

# ECONOMIC INTERPRETATION OF HUMAN BEHAVIOUR IN TERMS OF HEALTH PROMOTION

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**Zdeněk Chytil, Arnošt Klesla, Tomáš Kosička\***

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**Abstract:**

The economic approach to health promotion describes human behaviour towards preservation of individual health by methods of the economic analysis. We have developed mathematical model based on the Grossman's theory of Demand for Health (1972) showing two basic approaches. The investors prevent diseases by adopting healthy lifestyle and therefore minimize costs of healthcare. The consumers, however, depend on the healthcare system and cause further increase of its expenditures. It is also demonstrated that the latter approach leads to the increase of expenditures on maintaining the level of public health. Also the strong incidence of chronic and almost incurable non-communicable diseases excludes passive consumerism care for their own health from the rational choice. These effects vary in developing and developed countries and further burden healthcare systems for instance in the new EU Member States.

**Keywords:** health promotion behaviour, demand for health, healthy life style, rationality, health illusion

**JEL Classification:** I15, I18, I19

## 1. Introduction

Health as a factor of economic growth and prosperity has become increasingly important. In terms of economics, and social and financial policies, health must be understood not only as the capacity of persons to cope with their life conditions in a state of personal comfort, but also as the capacity to lead a socially and economically productive life (WHO, 1981). In terms of microeconomics, this means an approach to put emphasis on the significance of health as a condition for the full utilization of the human capital and the efficient use of all the productive factors. In terms of macroeconomics, health is considered as an important factor in the economic growth and prosperity of a society. Learning about the basic factors that determine their health (WHO, 2012) is a condition for the long-term good health of every individual. A healthy lifestyle is the most important of these factors;

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\* Zdeněk Chytil, University of Economics, in Prague, Czech Republic (chytil@vse.cz);  
Arnošt Klesla, University of Economics, in Prague, Czech Republic (arnost@klesla.com);  
Tomáš Kosička, University of Finance and Administration, Prague, Czech Republic  
(23111@mail.vsfz.cz).

it affects health by more than 50%. The remaining factors are genetic predisposition, healthcare, and life and socio-economic environments. All policies and programmes that aim to positively affect lifestyles within the healthcare policies of a country are based on the global concept of Health Promotion by Ottawa Charter for Health Promotion (WHO, 1986). This path of strengthening the public health by influencing healthy behaviour in the population can bring extremely effective results. In contrast to the cost of the treatment of diseases, it aims to adopt and keep a healthy lifestyle. It is the most effective prevention of disease and the only way to deal with development of non-communicable diseases (NCD). The NCDs are fully or partially incurable. The effect of health promotion on the economy can be demonstrated on the savings for treatment of NCDs. The costs of healthy lifestyle are also a part of the regular expenses of each consumer. There are generally two extremes of consumer behaviour. Adoption of healthy lifestyle that results in savings in treatment costs, or rising demand for treatment and incurring higher costs in the healthcare system. We therefore identified the methodology to express these two variations and their impacts on the health care economy. Our new model explains the influence of healthy lifestyle or consumption of health on the healthcare expenditures. The model and its construction is based on the health as the part of human capital (Becker, 1993) and on the model of demand for health according to Grossman (1972).

## 2. Health Promotion and Economic Analysis of Human Behaviour

Health promotion behaviour is a part, and a condition, for the acceptance of a healthy lifestyle, a manifestation of each person's goal to maintain and reinforce, as well as promote, his/her own health.

The possibilities of an economic approach to health based on economic analyses of behaviour also offer another opportunity to enrich knowledge, methods, forms and approaches to the healthy behaviour of individuals, groups and populations. The choice of behaviour of every person, the owners of their own health as a specific asset, can be influenced by several factors, in particular, with a change in conditions, by restricting and creating options for choices. In this way mathematical analysis and modelling of health care costs are based on people's behaviour that can provide a relevant basis. Not only to explain the behaviour of individuals in relation to their own health, but can also brought now approaches to improve the efficiency of the concepts of health promotion.

### 2.1 Demand for health

The theory of demand for health (Grossman 1972) can be considered as a basis for the examination of the health behaviour of individuals in terms of economics. This model of the demand for the commodity "good health" is based on the Becker's (1993) and Schultz's (1961) concept of human capital. To refer to the investment in health, he uses the term health capital, which equates to health, as a part of the human capital's supplies. The model is based on the consumer's utility functions, which Grossman (1972) formulated as  $U = U(\phi_0 H_0, \dots, \phi_n H_n, Z_0, \dots, Z_n)^1$ . Grossmann (1972) sees the demanding

1 where  $H_0$  is the initial supply of health,  $H_i$  is the stock of health in time  $i$ ,  $\phi_i$  is the number of services per unit of health,  $\phi_i H_i$  shows the total amount of health that has been consumed or invested in time  $i$ ,  $Z_i$  is the total consumption of the other commodities in time  $i$ .

individual as someone who at birth receives a “stock” of health, which deteriorates and decreases more rapidly with time, which in turn reflects the exponential function of time. The reduction of the health stock is expressed as  $H_{i+1} - H_i = I_i - \delta_i H_i$ ,<sup>2</sup>.

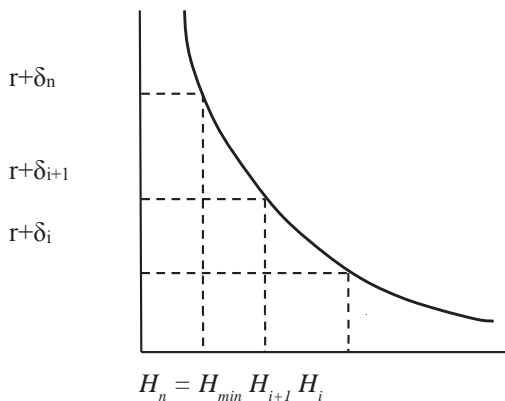
In order to use this model within the concept of health promotion it is particularly important that, in order to renew the consumed health, the model calculates, besides health care and treatment, healthy lifestyles. The consumer combines the market assets (medical care, diet, exercise, recreation, and housing) with their own time, producing health as result. In this way, the production of health results from two sources, from the point of view of the management of health determinants. From health care and from health promotion within a healthy lifestyle.

According to Grossman, the individual demands health (quite rationally) for two reasons: i) to obtain satisfaction (direct benefit) and ii) to invest in health, to maintain health in the future (indirect benefit). And important aspect of the model is the assumption that the level of the investment in health increases the amount of working time (productive activities) and leisure activities (Grossman, 1972). Because it strengthens the health and prevents disease. After a period of one year (365 days) the restrictions in time  $\Omega$ . consist in the time dedicated to investing in health,  $TH$ , disease  $TL$ , work  $TW$ , and the production of other assets  $T$ . Therefore,  $\Omega = TH + TL + TW + T$ .

The demand for health is illustrated with a Keynesian Marginal Efficiency of Capital (MEC) curve, expressed as a decreasing function of relationships  $MEC = W * G / C$ , where  $W$  is the wage rate,  $G$  is the rate or return on investments in health,  $C$  are the direct costs of the investments in health. The  $y$  axis shows the marginal capital costs, consisting on the rate of time preference costs on the health capital  $r$ , increasing according to the age related increase in the consumption of health, from  $\delta_i$  to  $\delta_n$ .

In order to apply this model under the conditions of the concept of health promotion, it is important that the demand curve expresses a lower supply of health  $H_{min}$  in old age, with high wear,  $\delta_n$ , which is expressed with the index according to the period of time.

**Figure 1 | Demand for Health by Grossman**



Source: Grossman, 1972, p. 237

2 where  $H_i$  is the current stock of health,  $I_i$  are the gross investments in health and  $\delta_i H_i$  is the wear (depreciation) of health.

The model assumes that every individual will, from his own resources, quite rationally and gradually invest in health and will choose not only the level of health (stock) renewal, but also the length of his life (which is endogenous in the model).

## 2.2 Demand for health, preferences and behaviour

Both in real life and in the Grossman's (1972) model, the level of health clearly declines with age. If individuals in order to renew their consumed stock of health ( $H_i$ ), rely only on the treatment of disease, they will not use the preventive effect of health promotion. If they follow the principles of a healthy lifestyle and prevention, the total amount stock of health ( $\phi_i$ ,  $H_i$ ) will increase as a result of the multiplication of biological process and consumption assets (diet) or the health promoting behaviour (exercise).

We are convinced that the preference choices and lifestyle are decisive factors that will model the course of functions of the individual demands for health. From the point of view of the development of a marginal benefit of the resources spent to renew health, the effect of a neglected health promotion will result in an increase in the convexity of the demand for health curve. On the other hand, continuous investment in health in the shape of the promotion of one's health (e.g. wellness) will have an effect on the shape of the demand curve so that its convexity will be reduced.

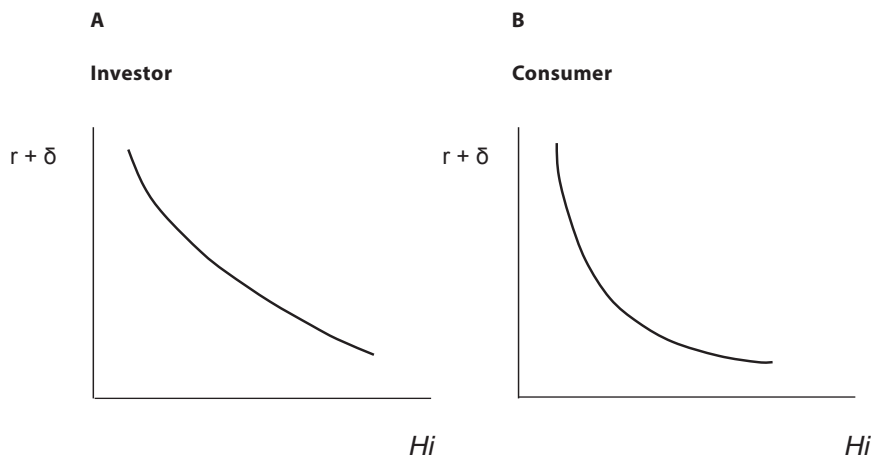
So, with the help of Grossman's (1972) model, let us consider the result that the consequences of the choice preferences that affect the lifestyle and behaviour of individuals can have in relation with ageing and the diminishing stock of health. We build a model of an individual approach to health promotion on this basis. It should be noted that the curve shown does not capture the evolution of health over the life of an individual, but just the model of expected evolution of the expenses (investment) on health, expressing the demand for its effective renewal.

As our model shows the first extreme case is represented by individuals that follow the principles of a healthy lifestyle. They consider health as specific and rare goods. They prefer to stay healthy throughout their life and follow the principles of a healthy lifestyle. With this goal, they do not expose their organism to excessive risk factors (obesity, smoking, alcohol, lack of exercise). They understand the expenses on stock of health mainly as an investment and keep an ideally natural decrease in the health stock  $H_i$ , in constant proportion to the marginal costs for their renewal. As a result of this, they are healthy a significantly greater number of days, especially during their productive age (18–64 years old) and increase their lifetime. Their function of health demand is expressed with a slightly convex curve that decreases very little. These kinds of health behavioural type (A) we call Investor.

The second extreme case are individuals with a significant future discount and low level of aversion to the risk of disease. The responsibility to renew their health in case of failure in the form of disease or injury is passed to the doctor, according to the effect principal – agent (Stieglitz, 1987). They prefer consumption of goods that will provide strong, short-term utility, and this includes assets harmful to their health like smoking or drugs. Their investments in their own health are insignificant, they buy healthcare only in the form of treatment of disease. They disregard the promotion of their own health and a healthy lifestyle, which results in being ill more frequently and longer as they age. Their health behaviour can be expressed with a significantly convex curve of the function of demand for health. The effectiveness of their investments in maintaining their health stock

is lower and the time spent ill or being treated (TL) is higher, at the expense of the time spent working and on other activities (TW, TZ). In terms of health promotion, their behaviour and lifestyle is prevalingly the behaviour of a passive consumer and therefore, this type (B) we called Consumer.

**Figure 2 | Two Approaches to Individual Health Promotion**



Source: own design

On the x and y axes are the indicators of the Grossman's (1972) model, stock of health  $H_i$  and the tenure costs of capital  $r$ , multiplied by the coefficient of health wear  $\delta i$ . The difference in the effectiveness of the costs of health maintenance, which increase with age, between the behaviours type A and B lies in the difference between the amounts of health  $H_i$  at the same price for its renewal.

### 3. Proposal for a New Model of Behaviour in Terms of Health Promotion

We propose a model that allows us to evaluate the influence of healthy lifestyle on level of public health and treatment based on the statistical data. Especially for the categories of population defined by the higher age. The model is based on the original Grossman's model (1972) and marginal efficiency of capital curve MEC. We identified two functions to describe basic and extreme types of behaviour in terms of health promotion - the Investor and the Consumer.

The general assumptions were made:

- investor keeps the conditions of healthy lifestyle; Investor invests in the renewal of his health stock on the continual basis. This constitutes his consumer choice as well as the prevention,
- consumer does not invest to the renewal of his own health intentionally. To renew his health stock in case of disease, he merely consumes treatment and healthcare provided by the healthcare system and insurance.

The other assumptions are:

- we evaluate the quality of healthcare and healthcare system based on the financial costs on the patient *per* year,
- we presume maximal efficiency (dollar spent cannot be spent with higher efficiency)

We do not take into consideration further assumptions and parameters determining the individual health (genetic predispositions, environment, *etc.*).

### 3.1 Mathematical derivation of the new model

We are looking for two convex functions  $f_1(x)$ ,  $f_2(x)$  at interval  $(0, \infty)$  which meets:

$$f_1(x) \leq f_2(x) \text{ for } x \in \langle x_1; x_{\max} \rangle$$

$$f_1(x) \geq f_2(x) \text{ for } x \in (0; x_1) \quad x \in \langle x_{\max}; \infty \rangle$$

$$x_{\max}/x_1 \in \langle 1,5; 4 \rangle$$

where in the relationship between the stock of health (H) and the variable x is defined

$$x = \frac{100}{H \cdot A} \quad \text{thus} \quad H = \frac{100x}{A}$$

Assuming a well-known function of the marginal efficiency of capital, which is convex, equiaxed hyperbola is a exponential function a more precise description utility function of the responsible individual.

General form the functions:

$$f_1(x) = \frac{A}{x}$$

$$f_2(x) = e^{A-x}$$

Solution of the equation:

$$\frac{A}{x} = e^{A-x}$$

get the intersections of these two curves. One is trivial  $[A; 1]$ , the second solve from

$$A - \ln(A) = x - \ln(x)$$

Now we will see what parameter for this relation is valid. Thanks to trivial solution  $x^1$  we find parameter A of equation

$$A = \frac{z}{z-1} * \ln(z)$$

where  $z = \frac{x_{\max}}{x^1}$

the value we obtain from the relevant statistical databases.

An alternative method of obtaining the parameter A is the calculation of the relationship

$$A = \beta * \log K$$

where  $\beta$  is a coefficient indicating the quality of health care and K is the average life expectancy.

However, we would stress that the coefficient  $\beta$  allows the pattern Grossman (1972) to include in the quality of healthcare healthy lifestyle factors ( $\beta_1, \beta_2, \dots \beta_i$ ), where  $\sum \beta_i \leq 1$ .

Curves are intersected by two secant

$$y_1 = k_1 x + q_1$$

$$y_2 = k_2 x + q_2$$

such that:

$$k < 0$$

$$q > 0$$

$$|q| > |k|$$

Secant  $y_1$  intersects the curve  $f_1(x)$  and  $f_2(x)$  in points  $x_1, x_{\max}$ ; secant  $y_2$  intersects the curve  $f_1(x)$  and  $f_2(x)$  at points  $x_{\min}, x_{\max}$ .

For practical reasons, convert explicit measurement (the statistics of morbidity, medication use, dependence digested days in the hospital at age ...) in standardized form, and limiting the interval  $x \in (0, A)$  than we obtain

$$f_1(x) = \frac{A}{x}$$

$$f_2(x) = e^{A-x}$$

with intersections  $x_{\max}$  and  $x_1$

Secant  $y_1$  we obtain

$$y_1 = \frac{1-Y_2}{A-X_2} x - \frac{1-Y_2}{A-X_2} A + 1$$

Secant  $y_2$  we can express thanks to the knowledge  $x_{\max}$  and dividing the intersections interval  $f_2(x)$  and  $y_1$  at  $x=0$  in the general shape

$$y_2 = \left( \frac{q1+e^A}{2} - x * \frac{q1-1+e^A}{2A} \right) * \alpha$$

where  $\alpha$  reflects possible changes in medical care (new methods, procedures, etc. ...)  $\alpha \in (0, 2)$ .

The costs of health throughout life find simple integrating the feature for the appropriate interval.

Thus, we obtain:

$$F_1(x) = \int_{x1}^{x_{\max}} \left( \frac{A}{x} - 1 \right) dx = [A * \ln(x) - x]_{x1}^{x_{\max}} \quad (1)$$

$$F_2(x) = \int_{x1}^{x_{\max}} \left( e^{(A-x)} - 1 \right) dx = [-e^{(-x)} (xe^x + e^A)]_{x1}^{x_{\max}} \quad (2)$$

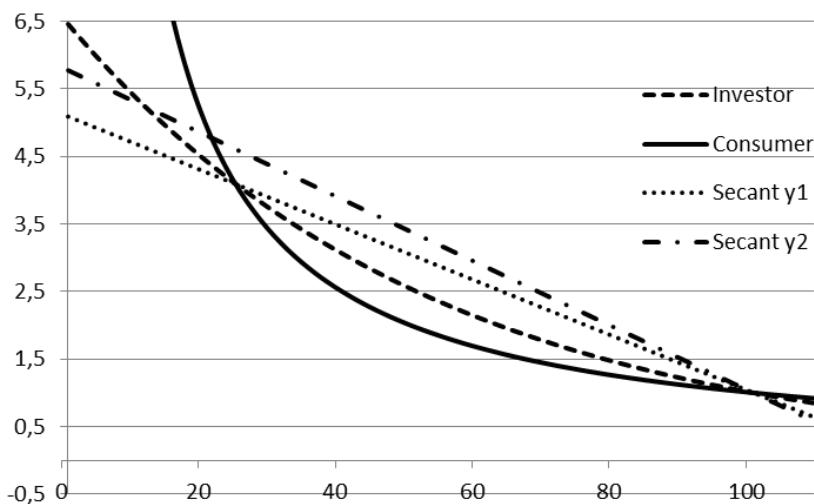
In the same way we calculate the difference in costs for the life expectancy of the point  $x_1$

$$F_3(x) = \int_{x_{min}}^{x_1} \left( \frac{A}{x} - 1 \right) dx = [A * \ln(x) - x]_{x_{min}}^{x_1} \quad (3)$$

$$F_4(x) = \int_{x_{min}}^{x_1} (e^{(A-x)} - 1) dx = [-e^{-x}(xe^x + e^A)]_{x_{min}}^{x_1} \quad (4)$$

The above function can be illustrated by chart that demonstrates the differences that the behaviour of consumers and investors bring in their health care and its cost.

**Figure 3 | Model of Health Promotion Behaviour**



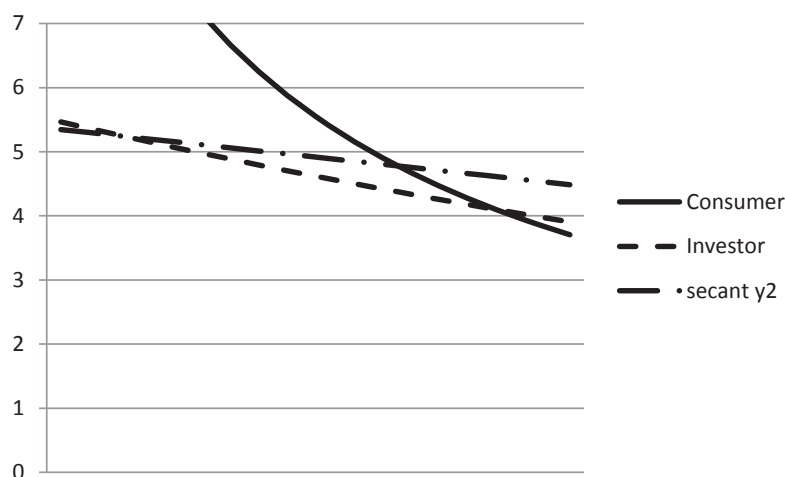
Source: own design

The curves shown in Figure 3 clearly show that the Consumer invests in his own health less than the Investor for the majority of his life. More importantly, the costs of healthcare are higher in the last and even shorter part of Consumer's life. Based on the conditions of European social state we presume that the majority of this extra costs is paid by the public health insurance system. Investor on contrary invests in his own healthy lifestyle in addition to the insurance. These investments repay during his life as the higher quality of life and longer lifetime expectancy.

The point of intersection of the Investor and Consumer curves with the auxiliary secant  $y_2$  shows higher lifetime expectancy of the Investor. Accelerating deterioration of the Consumer's health (decrease of his health stock) is shown by the growing part of the hyperbola after the point of hyperbola after the point  $(x_1)$  – the point from which the healthy lifestyle improves the level of Investor's health and due to the more efficient utilization of health stock by the Investor, it prolongs his lifetime expectancy.



**Figure 4 | Detail of Figure 3 with Intersections  $f_1$ ,  $f_2$ , and  $y_2$**



Source: own design

## 4. Application

Based on the OECD data of lifetime expectancy, costs of healthcare and GDP from the countries with high number of inhabitants (statistically conclusive data), we are able to demonstrate the aforementioned interpretation of the model. The values are shown in Tables 1 and 2 and Figures 5–8.

Table 1 shows the costs of public healthcare for both types of health behaviour. Functions F1–F4 are expressed by the expressions (1),(2),(3),(4), I/K ration demonstrates the difference that is invested by the Investor to his own health.

**Table 1 | Relative Cost of Health Care (OECD)**

	F1	F2	F3	F4	Total Consumer	Total Investor	Ratio I/K	Ratio I/K to the Breaking Point
<b>Japan</b>	1.21261	1.686	0.2387	0.8347	1.451313	2.5207	1.73684	1.39038508
<b>Czech Republic</b>	0.70175	0.8843	0.20305	0.771	0.904809	1.6553	1.82945	1.26012726
<b>Russia</b>	0.29099	0.3344	0.17483	0.5798	0.465818	0.9142	1.96257	1.1491859
<b>Nigeria</b>	0.07693	0.0823	0.12004	0.394	0.196969	0.4763	2.41815	1.06984551

Source: OECD, own calculations

Table 2 shows demographical data expanded by the average lifetime expectancy calculated by the Consumer/Investor model.

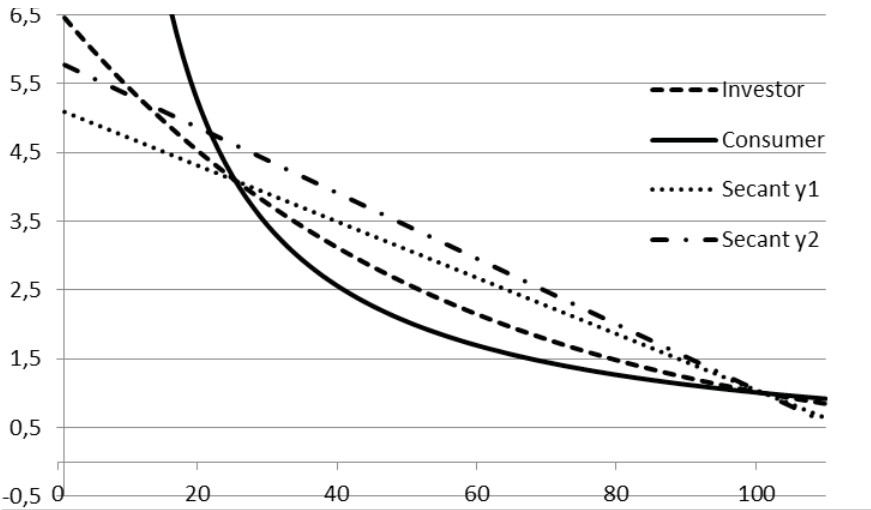
**Table 2 | Calculated Life Expectancy**

	Life Expectancy	Health Care Expenditures	GDP per capita	Population	Level of Health Care	Parameter A	Age of Consumer Death	Age of Investor Death
<b>Japan</b>	83.91	9.3	34,700	127	0.97	1.87	79	88
<b>Czech Republic</b>	77.38	7.6	27,100	10	0.87	1.64	72	85
<b>Russia</b>	66.46	5.4	16,700	142	0.77	1.4	55	76
<b>Nigeria</b>	52.05	5.8	2,700	170	0.7	1.2	47	70

Source: OECD, own calculations

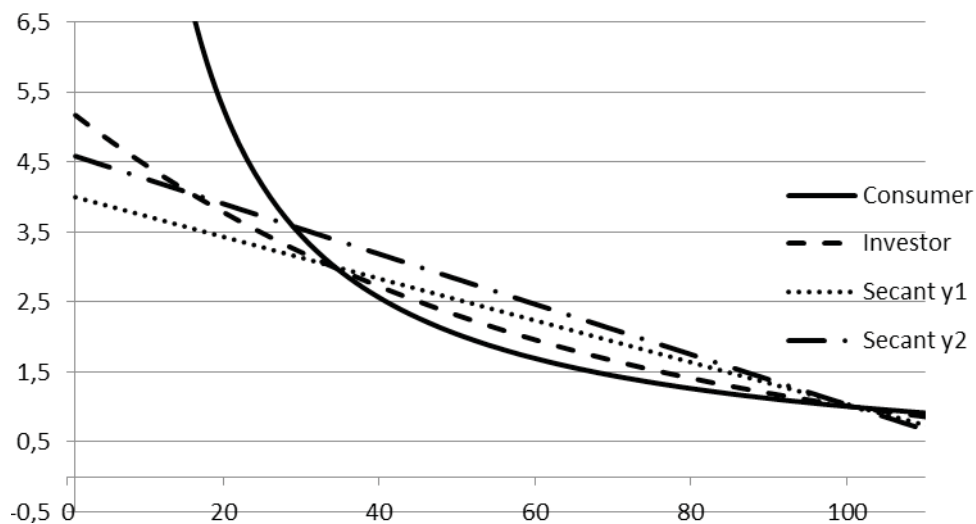
Figures 5–8 demonstrate difference between countries caused by different approach to the healthy lifestyle and level of health care.

**Figure 5 | Japan**



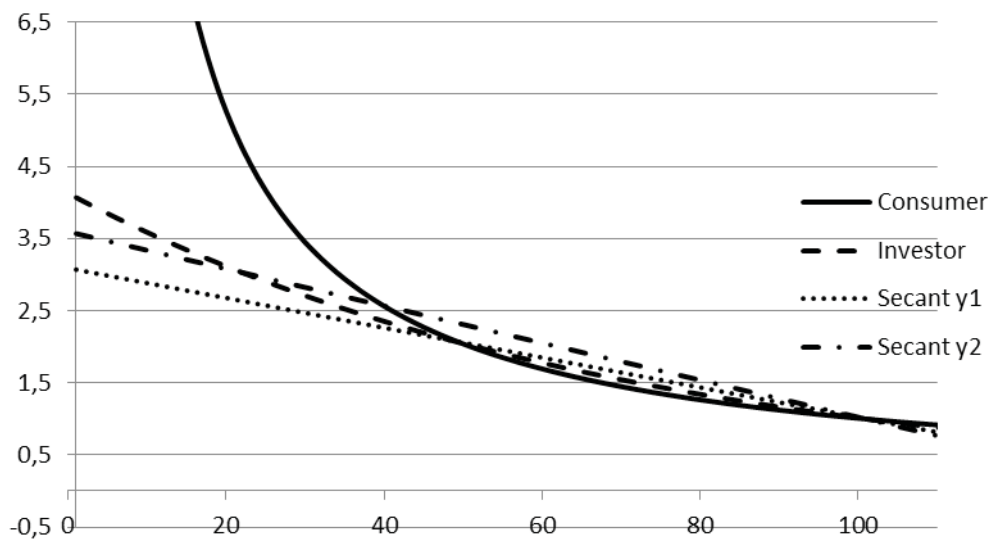
Source: OECD, own design

**Figure 6 | Czech Republic**



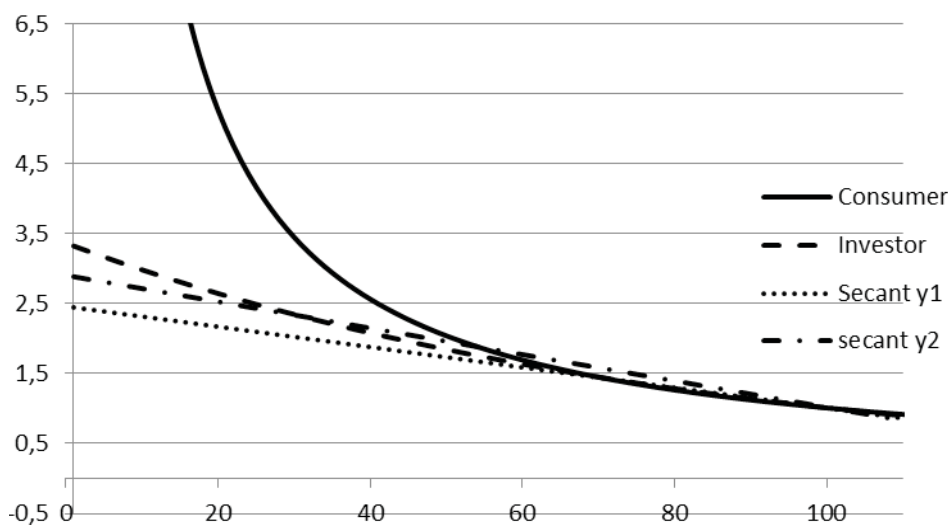
Source: OECD, own design

**Figure 7 | Russia**



Source: OECD, own design

**Figure 8 | Nigeria**



Source: OECD, own design

Tables and figures shall be interpreted as follows:

- i) Investments to the healthcare system and healthy lifestyle of population in the countries with low average lifetime expectancy have a positive influence on its prolongation.
- ii) Comparison of the influence of health promotion and health care in poor and rich countries shows that developed healthcare systems are able (with higher costs) to prolong lifetime expectancy even for those who do not invest to their own health (Consumer-type behaviour).
- iii) The healthy lifestyle has more significant influence on prolonging lifetime expectancy than increases of healthcare expenditures in economically developed countries with higher lifetime expectancy.
- iv) Further increase of investments to treatment and healthcare systems bring significantly lower effect (prolonging the lifetime expectancy) in the countries with better health care than in less developed countries. The comparison made in Figure 5 and 8 for instance shows that 1 per cent (GDP share) increase of investments to health care system in Nigeria leads to prolonging the lifetime expectancy for several years. The same increase in Japan results in outcome of several months.

## 4.1 Advantages of the model

Our model explains relation between increase in healthcare and health promotion investments and the resulting impact on prolonging the lifetime expectancy of the population. It is also possible to calculate real costs and savings on healthcare with the necessary level of accuracy. The model can be upgraded by the basic change of inputs to the health care or health promotion or other health determinants.

## 5. Behaviour, Rationality, Health Illusion and NCD

Both behavioural types, A and B, and their combination, are represented in the behaviour of the Czech and the European populations. The concept of health promotion aims to support the type A – Investor. The goal is that people will not only buy health care and treatment of disease, but, within a wider structure, also other assets (exercise, diet) that are necessary for a healthy lifestyle. Equally rational, though less effective according to standard economic approaches, appears the behavioural type B – Consumer. Is that really so?

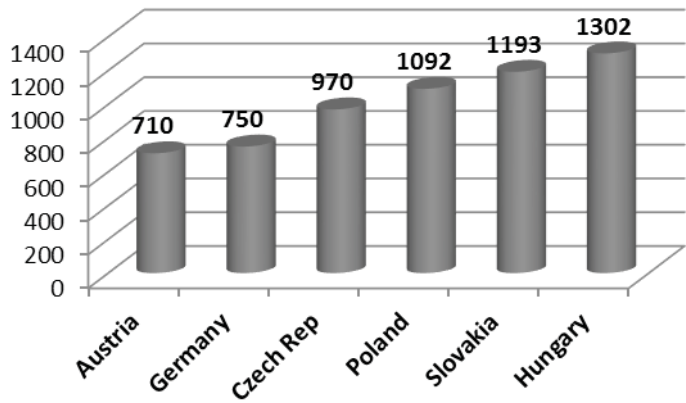
Standard economy addresses only the measurable consequences of the choice of better utility for behaviour that only shows the preferences of people. The method of choice is explained by the normative axioms of rational decisions (von Neumann, Morgenstern, 2004, pp. 8, 22). These are the (i) completeness, (ii) transitivity, (iii) continuity and (iv) independence. However, irrationality (in the economic sense of the word) represents the behaviour of persons only if their choices are not consistent with the axioms of rational decisions. Is then the behaviour of Consumer, who in the short term prefers the consumption of other assets and relies only on treatment in case of disease, really rational? Does treatment provide a reliable renewal of health in all kinds of disease?

While preparing our new model (Figure 3) we reached the conclusion that the adoption of a healthy lifestyle (behavioural type A) is prevented by the effect that we have called the illusion of health. Basically, we consider this illusion as the erroneous interpretation of the theory of health safety (Menahem, 1999). The lower risk of non-provided treatment as thanks to universal health insurance, together with the significant advances in the treatment of infectious diseases and neoplasm's have, in recent years, resulted in a significant part of the public opinion in developed countries having false expectations on the ability of modern medicine to successfully treat any kind of disease. Another source of this so-called illusion of health is the principal-agent effect (Stieglitz, 1987). Based on the aversion of risk of disease, people will entrust their health to doctors. This creates the false impression, and long-term illusion, that they have found a universal way to solve all their health problems, including the management of risk factors that lead to yet incurable, non-communicable diseases - NCD's. The people who, in the case of behavioural type B – Consumer, prefer treatment to a healthy lifestyle ignore the important factors of a rational choice. The basis of this irrationality is the indifferent relationship with the important factors of a rational choice, based on the fact that NCD's (diabetes, cardiovascular, cancer) are by and large incurable. However, they are successfully preventable only as long as the principles of a healthy lifestyle were followed, *i.e.* behavioural type A – Investor. After considering these key factors, we cannot consider behavioural type B – Consumer as rational because it is not consistent with the axioms of rational decision, especially with the axiom of completeness (von Neumann, Morgenstern, 2004). Consumer behaviour type B is not only inefficient but also irrational.

The irrationality of behavioural type Consumer is manifested in terms of health promotion, not only theoretically, in our model. International authorities, especially the World Health Organization (WHO), since the end of last century, have been drawing attention to the declining trend of infectious diseases and the contrasting dynamic growth of NCD, *i.e.* civilization diseases. This is a global health threat due to the rapid rising incidence in, not only, the developed countries. Statistical analyses of health factors in the Czech Republic, and Central and Eastern Europe show that the choices of people in

reference to following the principles of a healthy lifestyle present a significant irrationality. For instance, the consequences of this problem can be seen in the graph of deaths due to NCD (OECD, 2011) in Central European Countries.

**Figure 9 | The Number of Deaths with the Cause of NCD in 2008 (in 100 thousand)**



Source: OECD, 2011, own design

Mortality increased by 35–80% in post-Communist countries than in Austria, or Germany shows the persistence of unhealthy lifestyle. This result also shows a significantly higher degree of irrationality in terms of health promotion in the population of those countries. Rationality in terms of the individual’s ability to overcome unhealthy, historically, ethnically and culturally conditioned elements of lifestyle (alcohol, overeating, *etc.*) we consider (according to Grossman, 1972) as the basic conditions for use of economic analysis of human behaviour in terms of health promotion, including our model Investor – Consumer. Based on the results of the application of our model, we believe that a healthy lifestyle based on regular investment in own individual health is the main tool for suppressing irrational health u of the population in the context of growing public health threat by disease type NCD.

## 6. Conclusions

We have shown that our model based on the Grossman’s theory is able to demonstrate impact of two basic types of human behaviour in terms of healthy lifestyles on the costs of healthcare. As well as the overall level of public health. The Investor type consists in active, efficient and rational behaviour, particularly in prevention of diseases by strengthening individual health. The Consumer type, on the other hand, is defined by the irrational, passive, inefficient behaviour of a person that relies predominantly on the use of all possible treatments of diseases offered by modern medicine and provided by the healthcare system in the developed countries. The latter leads to the continuing increase of healthcare costs, especially in developed countries and for instance threatens the sustainability of healthcare systems of the EU Member States. Our mathematical model of individual behaviour confirms these conclusions and proves that increase of healthcare and treatment costs directly corresponds to the level of passive approach to individual health among the population.

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