

3

Demand for Health: The Grossman Model

Comprehension Questions

Indicate whether the statement is true or false, and justify your answer. Be sure to cite evidence from the chapter and state any additional assumptions you may need. Review the basic assumptions of the Grossman model before answering these questions.

1. In real life, investments in health can generate long-lasting benefits, but the Grossman Model neglects this aspect of health.

FALSE. One of the central features of the model is that health is (in part) an investment good. If someone invests in his health today, it will be higher both today and in the future.

2. In the framework of the Grossman model, one's level of health is completely controlled by her actions. Thus, in any given period, an individual is unconstrained in her choice of health status.

FALSE. Individuals do have a lot of control over their health level, but there may be high levels of health that they cannot achieve given time and income constraints. If someone invests all her time and money in improving health, she may still not be as healthy as she would like.

3. In the Grossman model, the marginal efficiency of investment in health care declines as health improves.

TRUE. Someone who is very unhealthy receives major dividends from even a small improvement in health, but someone who is already very healthy receives little benefit.

4. Aging shifts the marginal efficiency of investment in health curve inward.

FALSE. As aging occurs, the depreciation rate of health increases. This results in a movement along the marginal efficiency of investment curve upward, which implies worse optimal health.

5. An hour spent exercising always pays for itself by decreasing the time spent sick by more than an hour.

FALSE. This is only true in the “free lunch zone.” Once a certain level of health is attained, an hour spent exercising generates less than an hour of additional productive time.

6. Assume the PPF is as pictured in Figure 3.3. People might choose point *E* as their optimum even if they value the home good *Z*.

FALSE. The only way someone might choose point *E* is if his indifference curves are vertical. But a vertical indifference curve means he does not value the home good, *Z* at all.

7. In the Grossman model, optimal health status declines with age.

TRUE. See Figure 3.13 for an explanation.

8. The fact that older people spend more on health care is evidence against the Grossman model, which predicts that spending will decline as δ increases.

FALSE. The Grossman model predicts that health optimally declines with age; it does not predict that health expenditures decline with age. The effect of aging on health expenditures is ambiguous in the Grossman model. As you age, you need to spend more money and time on health to maintain a fixed level because of the increasing depreciation rate of health capital.

9. People who drop out of high school are able to produce more health than college graduates because they have more free time to invest in health production.

FALSE. In the Grossman model, more education shifts out the marginal efficiency of investment curve. This means that better educated people have a

PPF that is shifted upwards relative to people with fewer years of education. Thus, better educated people spend less time sick and have more productive time overall. See Figure 3.14.

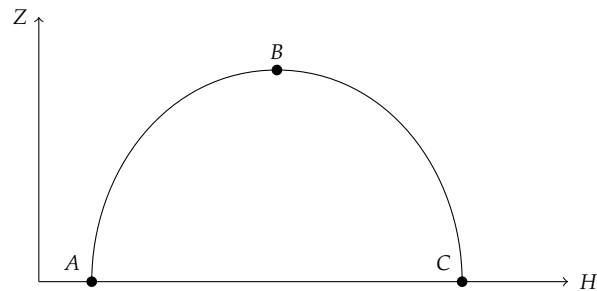
10. According to the Grossman model, people choose an optimal time to die (barring any unforeseen accidents).

TRUE. In the Grossman model, death occurs when it no longer makes sense to invest in health because the depreciation rate of health capital is so high.

Analytical Problems

11. The Grossman model envisions consumers deciding between investments in health H and investments in home goods Z . Figure 3.15 depicts a typical consumer's production possibility frontier for health and home goods.

Figure 3.15: The PPF in the Grossman model.



- (a) Succinctly describe why the graph is shaped the way it is between points A and B.

The main reason is that the health production function exhibits diminishing returns in health investment. Between A and B, small investments in health result in such large improvements in health (and hence large declines in the time spent ill). The extra time not spent ill more than replaces the time required in health investment to produce the extra time. Hence, the consumer can have both more health and more home goods over this portion of the curve.

- (b) Succinctly describe why the graph is shaped the way it is between points B and C.

BC is downward sloping for the same reason that AB is upward sloping: diminishing returns in health investment. The difference is that between B and C, the consumer has hit the flat part of the health investment curve. Hence the time spent on health investment does not decrease time spent sick by enough to offset the time exercising (for instance). To increase health over this portion of the curve thus requires a level health investment that will take time away from other productive activities, which will lead to fewer home goods.

- (c) Would any consumer with typical preferences ever pick a point on the graph between A and B? Explain succinctly (using Figure 3.15) why or why not.

No. Indifference curves are downward sloping in the Health-Home Goods space, since both are desirable. People choose health and home goods subject to the PPF graph above. The optimum occurs where the indifference curve and the PPF are tangent. Since the indifference curves are downward sloping, this tangency can only occur on the downward sloping portion of the PPF – that is, between B and C.

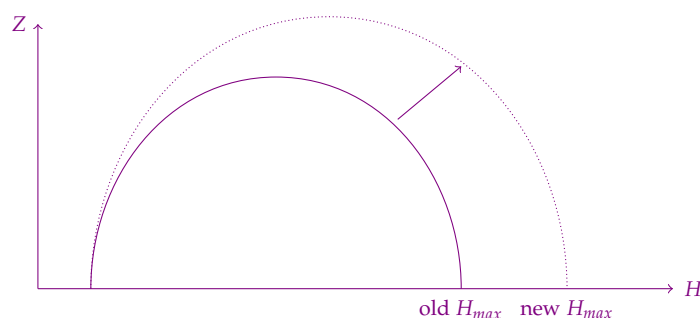
12. Suppose a new miracle pill is discovered that increases both the marginal health effects of health investment (at any given level of health investment) and the maximum level of attainable health from H_{max} to a higher H_{max} .
- (a) Draw the old production possibility frontier before the discovery of the miracle pill.

The old production possibility frontier looks just like Figure 3.15.

- (b) On this same graph, draw a new production possibility frontier that corresponds to the description of the miracle pill.

The graph below shows what the new health production technology might look like before and after the discovery of the new pill. Because the pill shifts out the health production technology, it expands the production possibility frontier.

Response to exercises 12(a) and (b).



- (c) How will the miracle pill affect H^* ?

The PPF bulges out because the increased efficiency of health investment brought about by the miracle pill enables the consumer to produce any given level of health with less health investment (holding all else equal) since it increases the marginal productivity of health investment. Thus, the consumer can use those extra resources either to improve health or for additional home production, or both.

- (d) How will the miracle pill affect the rate of jogging?

The pill's effect on jogging (a form of non-market health investment) is theoretically ambiguous. The pill increases the marginal return to health investment, so less health investment is needed to achieve any given health level. This means people could substitute the pill for jogging and have more time to watch TV. However, the pill also makes each minute of jogging more efficient, so people might start to jog more and enjoy even higher levels of health. These competing effects are akin to the income and substitution effects that occur when one's wage changes.

13. **Differences in wage levels.** Suppose Individual *A* received a much better education than Individual *B*, and consequently earns twice as much per hour of labor.

- (a) If both individuals work 40 hours a week, who will have greater H^* ? Why?

A will have a higher level of optimal health, H^* , because her marginal efficiency of health capital will be shifted to the right of *B*'s curve. This is partly because *A* will have more money to spend on her health status than *B*, and partly because *A*'s health production function is above *B*'s (due to *A*'s superior education).

- (b) If both individuals work enough hours so as to earn exactly \$50,000 per year, who will have greater H^* ? Why?

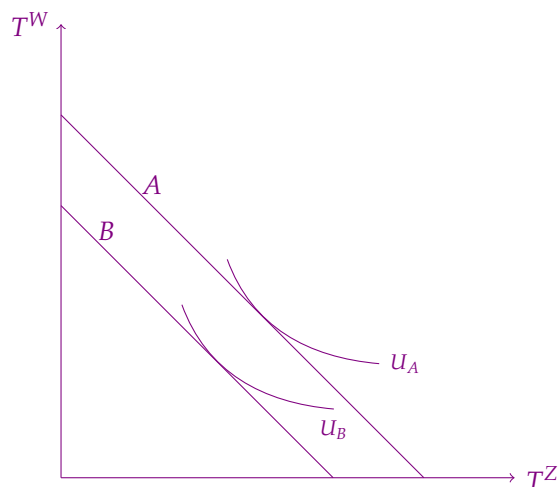
The bottom line answer is the same as above but for a different reason. Now *A*'s health will be better than *B*'s because she works fewer hours than he does to earn the same income. *A* will thus have more hours available to invest in health.

- (c) Draw a set of axes labeled T^W and T^Z that resemble Figure 3.8. Draw a line labeled *A* that shows Individual *A*'s time constraint during a given period (say, one month), and draw another time constraint for Individual *B*. Explain why and how they differ due to choices in previous periods.

A's budget constraint is shifted out relative to *B*, as *A* has greater H^* than *B* and consequently spends less time sick.

- (d) On this same set of axes, draw representative indifference curves for both Individual *A* and Individual *B*, including ones that lie tangent to their respective time constraints. Based on the way you drew your curves, does Individual *A* earn less than twice as much or more than

Response to exercises 13(c) and (d).



twice as much as Individual B ?

More than twice as much – because A works more than B and earns twice as much per hour.

- (e) Explain briefly why your answer to Exercise 13(a) may change if you found out that Individual A had to spend ten times as many hours on homework during her schooling years as Individual B did.

In that case, A 's budget line would be less likely to be shifted to the right of B , since she would not have had so much extra free time to spend exercising in the past. In fact, she may have had so little free time during school that she is still less healthy than B .

- (f) Explain why it is optimal for Individual B to invest less in health when she is already less healthy than A . Why does she not invest more to “catch up”?

It is not worth it for B to “catch up” because his rate of return to health investment is lower than A 's even though A is in better health than B .

14. True or false? According to the Grossman model, if a new drug were discovered that eliminated the steady deterioration of health that accompanies aging – but does not eliminate sudden events like heart attacks or being hit by a bus – then the demand for jelly donuts, french fries, and physical activity in the presence of buses would decline. Justify your answer.

TRUE. The effect of such a drug (assuming it is sold at an affordable price)

would be to decrease δ – the depreciation rate of human capital. Optimal health would increase, so optimal health investment would also increase. In such a world, health does not deteriorate, so any investment in health lasts forever and is very beneficial. Meanwhile, physical activity in the presence of buses is less desirable because a bus accident of the few remaining ways that H can decline.

15. How does aging change the shape or size of the production possibility frontier in the Grossman model from period to period? Draw a graph to demonstrate the effect of aging, and include a short paragraph of text justifying the changing shape or size of the PPF.

Aging shrinks the PPF – see Figure 3.14 and the related explanation in the text.

16. **Nutritional economics.** Suppose we are considering a hungry individual in the Grossman model deciding what to have for dinner. His options are listed in Table 3.2. Each dish has an effect on the level of the home good Z and health H .

Table 3.2: Meal options in the Grossman model.

Meal	Home good (Z)	Health (H)
Steak and eggs	+7	-2
Kale salad with broccoli	-2	+5
Entire box of cookies	+10	-20

- (a) Suppose the diner's single-period utility function is as follows:

$$U = 3Z + H.$$

If the diner is trying to maximize his single-period utility, and he can only select one item from Table 3.2, which meal would he choose?

If all he cared about was current period utility, he would choose steak and eggs. The utility from that meal is $3 * 7 - 2 = 19$, while his utility from the kale-fest would be $3 * (-2) + 5 = -1$, and his utility from the cookies would be $3 * 10 - 20 = 10$.

- (b) A miracle pill is discovered that halves the negative health impact of cookies. How does this impact your diner's choice?

Assuming the new pill costs him nothing, he would switch to cookies which now have a utility of $3 * 10 - 10 = 20$, which is greater than the utility from both other meals.

- (c) What effect does the miracle pill have on the diner's health H ? Interpret this result. Does this mean the diner would be better off without the miracle pill?

Since he switches from steak to cookies as a result of the new pill, his health would *decline* even as his utility increased. He is better off with the pill, even though his health is worse.

- (d) If the diner is instead trying to maximize his lifetime utility and not just his single-period utility, how might your answer to Exercise 16(a) change? Is he likely to value Z or H more in the lifetime context than the single-period context? Explain your answer, and be sure to invoke the concept of a capital good.

Since health is a capital good, the consequences of poor health help determine utility not just in this period, but also well into the future. By focusing on how his dinner choice affects his health in this period only, he is undervaluing the health consequences of his food choices. Meanwhile, the home good does not persist into future periods, so he is not undervaluing the home good at all. As a consequence, a more forward-looking version of our diner will value H more relative to Z .

Essay Questions

17. One curious finding from the RAND Health Insurance experiment was that the rate of treated bone fractures per capita was higher in the group of families that had been assigned to the free insurance plan, compared with those in the high copayment plans. Concisely describe how the Grossman model might explain the fact that people facing higher prices for health care would break bones less often. Be sure to discuss the concept of marginal efficiency of health investment.

A model in the spirit of Grossman's model that would explain this odd fact would emphasize distinct two trade-offs: (a) the demand for medical treatment is downward sloping, so people in the free plan (who pay nothing) will be more likely to seek treatment given a bone fracture than people in the copayment plans; and (b) since people in the copayment plans know that treating fractures will be more costly for them than for people in the free plans, they will be less likely to engage in risky activities that might result in fractures in the first place.

A second parallel approach to this problem in the spirit of Grossman's model might focus on the fact that heart attack patients are typically at lower levels

of health (closer to death) than bone fracture patients. According to Grossman's model, even small increases in health when health is low yield substantially higher returns than similar increases when health is high. Thus, heart attack care is worthwhile even for people in the cost-sharing plans whereas fracture care may be less worthwhile (especially if the fracture is minor).

18. **Munchausen's syndrome.** Munchausen's syndrome is a psychiatric disease first recognized by doctors in the 1950s. Sufferers will feign unusual medical symptoms and seek out the most complicated treatments and procedures, typically out of a desire to gain the sympathy and attention of family, friends, and medical professionals. In some sense, we could say that health care enters into the utility function of the afflicted. As much as most people viscerally dislike sitting in a doctor's waiting room or undergoing surgery at a hospital, people with Munchausen's often can not get enough.

Imagine an individual in the Grossman model who suddenly develops Munchausen's syndrome. How would this affect her optimal level of H^* ? Explain your answer, and make sure your explanation discusses the three roles of health in the model.

For people with Munchausen's syndrome, health care enters directly into the utility function, in addition to being an input into health, which retains its three roles – as a consumption good, as an input into production, and as a form of capital. Thus, the Grossman model predicts that someone with Munchausen's syndrome will demand more health care than someone without the condition, but with otherwise similar preferences.

In the version of the Grossman model that we present in this chapter, health care always has a positive effect on health status, though the marginal effect of health care on health declines at high levels of health care. This would seem to imply that Munchausen's syndrome should increase equilibrium health.

However, in practice, high levels of unnecessary health care can actually harm health. Health care that harms health is known as iatrogenic disease. This wrinkle can be accommodated in the Grossman model by permitting a negative marginal effect of health care on health at high levels of health care expenditures. In this expanded version of the Grossman model, patients with Munchausen's syndrome might have worse physical health as a consequence of iatrogenic disease. In fact, doctors who care for Munchausen's syndrome patients worry about the harm these patients cause themselves through tricking doctors into performing unnecessary surgeries and the like.

19. A recent paper entitled “Inheritances, Health, and Death” by Beomsoo Kim and Christopher Ruhm reports the following:

We examine how wealth shocks, in the form of inheritances, affect the mortality rates, health status and health behaviors of older adults, using data from eight waves of the Health and Retirement Survey (HRS). Our main finding is that bequests do not have substantial effects on health, although some improvements in quality-of-life are possible. This absence occurs despite increases in out-of-pocket (OOP) spending on health care and in the utilization of medical services, especially discretionary and non-lifesaving types such as dental care. Nor can we find a convincing indication of changes in lifestyles that offset the benefits of increased medical care. Inheritances are associated with higher alcohol consumption, but with no change in smoking or exercise and a possible decrease in obesity.

Interpret these findings using the Grossman model as a framework. In particular, comment on how exogenous income shocks change decisions about health status in the Grossman model. Is the evidence in this report consistent or inconsistent with your interpretation of the predictions of the Grossman model? Does this report support or contradict the theory that one’s wealth level determines his health status?

An inheritance in this context is effectively an exogenous one-time unexpected increase in income. In the Grossman model, a one-time boost in income will allow the consumer to afford more of both home goods and health since both are normal goods and increase utility. This will shift out the consumer’s production possibility frontier and allow her to achieve higher levels of both health and the home good if she wishes.

In the Grossman model, there are only two inputs into health: time spent on health producing activities and market inputs (health care). The consumer will presumably use both mechanisms to improve health since there is a decreasing marginal effect of time and of market inputs on health production. So the Grossman model also predicts an increase in health care expenditures despite the improved health.

The Kim and Ruhm findings are consistent with the predictions of the Grossman model. They find that inheritances lead to (slightly) improved health in the form of lower obesity rates. They also find that inheritances lead to higher health care expenditures. The Kim and Ruhm findings thus support the notion that improved socioeconomic status (or at least increased income) leads to better health.