Health Economics

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Week – 02

Lecture 09- Demand for Health: Grossman model-II

Welcome, dear students, once again to our NPTEL MOOC module. Welcome to our module on health economics. We are covering the unit on demand for health, focusing on the Grossman model. In the previous lecture, we discussed the Grossman model. Hence, this lecture is on Grossman model part 2. As you remember, in the first lecture, we discussed health as a consumption good as emphasized by Grossman and how the person used to have a habit of allocating her resources to normal commodities or health-related commodities.

Hence, we may define the consumption as good or bad. Then, in Grossman's second role, emphasize health as an input for production as a productive time. We will explain how far this will be a productive time. It depends on whether the person is carrying good health, and every additional unit of good health may be associated with diminishing returns or every sick time with an extra good time if you get it, which might substantially increase our priority hours and substantially decrease sick time.

We will discuss all sorts of things. Hence, if you remember in the previous lecture, we mentioned that productive hours are defined through T^P, which is nothing but T^W for work time, T^X for playing time and leisure time, and T^H for health-generating time. There are diminishing marginal returns to productive time from health. I mentioned specifically that Θ stands for 24 hours, P stands for productive hours, H stands for health, and X stands for time for playing or leisure-related activities, W for work. So, here is the illness avoidance curve.

We have mentioned how it is inversely proportional. If you are confused with this line, please refer to my discussion in the previous lecture. We have a tradeoff between health and time for sickness. And if you have the allocation of these two, you have a maximum of 24 hours. Out of 24 hours, sick time and productive time are essential.

With health, we have mentioned that health is considered an allocation of your time for productive purposes. Hence, Grossman defined the illness avoidance curve. And we know that minimum health is required. It will not start from the vertical axis or zero; it should begin with a minimum level. If the minimum level of health is not attended, then there is no

question of productive hours.

Since the minimum hours are not reached, the person is considered dead. Hence, Grossman defined the economic definition of death as a situation where there is no productive time left, and the person cannot generate any more health. Hence, a tradeoff exists: the illness avoidance curve is downward-sloping and inversely proportional. The three roles of health for Grossman are health as a consumption good, health as input for production, and health as an investment as capital. In terms of consumption, as we have already discussed, it contributes directly to the individual utility function in each period.

Being healthy is valuable in and of itself. It contributes to production by generating productive time, that is, T^P, which is useful for producing even more of H and X. And third we will be emphasizing capital. Still, at this moment, we are just clarifying how the three roles are defined. Unlike other goods, health endures from period to period. It can accumulate or depreciate over time.

Health improvement today can lead to better health tomorrow. This will be discussed in our multi-period setting. Till this time, we are discussing single-period analysis. Since investment is carried forward with your past health history as a health capital, the third rule will be emphasized with the multi-period setting analysis. So, another concept is called optimal day.

The optimal level of H and X in any given period depends on the decision we are taking for a lifetime, not just for a single period. In the following slides, we will discuss this optimization in a one-period setting followed by multi-period optimization. Single-period optimization and multi-period optimization will be discussed subsequently since we require a production possibility frontier for X and H. We have already started discussing budget constraints for a single-period setting.

Let us discuss what is our production possibility frontier. What is an PPF production possibility frontier we used to read in microeconomics theory. A country is optimally using its endowment or resources to produce the maximum level of X and Y commodities. And that is contrasting to a single production function. When you are taking labor and it is a function of or quantities of function of labor or capital that is basically we used to discuss isoquant etc. that might be convex to the origin, may be straight line, may be L-shaped etc.

This discussion, if you remember, used to make it in a microeconomics theory. Where in production function, the optimal use of resources and endowments important. Hence, we discussed for the production possibility frontier to be concave to the origin in general. Then you have used your resources effectively and there is no excess capacity. And that might be also straight line depending upon the context.

If you revisit your microeconomics theory, I am sure you can understand. There occurs

increasing opportunity cost to produce any extra additional unit of production. Whereas in the typical function we used to go by the isoquant, it is used in production function and its optimization. So, we are not discussing much on this. I will clarify how the commodities and its production possibility frontier and the health as a commodity and its production possibility frontier.

This production possibility set traces out the possible combination of H and X that are attainable given individual's budget and time constraint. In this context we are specifying about individual budget and time constraint, and its production possibility frontier is used. The edge or frontier of this set is called the production possibility frontier. In the other next subsequent slides, we will explore PPF for H and X in standard setting and PPF for H and X in Grossman's model emphasizing X and H. This is what is called standard model of PPF.

How the resources as for the country's budget and the country's optimal allocation, similarly individual allocation is also projected in a concave function. Resources allocated to one of H or X means fewer resources for X or H. There is an inverse relationship between these two. Whereas in a standard one, we have highlighted in the dotted line that resource allocation or H compromise with resource allocation of X, there is a clear tradeoff. And wherever in Grossman's framework of health and X, we have to restrict to a minimum H, H minimum.

Not only is our optimal resource allocation possible, but Grossman also defined this as our production possibility frontier. It is at the maximum level when other commodities allocation time is zero and consumption is zero. And why it starts from this point at 0? Probably because H minimum should have been attended for an individual in order to raise more resources generated for other consumption or even healthier products. Hence, we are rejecting the standard model as per Grossman's theory. Individuals with low H will have fewer resources to produce any X at all.

That is zero X. We are discussing some of the points to clarify further. At point A, let it be, that is basically H minimum. There is no productive time. So, T^p is no productive time and hence no other goods. At this moment no other goods.

At point B, H is greater than that of H minimum. The H corresponding to this we have a point H that will be of course greater than this. The portion is relatively healthier. Even small improvement in H yields large change in rise in productivity or productive time and even X. So, that is attached with increasing returns to a particular factor.

And therefore, we call it as free lunch where both has a positive direction, both H increases as well as X increases. Whereas once the person reaches point C, we are maximizing our X possible. So, maximum X is possible. At point D, clearly we have started trading off between the allocation of H and X. We have started allocating more on X.

And beyond that, those X units are not going to add more X, rather it will be declining your X. We are referring to this declining portion. Hence we call this as tradeoff zone as per Grossman's idea. So, this is clearly mentioned. Free lunch zone and tradeoff zone.

How does an individual choose the optimal mix of H and X? It is certain that when the portion grows in terms of both, we will not be restricted until this point. So, we will not optimally allocate our resources in the free lunch zone. When in tradeoff zone since we are compromising between our satisfaction with both X and H, we have to find out a point in this region from this to this and that has to be considered optimal day or optimal allocation. There is no optimal point in free lunch zone. However, the tradeoff zone that is C to E has a possibility.

Free lunch zone, once again both H and X can be increased, hence are positive inputs in terms of utility. Allocations in A to C do not take advantage of all opportunities and leave free H and X. We are left with this portion. Optimal allocation lies in tradeoff zone. Exact allocation depends on his test for health and other goods.

We need to map. In order to find out the optimal position, it depends upon our utility map or indifference function or indifference map. Wherever it is reaching a point, optimal allocation lies on a point D on which the indifference curve touches the PPF. Individual tradeoff helps with consumption of other goods. As per the prediction of the Grossman model, while optimizing utility, people choose a combination of health and other goods, leading to less H maximum.

There will be a combination. Hence, this is because we have all possibilities C, D, E all points on the PPF; it is called exotic preferences, exotic preference function. What it indicates if prefer only H, only H that means X is 0. So, we will be allocating at point E and that is possible when we have a vertical indifference curve, complete vertical indifference curve like this. So, indifference curve should be like this.

This will be our IC. So, we are referring to this point. And if only prefer X, that means we are selecting at point C, which means this is the point we should have a horizontal IC curve. So, note H is still positive in that case. H is positive in both cases. And H keeps productive hours and productive time.

We can optimally look at our resources accordingly. So, another argument is through the labor-leisure-health improvement tradeoff. So, the total productive time increases with health with diminishing marginal returns. This is what is mentioned.

Productive time increases with health. However, there are diminishing returns. As I already mentioned, initial increases and increasing rates will then grow at a diminishing rate. And in a three-dimensional set-off, you can understand on a space set of possible expected allocation, how to select optimal level of T^W, $T^{H,}$ and T^X in all three dimensions we

have discussed. In this case, we can plot an indifference map in a three-dimensional structure and derive an optimum possibility. So, basically, how is it derived? The point where the indifference curve touches the productive time plane, which you have highlighted in the triangular area in the space, basically is the space wherever it is convex or touches, defining the productive time as the best option.

This indifference curve is same as we selected in PPF function. So far, we discussed about single time optimization function. We are discussing multi-period. We have to refer to the third rule of Grossman, emphasizing human capital as an investment. We know that health is a stock, and decisions made in the past affect it today.

Decisions we make today will have implications in the future. Therefore, a full multi-period version of the Grossman model is required. So, in the next one, we will discuss the third rule, emphasizing investment good through health or health as an investment good. So, basically, we need to question that how does an individual navigate the tradeoff between health, work and play over the entire lifespan.

So, here is our function. We are continuing from the previous emphasizing this. So, accordingly, we will also clarify the third rule. So, here it is. We have a function, we derive utility out of so many things, other aspect at point particular period we have discussed. We are also in addition to this, we are defining other time period, one as against this.

We also refer to different successive periods and countdown the entire span of the individual's utility function. So, H_t, the health level we have defined, ranges from 0 to ω, where X_t should start with that particular period. It does not have a time horizon, we can start with a 0 period. ω is the length of lifespan in different periods. So, consider a functional form here that we have mentioned, utility, H is derived at the present period, in the next period, then next to next period and till ω period.

Hence, it is a summation of all the periods with the utility of time t's, coefficient of t times with a function of its health and consumption of other goods. And the sigma varies from 0, 1 and it is a ratio and discount. It is a basically discounted factor of utility in the successive period when you have composition of H and X, they will be discounting to a utility function as you used to see in our function, optimization function or utility function. Hence, the third rule is defined accordingly that relates health and investment for different periods. Health stores value from investment in previous periods and health also depreciates from period to period.

Let gamma be a depreciation rate. So, hence, $H_{t,}$ which we have mentioned, we have also defined earlier, (t-1), time for health, the stock of health in the(t-1), the time allocation for this and your market time period. And hence, it is defining your total health as a capital. And that can be also presented with this 1 minus γ (gamma), when we say it is basically gamma relates to your depreciation. Depreciation of health plays a critical role in

determining this function, the optimal level of health investment. Health stocks if increases, so that means the sick period etcetera decreases and hence your productive time or the monetary value of this is returns to investment in health that increases.

Hence the returns to capital, it is a function called we used to define marginal efficiency of labour or here at this moment marginal efficiency of health capital and it is an inverse function, rate of returns declines over time. So, MEC curve show how efficient each unit of health capital is in increasing lifetime utility, highest returns to health that means when individual is dying or reaching a certain level at a minimum health level. So, that is basically the returns we derive from minimum till the maximum of age. So, MEC curve we started from the minimum level till the maximum. MEC curve is downward sloping and reflects the diminishing marginal returns to health.

We need to understand that the return rate is not infinite, even at a minimum age. So, it is not infinite, it has to be with a non-infinite point. The rate of return is not infinite. What is this all about? Let me clarify again. What is the cost of investing in age, then? It is basically the cost of Fergin market investment opportunities that we have taken as r or in Grossman chapters as r.

Depreciation of health due to ageing we have already mentioned as gamma. Hence optimal investment health depends on r and γ. MEC curve shows the optimal health level associated with market price of health investment that is basically r plus the depreciation rate. Basically at this price individual optimally chooses H^* at which the marginal cost of health investment balances the marginal benefit of health investment. When this occurs, central health is considered optimal.

What are the applications then of this allocation, optimal allocation of resources? Grossman model is best known for providing economic explanation for two empirical health phenomena that is better health among the educated one and declining health among the ageing people. So, one is an education and its efficiency of producing health. So, socio-economic status health gradient is basically what is this as explained people with better education and wealth enjoy longer life expectancies. Explanation in Grossman model is that the gradient arises because the well-educated are more efficient producers of health, the more educated persons gains more health, stock for each unit of health investment. So, basically there is a shift of this MEC, marginal efficiency of capital or health capital which we already mentioned as downward sloping and that is basically due to the rate of returns.

If the MEC H is high, MEC_H if you are saying it is basically high school dropouts and MEC_C for college graduates, and MEC increases because of education. Another one is declining because of the ageing one; the health capital is an inverse function, or there will be regressive change with respect to age. Why does health optimally deteriorate with age? Grossman predicts that it is too costly to stay forever young. There are even biological reasons, organs as health assets, diminish over time, and the diminishing rate increases

with age. So, basically, the depreciation rate that is gamma increases with age, and in the figure, we have mentioned that as individuals age, the depreciation rate of health increases fromγ_0 to γ_1, and the minimum age attain.

Hence, the depreciation rate is accordingly followed and presented in this MEC curve. Why health optimally deteriorates with age is mentioned. In conclusion, we need to mention that we discussed the cost of health that rises with age if the depreciation rate on the stock of health rises over the life cycle. The cost of health falls with education if more educated people are more efficient producers of health. The MEC curve of health slopes downward due to the diminishing marginal productivity of health capital. Here are our readings for your ready reference or understanding.

Here is our like this used to refer largely. Grossman, you can also follow the original explanations we mentioned in our slides. Please read, and I am sure several questions are expected from this chapter in your assignment and our final exam. What is there in our next lecture? We will discuss the demand for health, and we will also discuss the implications of their policy. Thank you. After listening to these two consecutive lectures, I hope demand for health is well set and clarified, and especially the Grossman Model is essential. Thank you.