

Demand for Health: The Grossman Model



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Introduction

Demand for Health



Previously...

- Demand for Health care is _____ sloping
- People choose amount of health care based on

*People choose their health care,
but do they choose
their own health?*

“

Is Health something that happens to us?
Or do we choose it?



The Grossman Model



Roles of Health (H)

A Consumption good

People care about good health for its own sake. Good health is valuable and makes us happy

An input to production

Better health allows people to have more productive time – more time to work and have fun.

An investment

Health accumulates and depreciates. Health is a stock variable

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Role of Health

- A consumption good
- A form of stock/capital (an investment)
- An input into production



Health as a direct input into utility

- Heath 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. Netflix, time with friends, movie tickets
- **Note:** health $\neq$ health care
- Health *care* is not explicitly in the utility function
 - i.e. Getting vaccines does not provide utility but staying healthy does.
 - Who likes going to hospitals?

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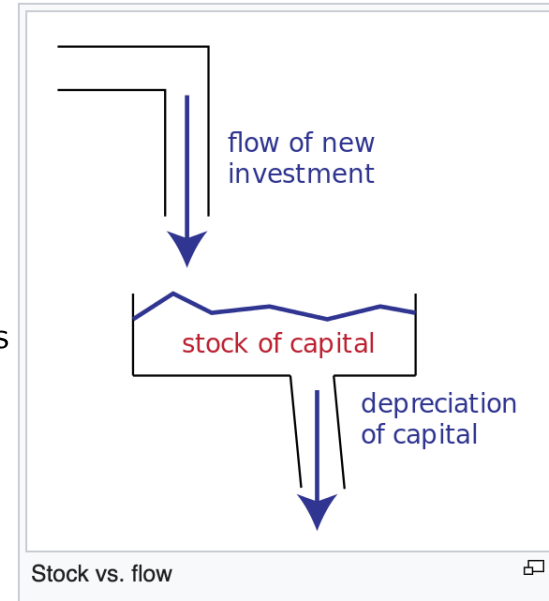
Role of Health

- A consumption good
- A form of stock/capital (an investment)
- An input into production



Health is a Stock variable

- Flow variables can add or subtract the stock of another variable
- E.g.) a glass of water: you can pour more water (a flow) or drink from the glass, which reduces the stock of water (another flow)
 - At any point in time, you could measure how much water is in the glass
- That's what the model assumes about health: it's stock that can be drained or added
- Health (H) is measured at one point in time but represents something that has been accumulated or depreciated over time
 - Health in year t depends on health in year $t-1$



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Role of Health

- A consumption good
- A form of stock/capital (an investment)
- An input into production



Acquiring and Producing H and Z

- Where do H and Z come from?
 - They can be acquired/purchased in the market
 - They can be “**produced**” by people 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 goods or services that we purchase to improve health. e.g.) weights, treadmill, health care
- Today's health H_t also depends on yesterday's health H_{t-1} . (health's role as a stock)
- J_t = market inputs for home goods Z. e.g.) TV, movie tickets

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Constraints

- Time Constraints
- Budget Constraints



Time Constraints

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

$$\Theta_t = 24 = T_t^W + T_t^Z + T_t^H + T_t^S$$

- Divide total time Θ between:
 - **Working T^W** : produces income to buy things that contribute to utility (H, Z) but need to spend time in those activities (T^H, T^Z)
 - **Playing T^Z** : enhance Z
 - **Improving health T^H** : enhance H
 - **Being sick T^S** : does not increase utility. Loss time.
- Remember: constraints imply _____

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Constraints

- Time Constraints
- Budget Constraints



Budget Constraints

- To buy things, we need money!
- How much money we get depends on wages and time spent on working:

$$Y_t = w * T_t^W$$

- Assumption:
 - People can't borrow
 - Wages (w) are **exogenous**
 - What is the problem with this assumption of **exogenous** wage?



Budget Constraints and Price

- We have two market goods in the model: M and J, with price P_M and P_J , respectively

$$Y_t = J_t^* P_J + M_t^* P_M$$

- In words, the amount of good and services we buy and consume during each period of time must be equal to the amount of income we earn.
- Since income depends on the amount of time we spend working, our consumption capacity is limited by the time we have to work

*Constraints imply **Trade-offs!***

“

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Let's put Everything Together

- Utility function
- Production function
- Constraints



Where are we?

Utility function: $U_t = U(H_t, Z_t) = U(H_{t-1}, T_t^H, M_t; T_t^Z, J_t)$

Production function:

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

$$Z_t = Z(T_t^Z, J_t)$$

Constraints:

$$\Theta_t = T_t^W + T_t^Z + T_t^H + T_t^S$$

$$Y_t = w * T_t^W = J_t * P_J + M_t * P_M$$

Exogenous variables: $H_{t-1}, w, P_M, P_J, \Theta_t$

Let's solve the model!

Wait. What do you mean by solving the model?!



Let's allocate our time: The time trade-off

- Time is a scarce resource:

$$\Theta_t = T_t^W + T_t^Z + T_t^H + T_t^S$$

- Productive time: $= T_t^P = \Theta_t - T_t^S = T_t^W + T_t^Z + T_t^H$

- Productive time depends on **health**

- Only way to reduce sick time (T_t^S) is to improve health
- A person needs to allocate T_t^W, T_t^Z, T_t^H

- How do people make this decision? It depends on _____, thus _____ function.



Let's allocate our goods: The H and Z trade-off

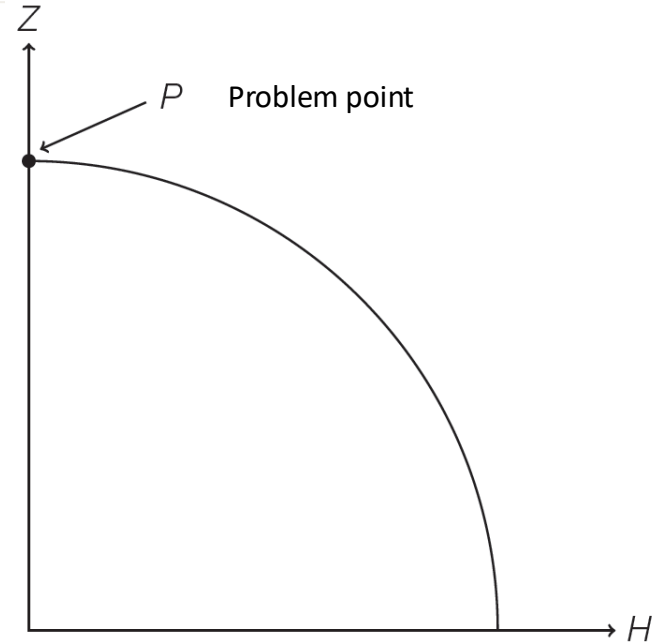
- The trade-off in the allocation of time implies a trade-off in H and Z
- Depending on preferences, a person could decide to spend all his time on health activities (T_t^H) and health goods and services (M)
 - But there is no way to purchase M if a person doesn't work ($T_t^W=0$)
- A person could decide spend all his time on T_t^Z and home goods (J)
 - But there is no way to purchase J if a person doesn't work ($T_t^W=0$)
 - If a person's $H_t=0$, that means he is dead (= no health stock at t)
- A graph (you learned from Econ 105) about the tradeoff between producing two different goods: _____



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

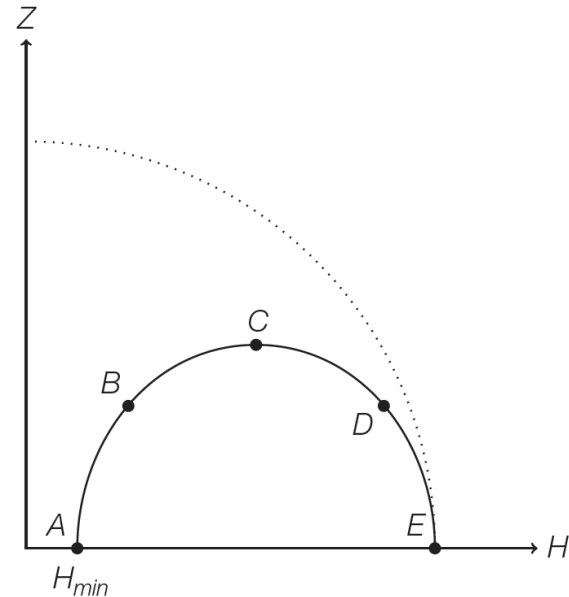




Production Possibility Frontier

- 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



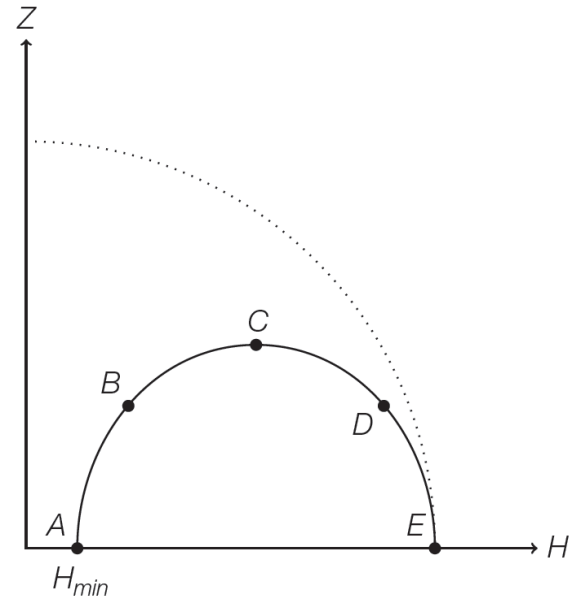


Production Possibility Frontier

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

A CORRECT PPF

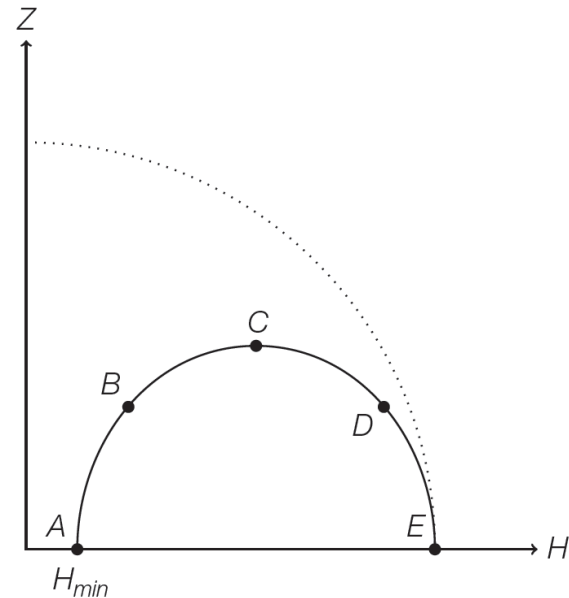




Production Possibility Frontier

- Point D
 - ▣ “tradeoff zone”
 - ▣ Increases in H , takes away from Z
- Point E
 - ▣ Spend all time and money on health
 - ▣ Ignores all home goods

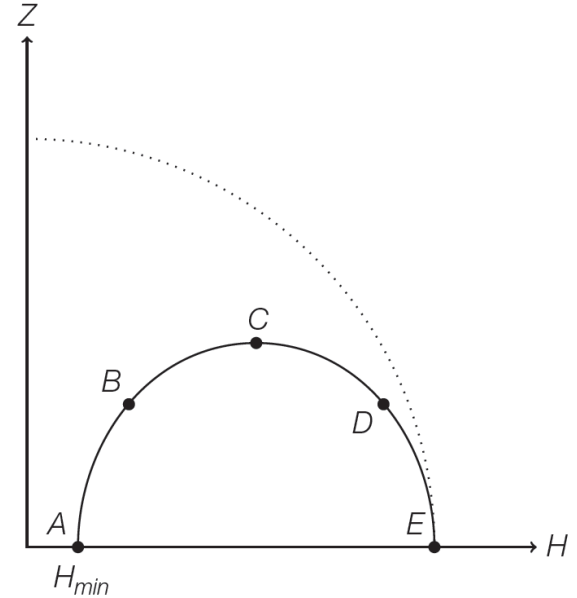
A CORRECT PPF



Which point would you want to be on?

It depends on your _____!

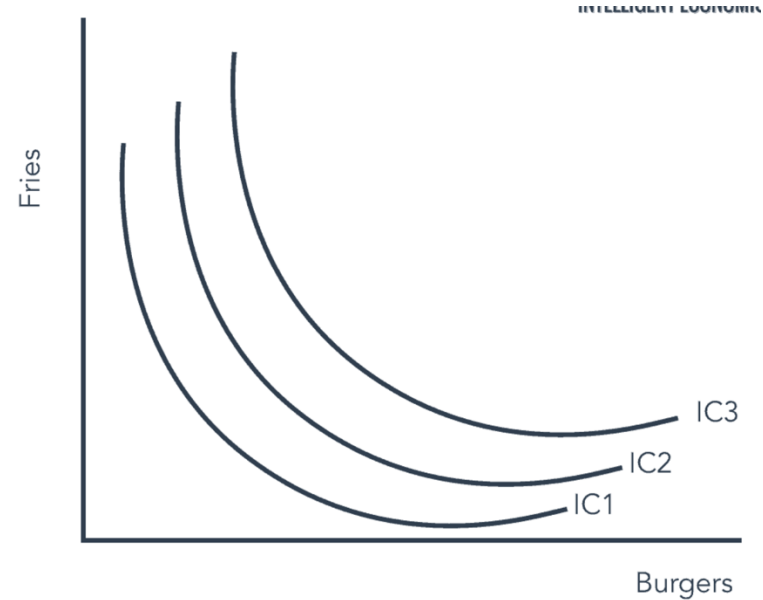
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Utility function (i.e. Indifference curve)

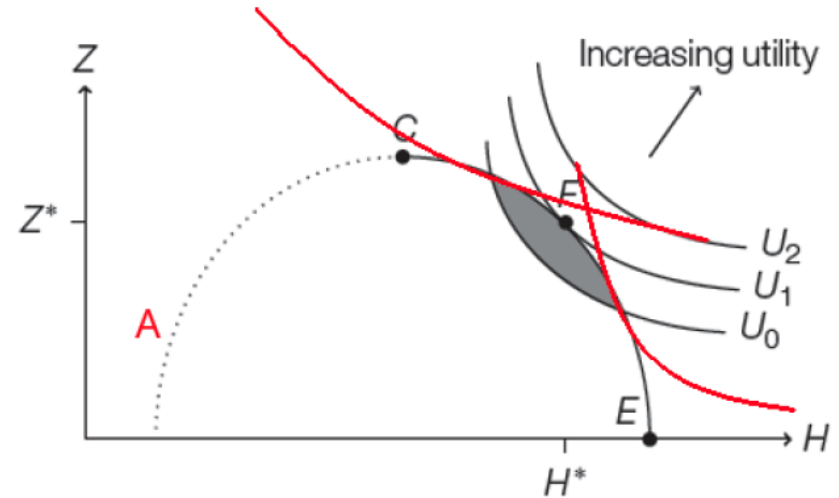
- IC represents all the combinations of two goods that consumers place **equal** value
- Any combination on the same IC provides the same level of utility to the consumer
- The **farther** away it is from the origin, the **higher** the utility
- Why is it convex?
- Can IC cross one another?





PPF + IC tangent (or kissed)

- Someone who values both H and Z chooses a point between ___ and ___ in order to maximize their utility
- With grey IC, optimal point: ___
 - 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
- Red curves are different possibilities with different _____
- Point A would not be chosen by a rational person since more of H and Z could be achieved, which gives a higher utility.

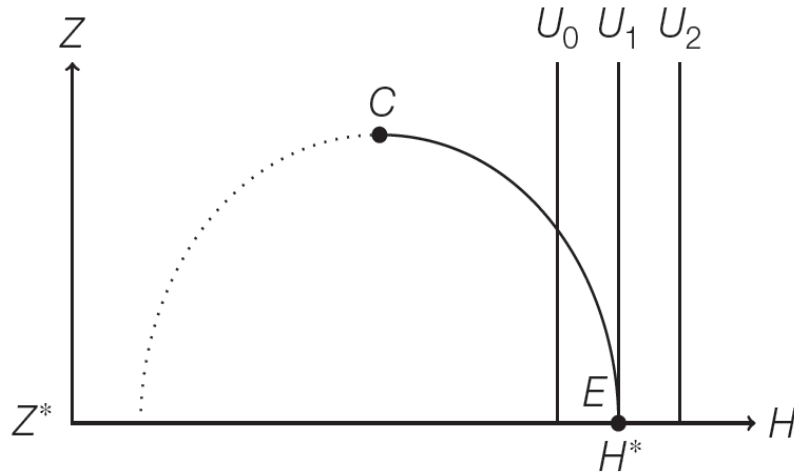




Exotic Preferences and Indifference Curves

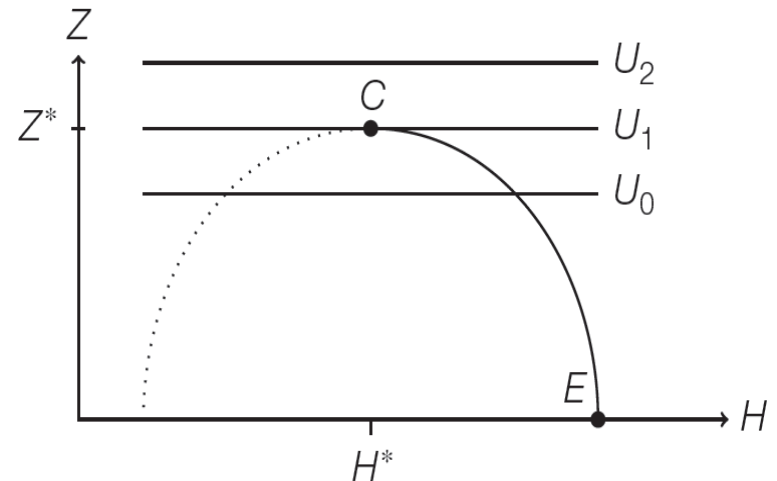
Cares only about Health H

- Vertical indifference curves
- H^* and Z^* at point E



Cares only about home good Z

- Horizontal indifference curves
- H^* and Z^* at point C



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Let's add Dynamics: over a lifetime

- Instead of a single period, t

Do you want \$100 now or in 5 years?

“

Opportunity Cost!



Lifetime Utility

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

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

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

- δ (delta) = individual's discount rate
 - A person values utility now more than in the future
 - We assume $0 < \delta < 1$, which means current utility is preferred to future utility.
- Ω (omega) = individual's lifespan (total number of periods)
- We get utility from a flow of health and a flow of home goods over time
- The amount of health you carry forward from one time to the next is reduced because you have the rate of _____



Lifetime Health

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

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

- γ (gamma) = 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)
- Health today depends on health goods purchased today (M_t) and the time we put into health activities (T_t^H), and depreciation of past-year health $((1 - \gamma)H_{t-1})$

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Returns to Health Investments

- Diminishing Returns



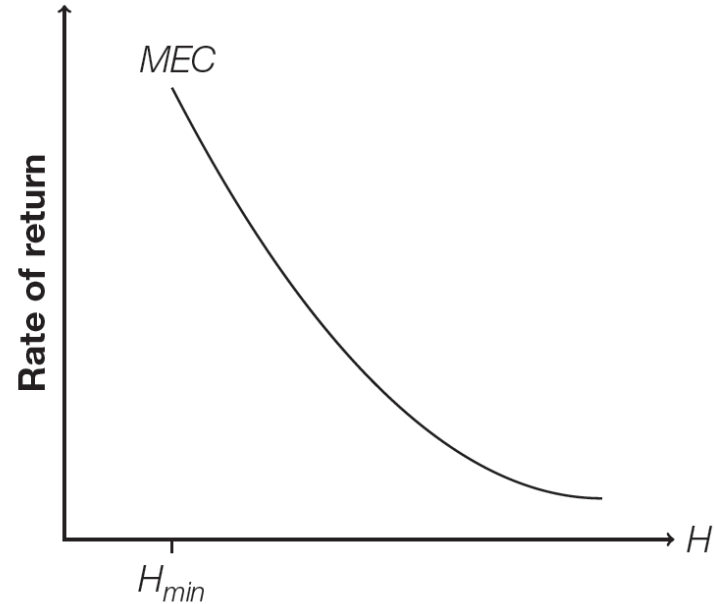
Health as capital

- As other forms of capital, health also has a rate of return: investments in health now have consequences for the future
- Better health > more productive time > more time to work > more income > more investments in health > better health ...
- Better health means more happiness!
 - Remember health enters the utility function (health as consumption goods)



Returns to Health investments: Diminishing Returns

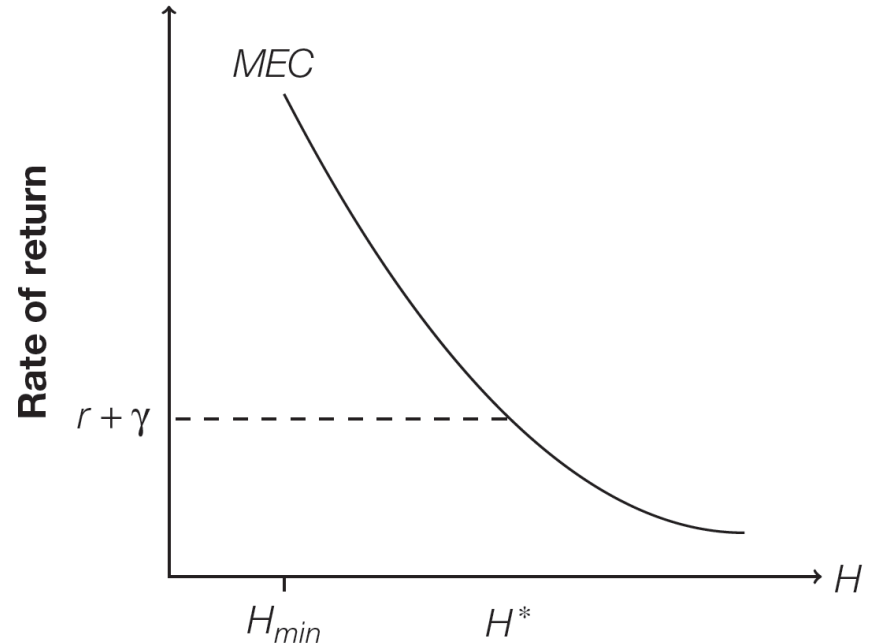
- Marginal Efficiency of Capital (MEC) curve
 - Indicates how efficient each unit of health capital is in creating lifetime utility
 - When level of H is low, small investments have high returns to Health





Costs to investing in Health

- Opportunity cost
 - Forgoes putting money into other investments (bitcoin? Houses? Stock?)
 - r = interest rate of alternative market investment
- Depreciation
 - Due to aging (γ)
- Health must pay a return of at least $r + \gamma$
- If return for health $< r + \gamma$: market return beats health investment return!
- H^* : optimal amount of health (MC=MB)





Michael Darden @michaedarden · 4h



Investment in health capital



Bobby Weir ✓ @BobWeir · 4h

At my age, if you let it go, it ain't coming back. I have a lot of stuff I want to get to. And I gotta fuckin' live to do it. Thanks for the feature, @MensHealthMag.

Follow along over on @TikTok_US: bit.ly/BobbyWeirTikTok.



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The cost of investing in health is _____ when the rate of depreciation is high (i.e. when we are older).

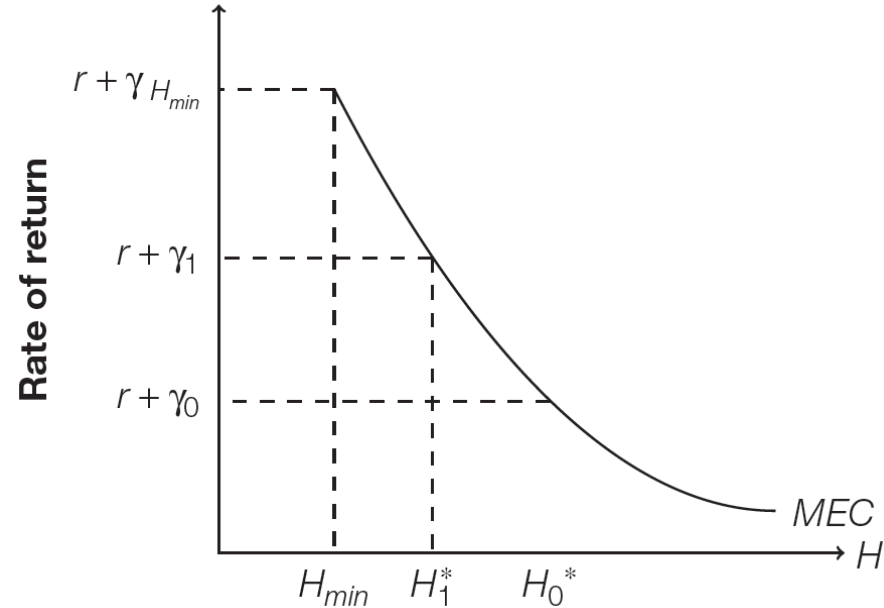
(Look at this guy.....)



Depreciation of Health

- Depreciation γ is **not** constant
- γ _____ with age
- As γ increases, costs $(r + \gamma)$ 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 _____ over time!



*Why can't people keep using
resources to live longer?*

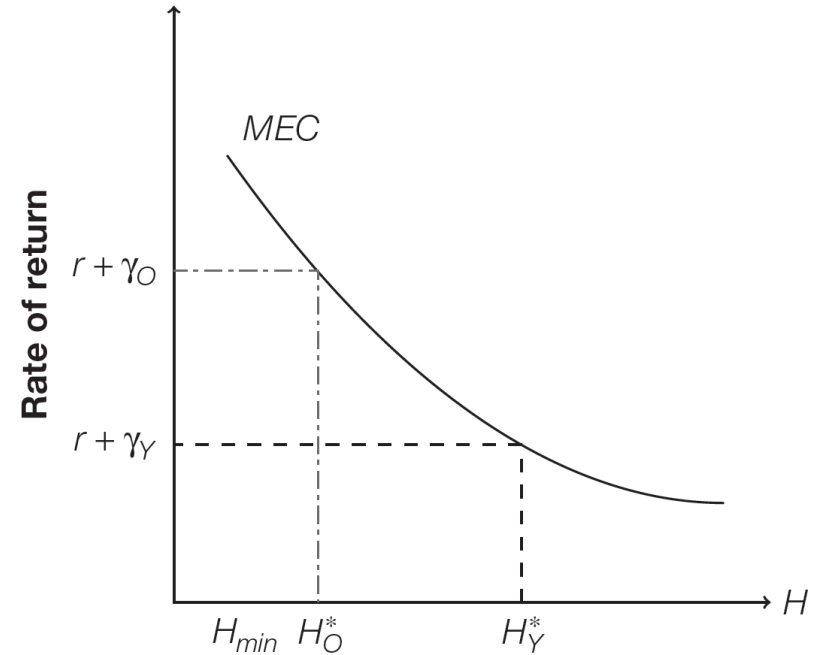
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It gets more and more expensive in terms of
opportunity cost to keep trying to maintain health
-- Death ensues.



Optimal Death

- 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?



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Education and Health

- Where is Education in the model?



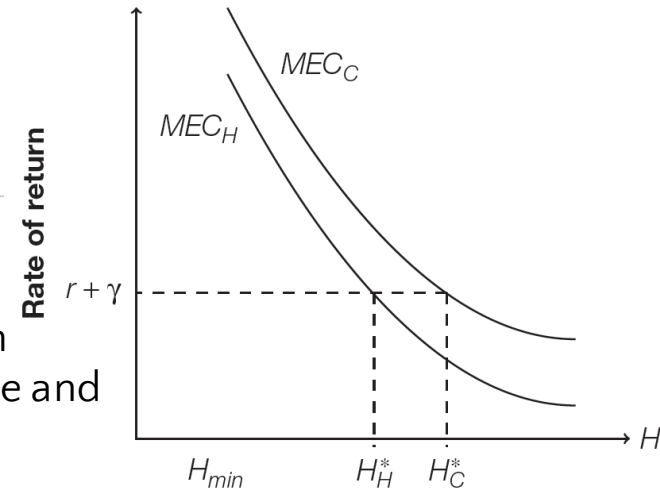
Grossman model and Education

- Grossman predicts better health among the educated
- Why more educated people have better health?
 - Why would that be based on the Grossman model?



Education and Health

- In the Grossman model, education is implicit in the production function for H and Z (and wages w , which means more income and thus more of everything)
- Education improves production efficiency
 - Better educated people can generate more H and Z with given resources. Higher returns for each level of H ($H_H^* < H_C^*$)
 - Better at using time and goods to produce H and Z
 - In this sense, education is like technology.
- Education make people better at managing time preferences in the sense of delaying gratification
- Education makes people choose better inputs in the production function (e.g. healthier life-styles with knowledge of the relationship between health behaviors and health)



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Is Health a Choice

- In other words, do people have ability to control their level of health?
- The Grossman Model says “_____”



Early Health and Educational Opportunities

- Children don't have control over H_0 and little over M_t or Z_t or time preferences.
 - It is parents, schools, peers, and living environments that affect their health over lifetime
 - Including educational opportunities
- This implies that early health and educational opportunities may have large consequences over a lifetime
- Investments that are made for us when we are kids can compound over time
 - Our early life has a sustained impact over time
 - Health as a child can influence education and future income
- We will use the Grossman model to understand the relationship between socioeconomic status and health

A photograph of two white doves in flight against a clear, bright blue sky. The dove in the foreground is shown from a low angle, with its wings fully extended upwards, revealing the intricate structure of its feathers. Its head is turned slightly to the right. The second dove is positioned further back and higher up in the frame, also in flight. The overall composition is clean and uplifting.

Conclusion





The Grossman Model

What are the insights?

What is your criticism?

Policy implications?

Shadow Price of Health



Insights

- A lot of “duh” dressed up with math
- Maintaining good health requires more resources as we get older because of the opportunity costs of maintaining health _____ with age. Said another way, fighting against aging (depreciation) gets more and more “_____” as we age
- Individuals who make more money (higher wage) will improve health (i.e. invest in health) by buying more health care rather than using their time since their time is more valuable (hire a chef to cook healthful meals. Why bother cooking?)
- The rate of depreciation is important. Things that affect health can _____.
- Investing in health can have a large payoff, but up to a point since there are _____ marginal returns
- Education is one “_____” that allows to make more of the resources we have.



Criticism

- There are plenty of criticisms about the Grossman model and modifications to this framework. It's almost 50 years old
- The model ignores social context, although we could still model this by seeing what happens when “external shocks” induce changes
- Odd stuff: health doesn't impact wages. Health affects income because of less time to work, but not the wage level itself
- Another interesting aspect of the Grossman model, however, is that it concludes that health does not affect productivity. He assumes that human capital affects productivity and wage rate; health only affects the number of days a person can work (because they are not sick). Thus, in the Grossman model, health affects one's annual salary but not one's hourly wage.



Policy Implications

- Investing more intensively in education, to improve health literacy, helping educate people how to pick an insurance plan, how to distinguish between different treatments
- Mandatory health insurance to lower the cost to individual consumer of buying health care goods/services
- Increasing bike sharing programs, expand green spaces in cities to contribute to better health
- Target public schools to make healthier choices in food and require more PT time for kids, so that they are growing up with more healthy habits
- Banning tobacco products
 - If you think of tobacco use causing you to age faster,
- More education on sexual health, drug use at school
 - Help people make better decisions about their health care. Contributes to have more efficient production of health and less reduction in the level of health from these risky behaviors
- Prenatal care and care early in life have big implications for the stock of health. So better and more accessible prenatal care so that babies are born with a higher health stock