Health Economics

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Week – 02

Lecture 11- Physicians as Health Provider-I

Welcome friends. Once again, regarding our NPTEL MOOC module on Health Economics, this module is considered to be one of the unique online platforms, including the NPTEL, because of its in-depth contents, which can be referred or credited to your master's program even wherever they have health economics or even for consulting services as well. This is going to build you the theoretical foundations, the contents, etc. I am not just alone; I am being supported by our TAs (teaching assistants). We are developing this unit with support from the entire NPTEL, including IIT Roorkee and IIT Madras. In this particular week, we will explain the supply side perspectives of health economics or supply in healthcare.

This has five lectures. In the previous week, we discussed in detail its modeling on the demand perspective of healthcare or demand in healthcare. We will just give you a very brief recap that is all about the demand side healthcare and different models of demand for healthcare. In this unit, we will discuss the supply side factors or supply side modeling.

We start with physicians and their role as the supplier or the most important supplier of medical services. Hence, we will model the physician behavior and supplier induced demand. We know in economic theory that whether demand derives supply or supply derives demand. So, both way it works. We already discussed the demand side.

We are actually explaining emphasizing in special in healthcare, we will see if the unit that is this healthcare unit is very good. Usually in the minds of the patients or the individual, they used to be influenced by the facilities or by the standard of that particular healthcare unit or the kind of advertisement the unit makes really influences the demand. In this perspective, we will highlight to what extent the supply is being optimized with the physicians' behavior. So, let us clarify. We start with certain stylized facts.

Those are in news. We are referring to one news article from ThePrint that is to meet world average India must add at least 10 lakh doctors to healthcare force. And this is from the 2020 paper. Doctors cannot be added to fight the pandemic overnight. So, each year India must add

at least 30,000 medical seats and casual attitude won't do anymore.

Some facts from different papers you can cite or you can also refer to the Hindu business line of 2022 on rural India is struggling with shortage of doctors and especially the tale of empty hospitals is due to a lack of incentives extended to doctors prompting them not to work in rural health facilities. Even two of my own writing in newspaper from their editorials are on healthcare quacks, how supply side created some form of irregularities in the healthcare system. Even we also discuss about the supply side factors emphasizing the role of traditional medicines. So, two other news articles you can refer from my own writing, though we have not cited at this moment, but we will provide you to read. Another one is from 2022 on how technology is influencing healthcare carriers and bridging gaps between supply and demand.

Another one is on harnessing the power of drones as providing the services, especially improving access to blood in rural India is a recent article from 2023. India builds more hospitals as population surges, but doctors still having short supply. Another one what is widening India's healthcare gap, a gap between demand and supply is evident across all aspects of India's healthcare sector. Similarly, some forecasting are also made, healthcare forecasting are adding to the woes of the problems of healthcare system in India. There are number of articles we can refer for you to read.

In this lecture, we will be sticking to the typical problem lies with the healthcare supply. We start with the physicians' perspectives. The last word I wanted to just mention is that India must add 30000 medical seeds in order to deal with the ratio. Physicians are the gatekeepers of the healthcare system. They play key role in the production and distribution of medical services.

They see physician first, then physician refer them to other providers of medical services such as specialists, hospitals, pharmacists, different types of therapists etc. The physicians indeed decide first on diagnosis, treatment and, prescribing drugs etc. There is dual role as well such as provider of medical services and advisor concerning the services to be demanded by patients. In healthcare, the relationship between the supplier that is the physician and the demander, they are the patient, is a bit unusual. Why is it so? Because demanders have incomplete information about their true needs.

They just know that their health state is low, and they require more medical treatment. And they have the choice of treatment from better-informed doctors. The demand curve mirrors the decisions of suppliers, not the demanders. The demand for medical services is suppliers determined in large Indian context. Let us explain supplier-determined demand.

In Economics, SID or supplier-induced demand can arise when there is a difference in information between the supplier and the consumer or the patient. The supplier can leverage their superior information to persuade the consumer to request a larger quantity of the product or service they offer than what would be considered Pareto efficient if there were no information imbalance. Even to some extent of this Pareto efficient provisions, we have tried to explain in the efficiency unit through the diagram. This ultimately leads to a decrease in overall welfare. If that supplier is determining the need where the need is juxtaposed with the problems of some

information asymmetries.

If suppliers or the doctors vary the information provided to demanders with an increase in physician density so as to secure their own full employment, then supplier determined becomes supplier induced demand. So, that is why it is called SID or supplier induced demand. So, we are now explaining this concept in detail. Before that you can just have some glimpse of the facts about number of registered doctors in India from 2001 to 2020. So, the reference is from Statista 2000 to 20, Statista database.

You can see it is rising, number of registered doctors in India is rising. The question is why do young people choose the medical profession? Is it due to the fulfillment of desire to serve other people or expectations to earn an above average income? The number of doctors has greatly increased in the past few decades. However, given the standard ratio as prescribed by WHO, still India is falling short. This is where we are mentioning density of medical doctors in India from 1991 to 2019. Per 10,000 population is mentioned.

This is from the same source. WHO recommended 1 is to 1000 doctor to population ratio or doctor to patient ratio. The number of doctors has indeed increased over the years. However, still more numbers of doctors are required. You can see recently there have been a surge due to many important actions taken both in doctors as well as in paramedical forces.

Those have added to a large number of the supply side. This diagram again requires further thinking. You may go through the source and go through the literature to clarify the gaps. At this moment, we are only emphasizing how supply side woes, or the supply induced demand is creating some kind of trouble in the optimization. Fuchs 1978 found that a 10 percent increase in surge in density, keeping other thing constant, led to 3 percent more operations per capita while surgical fees increased.

This positively correlates with physician density and per capita utilization of medical services. Cross-section studies show that greater supply of physicians goes hand in hand with an increased utilization of medical services per capita. We are presenting here the supply, how supply side is inducing the demand. At this moment, we are just focusing on the impact of an increase in physician supply as per the standard demand supply framework. In this case, you can easily see when the supply increases, you will find some change in terms of the prices and the medical services access is also increased.

That increase from M_1 to M_2. We are going by a non-market case or a regulated case where government regulated unit price is prevailing. If it is 100 percent regulated, then demand is considered to be inelastic and for some initial physicians, we start with S_0 supply curve and D_0 is the primary demand and P_0 is government regulated unit price. Physician density supposedly increased from S_0 to S_1, what really happens? The supply curve really shifts outward. Here we are discussing suppliers induced demand is a response to an increase in physician density.

Given this case, physician might act as a perfect agent or may not act as perfect agent. We

are heading for our modeling on induced demand. We are just giving the anecdote to the problems. In this case, physician will act as a perfect agent in the case 1, there is a possible to underutilization of physicians' capacity at the level of M_1 to M_0. Whereas if they do not act as perfect agent, they will welcome all demanders till M_1.

These facilities supply side shifts are there, they may induce the demand and demand might shift towards D_1, but that is not the case where they act as a perfect agent. In this case, they will recommend patients unnecessarily as a supplier side inducing factor. Hence, that has changed the demand curve and hence there is a shift in the demand. And hence this is called induced demand, or this induces demand.

This is what is emphasized. In the pre-case act as a perfect agent, we are just highlighting what are the change, but if they do not act as perfect agent, the new one is mentioned. The first circle is if they act as a perfect agent, still they stick to the rationing as I said by the government, and they stick to the natural demand. In the second case, they do not act as a person perfect agent, hence they influence the demand, and the demand curve might shift towards site. Then what are the conditions facilitating demand inducement? There are several reasons. We will also discuss about under which barriers or which societal factors that really led them to go for this inducement, we will also discuss.

But at this moment, we are just sticking to the conditions those facilitate demand inducement. Starting with health insurance, if patients are fully insured, then patients WTP or willingness to pay does not matter. The cost associated with medical care consumption may matter, but they can go for access. Riskless medical technology, another point, that means if medical services are available that do no harm even if have minimal benefits, then physicians may choose to induce demand without any hesitation since some of the drugs or some of the prescriptions are harmless or riskless medical technologies. In that case, demand inducement clearly occurs even in health insurance cases.

But there are some unethical directions as well where demand inducement occurs, we will clarify in another slide. Let us start with the physician's behavior. We have to or let us model the physician's behavior. Before that we need to take some assumptions. Starting with that physician is utility maximizing, medical treatment is homogeneous in nature or the treatment as a good is homogeneous.

There is one consumer good used as numeraire to compare the other facilities. All physicians are indeed identical as per the assumption. Price per unit of medical care is regulated with a regulated as price **p**. Patients are fully insured, the demand does not depend on **p**. So, the demand they are registering higher or higher is not really influenced by **p**.

Hence, we can model physicians influencing behavior or inducement behavior through this assumption. So, **p** stands for price, **a** will be using as identical physicians. So, this is **a** we are going to refer. **n** is number of inhabitants or population or the patient. Hence delta (δ) stands

for physician density or physician population ratio that is **a** upon **n**, physicians divided by population.

$$\delta = \frac{a}{n}$$

We will be using this in your framework model. Starting with the first case where there is no demand inducement and second one is with demand inducement. The case one with no demand inducement, primary demand per physician is equal to then how much we simply said the number of population times the medical services, **M** stands for demand for physicians' services that is in units of physician working time out of the physicians, number of physicians those we considered as identical in nature. As a ratio, we present this as **M** divided by $\boldsymbol{\delta}$. We have defined δ as **a/n**. So, the primary demand for physician is interpreted as **M** upon $\boldsymbol{\delta}$.

$$Primary\ demand\ per\ physician = \frac{M}{\delta} = \frac{nM}{a}.$$

Then, there occurs some inducement of demand through supply. We start with physicians creating certain extra supplies unit **s** that is indeed induced. Hence, the total demand for physician for working time is of course, will be M upon δ plus but **s** which is extra registered, **s** has to be greater than or equal to 0, has to be positive. Then only we said that H is a function of δ and s, we define this as the supply induced demand (SID).

$$h(\delta, s) = \frac{M}{\delta} + s \text{ where } s \geq 0$$

Working time is let it be **t** expressed as a fraction of total available time with a maximum available fraction time is 1 and the other limit is 0.

Hence, it is presented as the minimum of the total demand **t**, the allocation of **t** or the time required for the doctors will be a minimum of this or 1, whichever is the minimum that the time has to be allocated. Physicians adjust their working time to demand unless there is the upper limit of their available time. Time constraints explanation we have discussed. You can just cross check why minimum is required because minimum hour allocation is required from the doctors or the physicians which really influence the **h** function, **h** or the healthcare induced services. Then we are again emphasizing another direction through the disposable income of the physicians that is **y**.

y is basically their revenue minus the practice expenses and the taxes they are supposed to pay. Practice expenses are a fixed share of their revenue. Again, this is part of the revenue and even taxes are progressive it is also part of revenue hence mostly it is presented as **pt** because the two are inclusive. So, **y** is a function of **pt** and you can just see the first derivative is positive as income increases, the slope is considered to be positive, the physicians income rises, then the second one is actually reaches the maximum then there is a possibility of declining trend as typical with the income function. Hence disposable income is an increasing and concave function of physicians' consumption.

$$y = y(pt) \quad with\, y' > 0\, and\, y'' < 0$$

So, it is a concave function. We have presented time constraint, we presented the very simple framework of induced demand for healthcare through the supply, then time, then we discussed about disposable income of physicians. Now we are presenting all the utility, physician's utility function, which is strictly concave, the willingness of the physicians to act as a service unit. Hence their utility really matters that then only it can influence, or he or she can influence the demand. This utility function is strictly concave, and this depends positively on consumption that is **y** and negatively on the working hour that is **t** and the demand inducement **s**. Why it is again negative? Because higher the demanders are there more time again or the more burden is on the physicians.

Hence, it is negative. You can just see their first order and second order derivative; you can just see from the income side. We have mentioned that the first one, with the first one is positive and the second derivative is negative. Hence, we said that with the physician's utility function with respect to their consumption is strictly concave and it is concave. Then with respect to time it is negative and the second is maybe negative or even equal to 0, might remain constant after certain time. And even with respect to the supply induced demand that is **s**, first derivative is negative and second one is at least non-positive.

We also assume that the second derivative with the cross substitutions or the substitution between **y** and **t**. Why **y** and **t**? Because we wanted to emphasize the complementarity nature between these two. Assume that these two y and t that is consumption and leisure are complementary goods. y stands for consumption and t times for the time left or leisure are complementary goods. Hence, his second derivative is negative or non-positive at least.

The relationship between y and s that is higher disposable income means more important is professional ethics. If doctors are receiving comparatively higher income their professional ethics is considered to be better. Hence demand inducement is less. Then s and t that is the inducement and the time, workload time has no effect on physician's attitude towards professional ethics.

Hence it is 0. We need to assume that the relationship between these two and their changes are having no relationships. Utility functions of the physicians are presented here. Here we want to say one thing that with respect to the supply induced demand and this is negative mostly because it is incompatible with professional ethics. Let us start with a physician maximizes his or her utility by choosing optimal amount. Out of these three we mentioned y to be the maximum, $y^*, and\, A^*$ given certain constraints.

So, constraints, we start with the induced healthcare demand function as $h(\delta, s)$. So, we have already clarified in the previous slides that this is the natural healthcare demand function plus the induced demand function or the extent of this induced demand. Subject to the **t** which we have already mentioned that **t** is a minimum of out of these two the maximum is as a fraction of **t** is used as 1 and the minimum is the $h(\delta, s)$. So, here is the type of optima we know that we used to find out the optima conditions using Lagrangian multiplier or if the constraint function is

identical in nature or constraints function follows a strict boundary point. When the constraint function is not rigid or following a strict boundary function in that case we are supposed to deal with other approaches like Kuhn-Tucker.

Here in the types of optima, there are four possibilities. The boundary optimum with **s** equal to 0 and **t** equal to 1 ($s = 0, t = 1$) and these are all based on market condition and physicians' preferences. Others are like s might be 0 and t is less than 1 ($s = 0, t < 1$) and other interior optimum with both are not following at the boundary point like s is greater than 0 and t is less than 1 ($s > 0, t < 1$) and another optimum point is **s** is greater than 0, but t equal to 1 ($s > 0, t = 1$). This is interior because both are not following the boundary. So, what are all those? In the first case boundary optimum with both at the boundary s equal to 0 and t equal to 1 ($s = 0, t = 1$) when physician density is low that market demand cannot be met with all physicians working maximum amount of time. In the second case optimum with no induced demand, but t is a fraction of leisure time is left when ethics or preference for leisure are very strong and even if physicians are working below capacity, but they are just meeting primary demand only.

Therefore, s equal to 0. On the third case with interior optimum occurs because the supply induced demand is positive. That means professional ethics is not there or less when physicians density is so high that even with optimum amount of demand induced, they are working below full capacity because their t is less than 1. So, another optimum with induced demand is there and working with full capacity when physicians are inducing demand until full capacity is reached. We will be utilizing these directions and the first case when the boundary is rigid or that is called constant follows the equalities. Hence, we will be following Lagrangian multiplier method and whereas in other cases where the constraint function is non or constraint optimization with inequalities or non-linear programming is noted in the constraint function, in that case we are supposed to go through Kuhn-Tucker conditions.

So, these three options will be clarified in a short while. I will just clarify these at this moment, then we may proceed to the next class and clarify in detail. For the cases involving inequality, the Kuhn-Tucker condition will be formed as follows. That is putting the total demand for physician equations in utility function of physicians, that is U as a function of y, t and s, as $u(y, t, s)$ that will be a function of induced demand s only. The constraint will be formed out of time constraint, and it will be an inequality. So, anyway utility as a function of y, t and s, we know that y is equal to yp and so p as a function of M upon delta plus s.

You can just have a check once again. I will just go back and clarify. So, this is your h, M upon delta plus S and this is y, t and s and this is yp, t which we already clarified. So, y function we are just clarifying at this moment and then your t function is here, and s is explained. So, subject to the t, you can present is as a maximum fraction of time is 1 and with the h healthcare services as a function of delta and s or it is a function of the minimum of h is precisely as M upon delta plus s, this is what is the h. And or in short, we have already checked that the maximum time that is to be allocated is 1.

M upon delta plus s would be less than equal to 1. This is the basic equation. Let us take a

dummy variable that is X such that X is greater than or equal to 0. What is this indeed? We are just clarifying. X is a variable such that it makes inequality into equality. So, since we know that there are inequalities and hence it is less than 1, so we are just introducing X here so that we might find an equality equation.

We will present all sort of things then once equality is identified the Lagrangian function will be formed by taking lambda as a Lagrangian multiplier. Subsequently, the first order conditions will be given as below. Similarly, there are so many other details of optimization. We will find out what is the best optima condition. I am just going to show it right now, but we will carry forward to the next class.

From this once again I will take up from this page number 24 onwards to our next lecture. We will again clarify types of optima with Lagrangian optimization and Kuhn-Tucker optimization and what are their interpretations. I will clarify and certain empirical examination of SID will also be given, and sample questions would also be discussed with you in our next lecture. Till that time you can just follow some of these readings. Zwifel of 2009 book is important, chapter 8 is mostly referred, and I think I will just stop here in this slide.

So, after explaining this, I will take up from this from the next class. Thank you.