PRODUCTION FUNCTION. EXPLANATORY MODELS REGARDING THE HEALTH PRODUCTION SERVICE

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Abstract:
The measure of health, regarded from the point of view of human capital, has met, over time, difficulties. The hardship in elaborating a standard method of measurement, is, for the most part, determined by the multitude of factors that can influence the health state of the population. The pioneering study regarding the production function of population health is the one of Auster, Leveson and Sarachek (1969), who have investigated the manner in which health supervision and environmental factors affect the mortality (the mortality rate being one of the measures identified for health). Subsequently, the research has focused on identifying determiners of life expectancy or of mortality rates.

Key words: *Production function, models, health, demand.*

JEL classification: O01

INTRODUCTION

A. Grossman's health demand model (1972). Health demand

One of the promoters of human capital theory is Gary Becker (1975), who has highlighted the fact that the individual is not a simple final consumer, but a genuine producer that, through education and training, makes an investment in human capital. Schultz (1961) and Mushkin (1962) have proved that, by improving health, human capital can be accumulated.

Grossman's approach regarding health requirement has been considered a model of human capital, as it is greatly based on Becker's human capital theory (1964, 1967). According to it, the increment of knowledge reserve of a person increases its productivity in the market economy sector, where it produces income, and in the non-commercial or household one, it produces merchandise that assumes the function of utility. For accomplishing these incomes, the individuals invest in education and in trainings on the job. Becker (1967) has developed a model that determines the optimum quantity of investments in human capital, regardless of age.

Considering that the basic demand is a good health state, the making of a health demand model was necessary. Mushkin (1962), Becker (1964) and Fuchs (1966) have presented the health capital as a component of human capital reserve, but Grossman (1972) is the one that has designed one. If the evolution of the health reserve would

simply increase salaries, Grossman's model (1972) wouldn't have been necessary anymore, as Becker's theory would have applied (1964).

The traditional theory of this model presumes that assets and services acquired from the market assume the utility function of consumers, economists emphasizing the prevalence of medical care demand to the detriment of health demand. In the new setting of consumer behavior examination, it is assumed that individuals inherit an initial reserve of health, that depreciates in time, at least after a certain phase of the life cycle and can be increased through investments. Death is produced when the reserves decrease beneath a certain level. One of the characteristics of the model is that individuals „choose" their life span, through their choices.

Raw investments in human capital are included in the household production function, whose direct entries include *their own period of market goods consumption* such as:

Medical assistance, diet, physical exercises, rest and housing.

The production function depends on certain „environmental variables", the most important one being the one linked to the producer's education level, influencing the efficiency of the production process.

Thus, in this model, the individual health level is not exogenous, but it depends, at least partly, of the resources assigned for its production. Health is demanded by consumers for two reasons:

- *As a consumption good* – which enters their preference directly, in other words, sick days are a source of futility
- *As an investment good* – the total amount of time available for the market and non-commercial activities

In other words, an increment of health reserve reduces the amount of time lost caused by disease and the monetary value of this reduction is a gain of health investment.

Considering the decreasing slope of demand curve, the health quantity requested must be negatively correlated with its „hidden" price.

This *unseen* price of health depends of many other variables, besides the price of medical care. The changes within these variables modify the optimum health quantity and, also, the demand derived from raw investments, measured through health expenses (medical). This" hidden" price increases with age, in which case the depreciation rate regarding the health reserve increases during the life cycle and decreases, based on the education level. The individuals with a higher education level are more efficient health producers. As an important conclusion, in certain circumstances, an increment of the „hidden" price can simultaneously reduce the requested health quantity and increase the demand for medical care.

The formalization of Grossman's health production function

Grossman (1972) has elaborated a demand model regarding health capital, having as a first hypothesis the adaptation of Becker's economic interpretation (1967), regarding the educational part of the human capital' component in health, on the principle that individuals invest in themselves to increase their knowledge, which will lead to the increase in their productivity in the economy market sector. The second hypothesis is the one that the demand of medical services actually represents a request for a good health state, regarded as well as an asset, as well as an investment in human capital, whose reserve depreciates in time, but that can be enhanced through investment.

Such a relationship is rendered in the following image, in which Hirtzlin-Pantheon (2003) considers that death is an endogenous factor, it being elected optionally by the consumer.

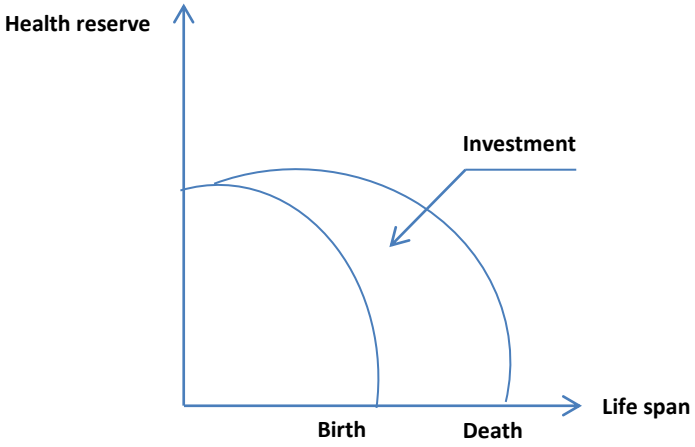

Image No. 1: The relationships between the health reserve and investment
Source: Hirtzlin-Pantheon, 2003

Grossman's model (1972) starts from the utility function for a typical consumer. This function, from a theoretical point of view, presents itself in the following manner:

$U = U (X_1, X_2, \ldots X_n)$

Where:
U – represents the utility's level
X_i - the quantity consumed from certain goods, and
n - the amount of consumer goods

Graphically, this function can be rendered in the following manner:

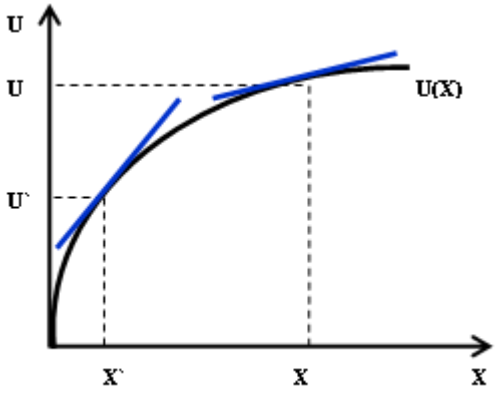

Image No. 2: Utility Function U(X)
Source: https://ro.wikipedia.org/

Starting from this function, Grossman describes the utility function of health for a consumer in the following manner:

$$U = U(Q_0 H_0, \ldots\ldots Q_n H_n, Z_0, \ldots\ldots, Z_n)$$

Where:

H_0 = the inherited health reserve
H_i = the health reserve in a certain period of time
$\emptyset_i =$ the flow of services on a stock unit
$h_i = \emptyset_i H_i =$ total consumption of health services
$Z_i =$ the total consumption of other "merchandise" in a determined period of time *i*

By definition, net investments in the health reserve are equal to raw investments, from which depreciation is subtracted.

$$H_{i+1} - H_i = I_i - \delta_i H_i$$

Where: $I_i =$ Raw investment; $\delta_i =$ Depreciation rate during the *i* period.

Consumers produce raw investments in health, as well as other merchandise, according to the utility function, through a set of household production functions.

$$I_i = I_i(M_i, TH_i, E_i), \quad Z_i = Z_i(X_i, T_i, E_i)$$

Where:
M_i = medical care
$X_i =$ the entrance of goods for merchandise production
Z_i, TH_i, T_i = time inputs
$E_i =$ human capital reserve

The health production function describes the relationship of entry and exit flows during a certain amount of time. The production (exits) is a measure of the health state, being represented by the life expectancy or morbidity. The medical expenses, the environment, education, life style, genetic inheritance etc represent the entries representing health. The simplified model tries to establish the optimal investment in human capital from a health perspective: "a person determines the optimal reserve of health, utilizing the marginal efficiency of this capital with its cost in terms of the total price of the investment. (Grossman, 1972, page No. 228).

If we were to exemplify, the health production function would look like that:

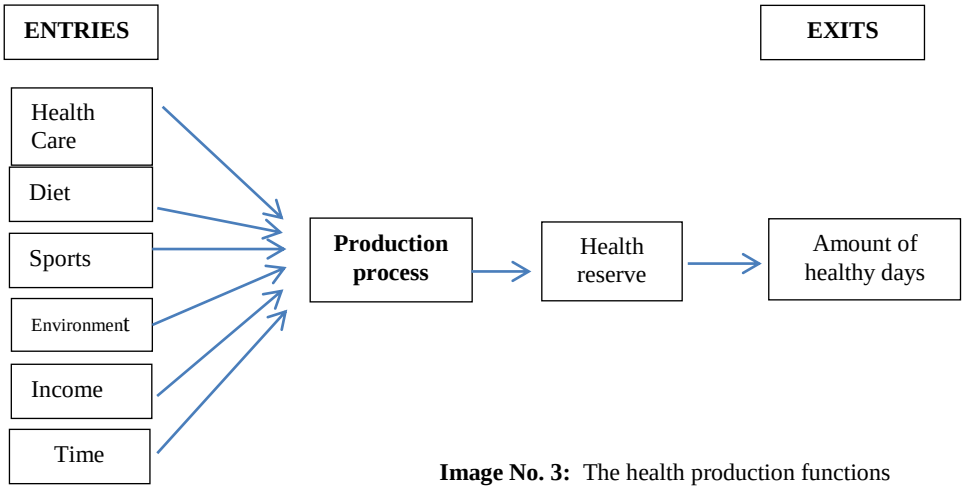

Image No. 3: The health production functions
Source: Processed based on specialized literature

The model elaborated by Grossman (1972), uses the household production function regarding the consumer behavior in order to justify the difference between health – as an exit – and medical care – as one of the entries. This model draws a clear distinction between the fundamental choice objects – called basic products – expressing utility and goods and services market.

The concept of household use production function is perfectly similar to a society's production function, as the goods and services are entries in the merchandise production, the demand for these goods and services being a demand derived for a production factor.

Thus, the demand for medical care and other entries regarding health, is derived from the basic demand for health, an important connection between household production theory of consumption behavior and the theory of investments in human capital existing.

Because health capital is a component of human capital, an individual inherits an initial reserve of health, which depreciates with age and can be enhanced through investments. The outings of the reserve regarding health capital are measured by "healthy days". The consumers use a set of entries in order to make investments in the human capital, and this reserve can increase, decrease or remain constant along time, according to age, disease and so on.

According to the model, people are regarded as health producers through the choices they make regarding the behavior and use of medical care, the result being a life more or less healthy. People are limited in the possibilities to produce health from various reasons: financial constraints, time constraints, basic features regarding mental and physical health, as well as environment, social and native context in which they live in.

When talking about time constraint, Grossman (1972) uses the following function:

T= 365 days = $T_H + T_L + T_W$

where: T = total available time

T_W = time granted for work (income is necessary for purchasing goods required for ensuring medical needs)

$T_L =$ time wasted because of the disease (a fraction of the time is dedicated to health care)

Thus, we get to the following equation:

Time available for work or free time = $365 - T_{HO} - T_{LO} = T_W + T_B$

Where: $T_B =$ free time; $T_{H0} =$ time dedicated for health improvement and $T_{L0} =$ time wasted because of the disease.

The relationship work-free time can be presented through a chart, such as the following:

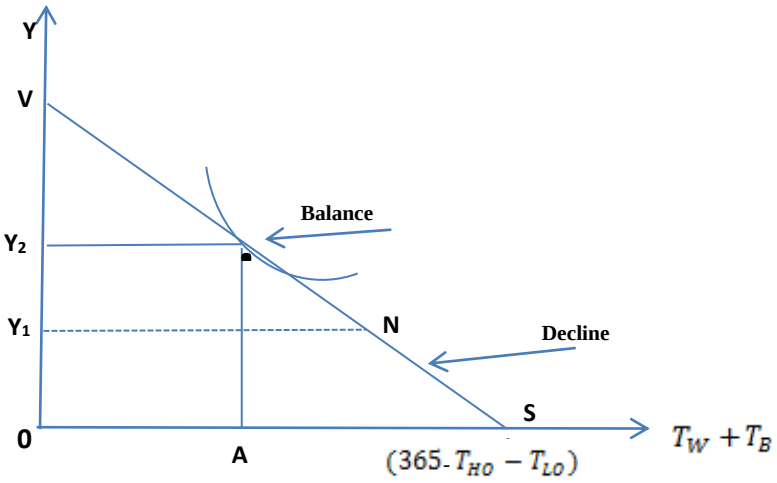

Image No. 4: Work-free time relationship
Source: Pruckner, 2010

The theoretical model of Grossman (1972) can be formalized in the following manner:

H = f(X)

Where: *H* = health production measurement and *X* = a vector of individual entries for the health production function.

Starting from this function, in order to perform an analysis on a macro level, Favissa and Gutema (2005) have divided that vector of the entries in three sub-categories:

H = f (Y, S, V)

Where: *H* = life expectancy (as a health measure), *Y* = a vector of economic variables/capita and V = a vector of environmental factors/ capita.

Even though it is the most well-known model regarding health production function, Grossman's model (1972) has also received criticism, over time, such as: ignoring insurance markets, being a determinist model, including choosing the time of death, health care is a constant investment throughout life.

B. Cropper's models (1977)

He has developed two models of health investments. In the 1st one, he points out that individuals invest in health capital when the reason for this investment is that of reducing the probability of getting ill. In the 2nd model, individuals invest in health based on the job they have chosen. Cropper's models show an investment in health in uncertain circumstances, health capital reserve being the determining factor, and the main element being the disease.

In the 1st model, Cropper explains the fact that a person's health or sickness depends of certain events such as: climate change, exposure to germs or viruses, as well as of the health reserve dimension, these being called random events.

The author presumes that the disease emerges every time the health reserve drops under a critical level of disease, represented by the individuals' exposure to germs or pollutants. Thus said, the individual is ill if, at a certain time, the value caught by the disease threshold is greater than the health reserve, while if it drops below the health reserve, the individual is healthy.

Therefore, his chance of keeping himself healthy is by maintaining a high health capital reserve or the health reserve should always be above the disease threshold.

In Cropper's opinion, the emergence of the disease in time is not excluded or guaranteed, it explaining one of the two stages, of being or not being sick.

In the 2nd model, an individual invests in his health state by choosing to be busy (of working), respectively, choosing his workplace conditions. The degree of pollutant exposure determines death probability increment, this being accepted by the worker in exchange for a higher salary. Cropper also has a result for this hypothesis, arguing that, if an individual chooses to work in a polluted environment, it's better to choose to do so when he is young, because his health reserve is greater, depreciating with age.

According to Cropper (1977), a person would not suffer, even when disease emerges, if the health reserve exceeds the disease threshold, which implies that a greater health reserve has as purpose the reduction in chances of getting the disease. An important part in creating this reserve is owned by health and safety practices in the workplace, a healthy lifestyle, the most important part being avoiding smoking.

A disadvantage of this model is that, according to it, disease doesn't reduce the health reserve, because, with the same health reserve, the individual can be healthy as long as it doesn't drop below the disease threshold.

C. The model of Laporte and Ferguson (2007)

Laporte and Ferguson (2007) claim that the disease affects the health reserve and causes a reduction of it, serious diseases causing an impact on the individuals' health reserve. They claim that, when a person goes through a serious disease, doesn't automatically return to a full health state, to an increased level of health capital. The model implies that the health reserve of the individual, as well as the health state felt by him should be the same. Also, the increment of the health reserve through private

investments is a determining factor. Random factors could be: a car accident, an explosion and their own guilty pleasures: these, according to the authors, have the tendency of determining the dimension of the health reserve.

This model regards the disease from two perspectives:

i) The reduction of the individual health reserve of the person by a certain proportion
ii) The reduction of the individual health reserve to a certain level

In the first case, the quantity of the individual health reserve decreases, and the gravity of the disease depends on the individual health reserve held before the emergence of the disease.

This implies the fact that a greater individual reserve of health, accumulated through investment, causes a smaller loss once the disease emerges. The health reserve before getting ill determines the recovery rate after the individual is affected in a certain proportion by a disease, and also, diminishes the probability of getting ill.

In the 2nd case scenario, as the health reserve of the individual diminishes at a certain predetermined level, the health reserve before the sickness doesn't have an influence on the health reserve after the sickness. This implies that the investment should regard preventing sickness and not the recovery after an illness.

Laporte and Ferguson (2007) claim that downward shocks, called illnesses, are easy to observe, while the recovery after illness is seen as an ascending shock, but the probability of these ascending shocks to appear in a person that is in good health is low.

An example in this regard is the following: in the case in which an employee gets sick during working hours, he can resort to medication that will allow him to revert to the good health condition he had before, enabling him to continue or cease his work and returning to work the following day. According to the model, the efficiency of the investment will be great, but it decreases with his recovery from the disease.

CONCLUSIONS

The theoretical and empirical literature describe how an increment in the health reserve reduces the amount of time wasted because of the disease and the monetary value of this rebate is thus, a gain from the investment in health. *The health production function* describes the relationship or flows of entries and exits in a certain amount of time. Medical expenses, environment, education, lifestyle, genetic factors and so son represent the entries regarding health. The simplified model attempts to establish which is the optimal investment in human capital from a health point of view: "a person determines its optimal health reserve, using, in an equation, the marginal efficiency of this capital with its cost, in terms of the total price of the investment.

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