in efficiency in the production of health. The higher MPH raises the marginal benefits or returns to health investment, and shifts the MEC curve upwards. At the new equilibrium, optimal health stock is higher.

7. What is the effect of an increase in wages on the demand for medical care?

The MEC equals the wage rate (W) times the marginal product of health (MPH): $MEC = W \cdot MPH$. Thus, higher wages lead to a higher marginal efficiency of investment. An individual with a higher wage rate has a higher opportunity cost of being sick; since investments in health reduce time lost to illness and this extra

time can be used to earn income, higher wages raise the return to health. This shifts the MEC or the demand curve for health capital upwards.

8. Using the Grossman model, discuss what happens to the demand for health and the demand for medical care when the price of medical care (P_m) increases.

With respect to the demand for medical care, an increase in the price of medical care has two effects. Both predict that an increase in medical care prices will reduce the demand for medical care. The scale effect indicates that, since the individual's optimal health output is lower, he needs and therefore demands less medical care to produce the lower level of health. The substitution effect relates to the optimal mix of inputs to be used in producing a given output. Since the price of medical care is now higher, and wages (and all other factors) are assumed to remain unchanged, it is cheaper for individuals to produce health using their time rather than with medical care. For instance, if the price of a doctor visit or prescription drugs increases, an individual might find it cheaper to produce health with exercise and diet rather than through medications and doctor visits.

9. Using the Grossman model, discuss two factors that may have led to the increase in obesity in the United States.

During the past three decades, the number of obese adults has more than doubled to about 34 percent of the population. As Chou et al., (2004) note, no one desires to be obese; rather obesity is a by-product of other factors that the individual desires such as health, palatable eating, and other activities. The following extensions can be built into the Grossman model: (1) Certain experiences, such as a palatable meal or lack of rigorous exercise, directly raise utility because they are enjoyable but also indirectly reduce utility because they adversely affect one's health by increasing obesity. (2) Exercise may reduce utility for some individuals (some persons do not enjoy exercising per se). Higher real wage rates have raised the opportunity cost of time and also raised real income. More women have entered the labor force in the past three decades, which has reduced total available nonwork time for the household. All else equal, this would predict a decline in exercise (a relatively time-intensive activity).

10. Using the Grossman model, discuss two factors that may explain why individuals in less developed nations have a lower life expectancy relative to those in more developed nations.

Developing and developed nations have different levels of per capita income, education, and health infrastructure. An individual's wage rate affects his/her stock of health. In a developing nation, the per capita income is lower as compared to a developed nation. So an individual's stock of health is lesser in a developing nation as compared to that of an individual belonging to a developed

nation. Grossman also suggests that better education leads to better health as education raises an individual's efficiency in health production. The education level in a developing nation is likely to be lesser than that of a developed nation. Consequently, the stock of health of an individual in a developing nation is also lower than an individual belonging to a developed nation. Wage rates and education can be two vital factors, according to Grossman's model, which can explain why less developed nations have a lower life expectancy relative to those in more developed nations.