CHAPTER 3
DEMAND FOR HEALTH: THE GROSSMAN MODEL

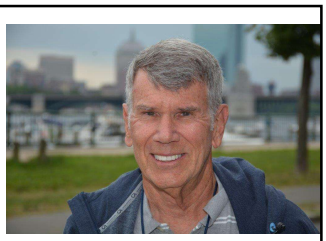
Intro

- Previously…
  - Demand for health care is downward sloping
  - People choose amount of health care they receive based on price
- People choose their health care, but do they choose their own health?
  - Is health something that happens to us? Or do we choose it?
  - We use the Grossman model to explore this question

Michael Grossman

On the Concept of Health Capital and the Demand for Health

The Journal of Political Economy (1972)



The aim of this study is to construct a model of the demand for the commodity "good health." The central proposition of the model is that health can be viewed as a durable capital stock that produces an output of healthy time. It is assumed that individuals inherit an initial stock of health that depreciates with age and can be increased by investment. In this framework, the "shadow price" of health depends on many other variables besides the price of medical care. It is shown that the shadow price rises with age if the rate of depreciation on the stock of health rises over the life cycle and falls with education if more educated people are more efficient producers of health. Of particular importance is the conclusion that, under certain conditions, an increase in the shadow price may simultaneously reduce the quantity of health demanded and increase the quantity of medical care demanded.

The 3 Roles of Health (H)

Health plays three roles in the Grossman model:

1. A consumption good
2. An input into production
3. A form of stock/capital (an investment)

Health as a consumption good

Health as a direct input into utility

- Health as a consumption good enters **directly** into utility
- Single-period Utility at time *t*

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

  - H_t = level of health
  - Z_t= "home good"
    - Everything non-health that contributes to utility
    - E.g. video games, time with friends, movie tickets

**Note: health ≠ health care

- Health *care* is not explicitly in the utility function
  - i.e. Getting vaccines does not provide utility but staying healthy does

Time constraints in the Grossman model

- In a single period, there are only 24 hours in a day to contribute to your utility:

$$\Theta = 24 = T^W + T^Z + T^H + T^S$$

- Divide total time Θ between:
  - Working T^W
  - Playing T^Z
  - Improving health T^H
  - Being sick T^S

Time constraint means time tradeoffs

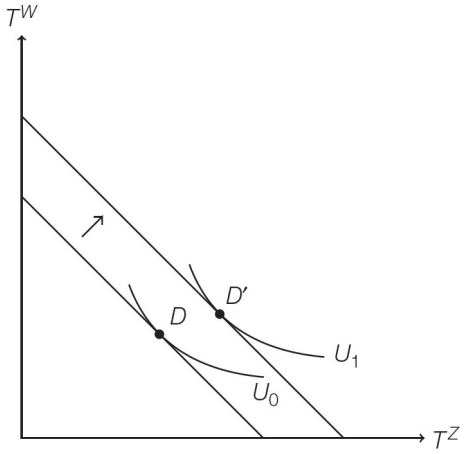
- Time working T^W produces income
  - Buy things that contribute to utility (H, Z) but need to spend time in those activities (T^H, T^Z)
- Time sick T^S does not increase utility
  - Every hour spent sick takes away time to do other utility-increasing activities (loss time)

Table 3.1. *Activities in the Grossman model.*

Activity	Example	Purpose
Working (T^W)	Working at a power plant; playing professional sports; teaching health economics	Earn income to purchase items that will enhance H and Z
Playing (T^Z)	Doing a jigsaw puzzle; going to the opera; logging onto Facebook	Enhance Z
Improving health (T^H)	Jogging; undergoing surgery; beauty rest	Enhance H
Being sick (T^S)	Spending the day home in bed, doing nothing	None; T^S is always wasted time

The labor-leisure tradeoff

- Given levels of T^S and T^H, individual chooses how to allocate time between work T^W and play T^Z.
- Optimal point decides on indifference curves
- When health improves, more productive time is available for use
  - Pushes time constraint outward (from U_0 to U_1)
  - Can reach higher utilities



Health as an input into production

The three roles of health (H)

Health plays three roles in the Grossman model:

1. A consumption good
2. An input into production
   - Of health (H)
   - Of productive time (T^P)
3. A form of stock/capital (an investment)

Producing H and Z

Both Health and Home good Z must be **produced** with time and market inputs

$$H_t = H(H_{t-1}, T_t^H, M_t)$$
$$Z_t = Z(T_t^Z, J_t)$$

- M_t= market inputs for health H
  - Ex: weights, treadmill
- J_t= market inputs for home goods Z
  - Ex: video games, opera tickets
- Today's health H_t also depends on yesterday's health H_{t-1}
  - This is health's third role as a stock which we discuss later

Health affects production by lowering T^S

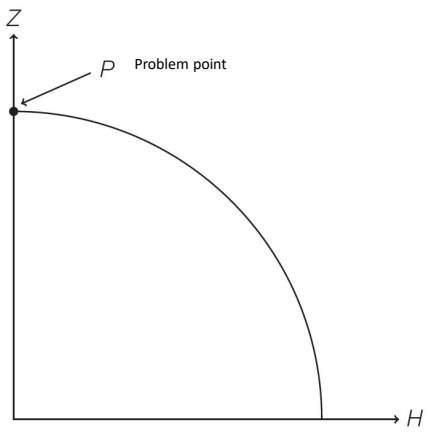
$$T^P = \Theta - T^S = T^W + T^Z + T^H$$

- Healthier you are, the less time you spend sick
- T^P is productive time spent on useful activities
  - Increased productive time can be reinvested into health (T^H) or other useful endeavors (T^W, T^Z)
- Only way to reduce sick time (T^S) is to improve health

Production Possibility Frontier

- **Production Possibility Frontier (PPF):** the possible combinations of H and Z attainable, given an individual's budget and time constraints
- Standard economic PPF shows H and Z as substitutes
  - Wrong! Why?
- Maximum Z is minimum H
  - If individual is at minimum H, they are dead and cannot produce any Z

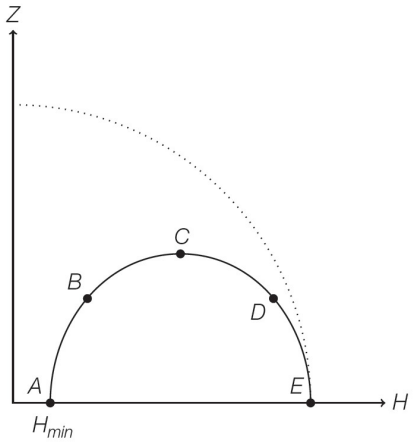
An **INCORRECT** PPF



PPF in the Grossman model

- Point A
  H_{min}: no productive time for work, play, or improvement of health
- Point B
  - **"free-lunch zone"**
  - Small improvements in health yield large increases in productive time; can increase Z without giving up H

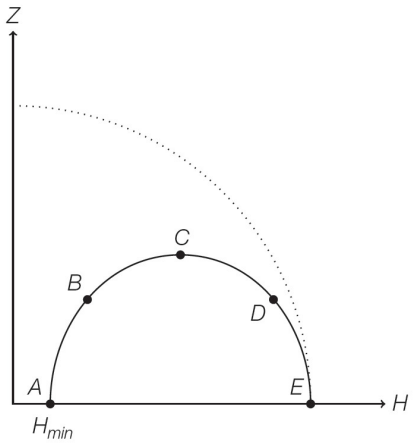
A **CORRECT** PPF



PPF in the Grossman model

- Point C
  - Maximum Z possible
  - Can't improve health without taking away Z
  - If try to increase Z by shifting resources, sick time will increase and outweigh gain in resources for Z
  - Increases in health will not produce extra time to offset time spent improving health

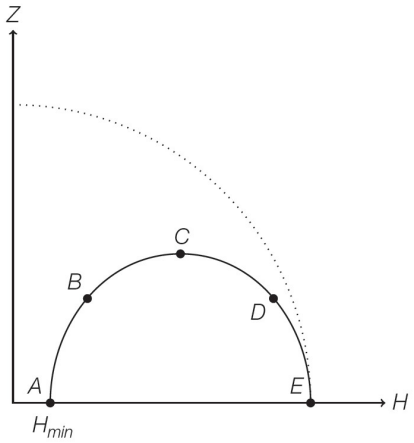
A **CORRECT** PPF



PPF in the Grossman model

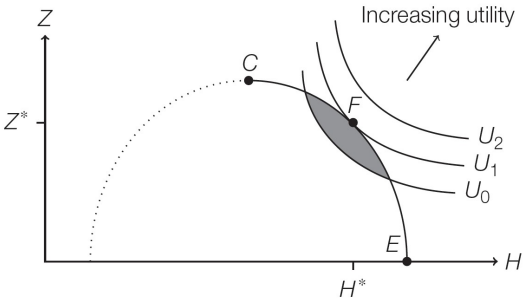
- Point D
  - **"tradeoff zone"**
  - Increases in H only yield small decreases in sick time
  - Increases in H, takes away from Z
- Point E
  - Spend all time and money on health
  - Ignores all home goods

A **CORRECT** PPF



Choosing optimal H* and Z*

- Someone who values both H and Z chooses a point between **C** and **E** in order to maximize their utility
- Chooses point F
  - U_2 is unattainable given PPF constraints
  - At U_0, an individual can attain more utility
  - At F: U_1 and PPF are tangent
  - H* and Z* are optimal levels of health and home goods



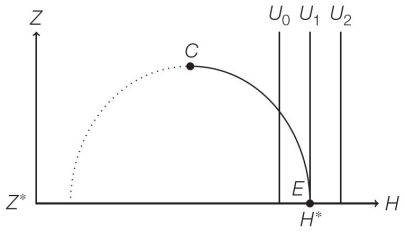
Exotic preferences and indifference curves

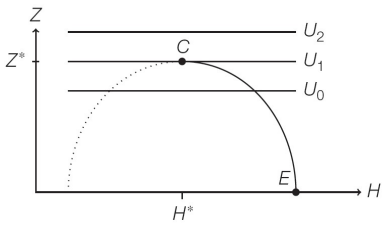
Cares only about Health H

- If individual only cares about Health
  - Vertical indifference curves
  - H* and Z* at point E

Cares only about home good Z

- If individual only cares about home goods (Z)
  - Horizontal indifference curves
  - H* and Z* at point C





Health as an investment

The three roles of health (H)

Health plays three roles in the Grossman Model:

1. A consumption good
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3. A form of stock/capital (an investment)

Lifetime of utility

- On any day, an individual considers not only *today's* utility $U(H_0,Z_0)$ but all *future* utility as well!

$$U = U(H_0,Z_0) + \delta U(H_1,Z_1) + \delta^2 U(H_2,Z_2) + \cdots + \delta^{\Omega} U(H_{\Omega},Z_{\Omega})$$

$$= \sum_{t=0}^{\Omega} \delta^t U(H_t,Z_t)$$

- Health is a **stock;** some of it carries over each new period
  - Home good *Z* is a **flow** (it lasts for only 1 period)
- δ = individual's discount factor
  - A person values utility now more than in the future
- Ω = individual's lifespan (total number of periods)

Health depreciates over time

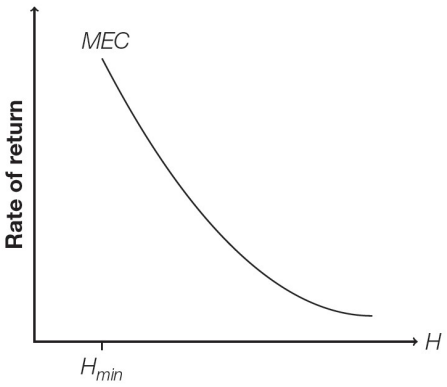
Some of yesterday's health lasts to today but not all of it

$$H_t = H\left((1-\gamma)H_{t-1}, T_t^H, M_t\right)$$

- γ = rate of depreciation
- Recall:
  - H_t = health at time period t
  - H_{t-1} = health from previous period
  - T_t^H = time spent on health in period t
  - M_t = market inputs for health (like checkups and prescription pills)

MEC curve and investments in health

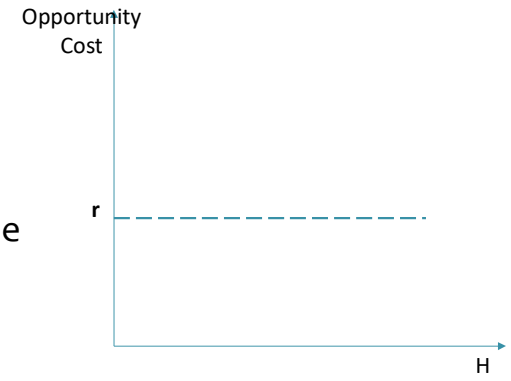
- **Marginal Efficiency of Health Capital (MEC):** indicates how efficient each unit of health capital is in increasing lifetime utility
- When level of H is low, small investments in health have high returns (health benefits)



Costs to investing in health

- **Opportunity cost**
  - Forgoes putting money into other investments or other activities
  - **r** = rate of return of alternatives (e.g. interest rate, wage,

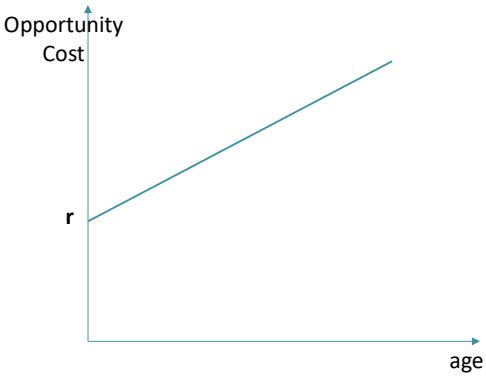
Individuals compare the MEC with the market interest rate to decide whether to invest in health



Aging and Costs to investing in health

Aging (γ) increases the opportunity cost of a health investment (Why?)

- Decreasing productivity
- Increased healthcare needs
- Competing financial pressure
- Alternative investments



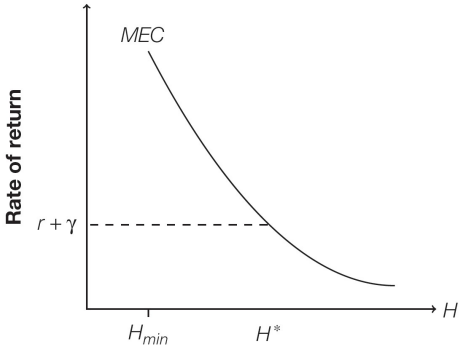
Aging and Costs to investing in health

- Aging (γ) increases the opportunity cost of a health investment
- Decreasing productivity
- Competing alternatives

- Health must pay a return of at least r + γ
  - If return is less than r + γ, then market return beats health investment return

Optimal investment in health

- H* = optimal amount of health
  - Marginal cost of health investment balances with marginal benefit of health investment .



Predictions of the Grossman model

The Grossman model helps explain why we observe:

1. Better health among the educated
2. Declining health among the aging

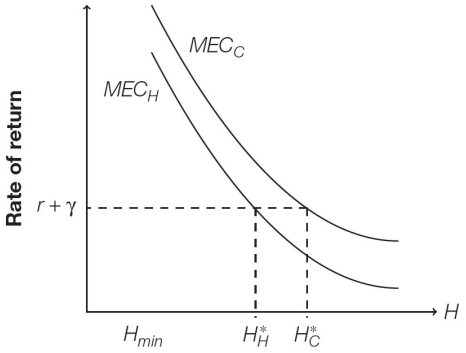
Health and education

- Well-educated individuals are more efficient producers of health
  - College grads benefits more than a high school dropout.
  - Explanations?

MEC and efficiency of health investment

Better educated are *more efficient* at each level of health investment

- $MEC_C > MEC_H$
- H^*_C is higher than H^*_H



- MEC_C = college graduate
- MEC_H = high school dropout

Predictions of the Grossman model

The Grossman model helps explain why we observe:

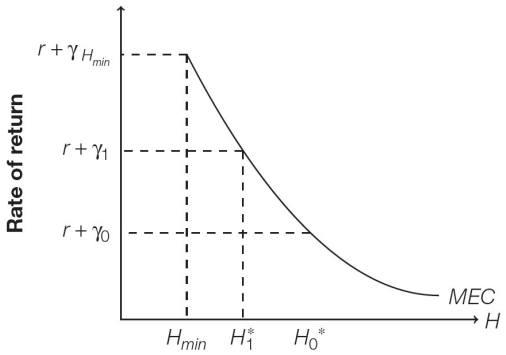
1. Better health among the educated
2. Declining health among the aging

Depreciation of health

- Recall:

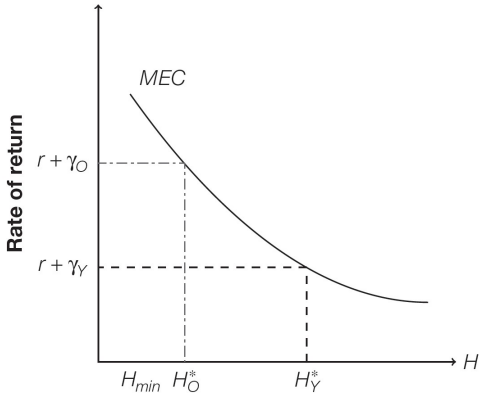
  $H_t = H\left((1-\gamma)H_{t-1}, T_t^H, M_t\right)$

- Depreciation γ is **not** constant
- γ increases with age
- As γ increases, costs (r + γ) increase and it takes more resources to maintain same level of health



As a result of increasing depreciation *γ* over time, optimal health H* also declines over time!

Optimal death in the Grossman model



- Because of rising depreciation, there are better investments in the market than the individual's health
- H* eventually reaches H_{min}
- Why would anyone choose H_{min}?
  - How is H_{min} utility-maximizing?

Conclusion

- Is health something that happens to us or is chosen?
  - Grossman model says it is *chosen*
  - In fact, we even ***choose*** when we die
  - While that may seem far-fetched, Grossman model a useful tool for understanding the roles and tradeoffs of health
- Next we use the Grossman model to understand empirical findings about the relationship between socioeconomic status and health