University doctoral (PhD) dissertation abstract

ECONOMIC ASPECTS OF THE HEALTH CONSCIOUSNESS

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1. A THE BACKGROUND AND THE AIMS OF THE RESEARCH AND THE INTRODUCTION OF THE RESEARCH HYPOTHESES

In the 21th century, the prevention of cardiovascular disease has a more prominent role not only because of the health promotion but also the impact of the third industrial revolution after the turn of the millennium. In the financing of the health care system, the cost of purchasing medicines for treating and relieving illness is a key factor: although in the economically advanced countries in the industry it is only 10-15%; in some countries, this ratio is already around 40%, according to some estimates.

If the vaccines are ignored, the former cost burdens are mostly due to the long-term treatment of chronic diseases that can be prevented on the one hand, and have become responsible in both Hungary and developed regions for a significant proportion of job loss and death. That is why, in the context of the relative protection of vaccines, it was necessary to recognize the importance of consciousness-based disease prevention from both an individual and national perspective.

1.1. Background of the research

Many studies and professional books have been published over the past decades on both the prevention of chronic illnesses and their economic aspects, discussed in the framework of the health economy (in the field of prevention among others CZURIGA [2002]; BUSE [2007]; KÉKES [2009]; MARMA [2009]; LABARTHE [2011]; BERRY [2012]; VARGA [2016]; in the field of economic and financial aspects GROSSMANN [1972]; COHEN-HENDERSON [1988]; KENDEL [2000]; BROUWER et al. [1997]; OWEN et al. [2012]; HOOGWERF-HUANG [2012]). At the same time, the research topic necessarily affects the relevant chapters of behavioral economics through the examination of consumer decisions, which has also been the subject of many domestic studies (among others KOLTAY [2009]; BÖLCSKEI [2009]).

Overall, in Europe, cardiovascular diseases (hereinafter referred to as CVDs) are "the main causes of incapacity for work and higher health costs, and are among the most frequent causes of premature death" (KÉKES, 2009). GÁRDOS [2001] states, relying on the World Health Organization estimate, that the lack of metabolic syndrome, stress, smoking,

excessive alcohol consumption and physical activity is a group of lifestyle-related risk factors that are responsible for at least 40% of mortality in developing countries and 75% in developed countries. Partly the extraordinary cost and indirect economic impact of formal and informal health care for patients also require the prevention of the former. Its aggregate values only in the European Union are illustrated in *Figure 1*.

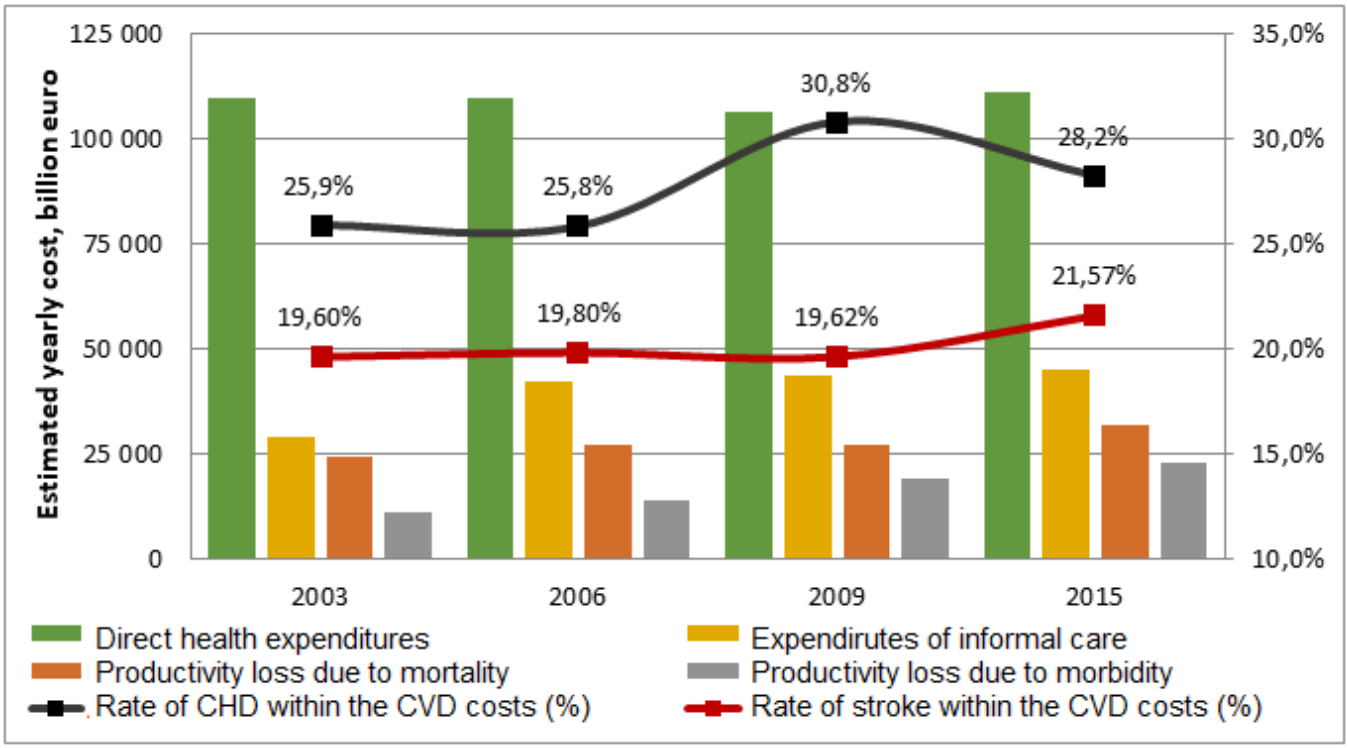

Figure 1: Estimated economic costs of CVD, including coronary heart disease (CHD) and stroke, between 2003 and 2015.

Source: European Cardiovascular Disease Statistics.

Although the direct health care expenditures for the heart disease (emergency, basic, out-, and inpatient care, medicines) in the European Union has only contributed to decreasing extent to the total economic cost generated by the CVD after the millennium (those rate fell by nearly 10 percentage points in the period concerned), the increase in hospital nursing time due to the proliferation of overnight surgery and more advanced diagnostic tools was offset by the increased cost of outpatient care (nearly € 6 billion), thus in the year of the financial crisis (2009), even in most of the EU Member States, the total cost did not fall below the EUR 100 billion, even in the context of budgetary constraints.

While the costs of informal care increased in the EU in the mid-2000s, the loss of output due to the growing number of patients was already over EUR 20 billion by 2015. The

treatment of coronary artery disease within the CVD disease group has made the most of EU resources for this purpose.

At the same time, it is still below US level at CVD compared to its total cost (including the treatment of coronary artery disease in the EU to a great extent), which in 2016 reached 3% of the gross domestic product in USA, EUR 451 billion. According to estimates by the American Heart Association in 2017, it would nearly double by 2035, rising to EUR 893 billion, meanwhile direct management costs rising by 10 percentage points by that year compared to 2016. However, this latter significant increase is still a moderate forecast compared to the previous estimate of HEIDENREICH et al. [2011], which has seen a tripling of direct health care expenditures and an increase more than one and a half times of indirect costs by 2030. Dor decades recognition of these economic burdens has led to the development of health policy in developed countries to identify some of the cost of treatment, and to influence all the factors that may increase the risk of developing chronic diseases.

1.2. Hypotheses and main objectives of the research

The research topic, discussed in my dissertation, in a broader sense, aims to present the general financial aspects of disease prevention, including the decision-making and cost-benefit aspects of this area. The examined problem can be limited to exploring the material motivations of individual attitudes to disease prevention and those justification: *do consumers expect any economic-financial (positive or negative) benefits beyond their health when making decisions about their lifestyle, and does the latter actually occur at the individual or national level, either in the present or in the distant future?* The ability to grasp financial utility can be best illustrated through the cost aspects of group of diseases which can prevent with lifestyle.

The focus of my research has been on the prevention and treatment of cardiovascular disease due to the reduction of database needs, the elimination of distorting effects, and the easier availability of related medicine and more detailed disease-specific data. Within the framework of this, I examined that is it possible to detect and, if so, what is the significant difference between the private expenditures required to achieve the highest standard of living in healthy and heart patients who can prefer and not prefer the use of indication. The

main objective of the research was to find out how the expenditure of the disease at individual and social level depends on following behavioral patterns that are typical of health conscious consumers, and how those differ from the subjective estimates of individuals that may partly explain their behavior.

My first research hypothesis is that *with the same standard of living, the extra cost of heart disease is lower among health conscious consumers*. Under the standard of living for consumers I meant the level of satisfaction of their short-term needs, which are in line with the duration of their income renewal. The highest level of living standards at the same level among people is justified by the fact that the separate presentation of the impact of the disease on expenditure can be distorted by the constraints of income and life prospects, which make short-term needs inadequate for the majority of consumers, so they can only achieve lower levels of welfare than they would want. This constraint and lack of sense can strongly influence the perception of the potential financial-economic benefits of a preventive lifestyle, as well as the comparability of segmented consumer spending. The assumption behind the hypothesis that people who likely pay attention to their health, proposed lifestyle therapists, participate more frequently in screening tests and visit their general practitioner even if there are initial symptoms, so that as patients they can maintain the same health status with lower-cost therapies like their peers, who neglect their health and consult with their general practitioner less, trust them less, so they can diagnose the diagnosis only at a more serious stage. Although health-conscious people spend more on their health during their higher life expectancy, for reasons of comparability, this should only be established for a specific period, closely aligned with the use of income.

My second research hypothesis is that, *with the same standard of living, the extra cost of heart disease is lower among consumers who estimate the cost-benefit of health consciousness to high*. Accoring to my assumptions the expense associated with heart disease can be influenced not only by the lifestyle actually used, but also by subjective beliefs about the cost-benefit, so it is worth analyzing whether it changes the outcome of the first hypothesis if consumers are segmented based on their attitudes rather than their actual actions. It can justify that in some cases, the motivation behind the continuation of healthy lifestyle is not closely related to health and in some cases, prevention is not used even because of self-control problems despite its cost benefit is otherwise considered

favorable (those who appreciate the change of lifestyle will have become beside significant but not 100% probability actually health conscious).

My third research hypothesis is that, *with the same standard of living, non-conscious and healthy consumers estimate*
(a) higher extra immadiate expenditure for lifestyle changes;
(b) lower extra future expenditure associated becoming disease
compared to the actual expenditure that can be detected or saved.
The hypothesis is divided into two sub-hypotheses. I examined on the one hand, how influence the stay away from the conscious lifestyle by the fear of its cost, and underestimating the likelihood of the disease occurring in the distant future and the subsequent increase in consumer spending, so that, how well the preconceptions of lifestyle change are founded. In addition, the aim of the hypothesis examination is to prove whether, in contrast to individual expectations, significant cost increases in lifestyle change or financial savings by avoiding the disease can actually be detected. The evaluation of the results of the questionnaire survey used as the primary database serves to support or refute the first three hypotheses.

My fourth research hypothesis is that *if the population is less health consciously in a country, then the cost of hospital treating for a heart patient is higher assuming the same cost-effectiveness of cardiologic inpatient care systems*. Because of the progressivity of patient care, while health awareness in general practitioner and outpatient care may be associated with even higher costs in the short term due to frequent doctor-patient consultation or early diagnosis and treatment of illness, hospital care costs may only arise if the severity of the – mostly chronic – cases reaches a level that can only be explained by the consequence of failure of primary or secondary prevention procedures. So, in my assumption – by reason of non-recognition of symptoms, neglect of severity, late arrival of professionals, irregular medicine use, failure to follow medical instructions, or omission of screening – the services offered to the inpatient population in societies, that follow less health conscious consumer patterns, shift towards more resource-intensive therapies, which should be taken into account on average higher weighting in hospital performance financing. At the same time, the efficiency of the use of resources can be influenced by the infrastructure, organization, resource capacity and the rate of funding of the inpatient care

system, which is exogenous, time-varying factors vary from country to country, and therefore need to be standardized.

My fifth research hypothesis is that *if the population is less health consciously in a country, then the productivity loss generating a heart patient is higher*. Under productivity loss, I meant the monetary value of the loss of production due to a more severe loss of health function or premature death, which was available throughout the study. I considered it necessary to examine this, for the reason that the shift in the composition of the patient population in case of more costly interventions, such as frequent use of limb amputations, is not manifested in a significant increase in hospital costs, but in a loss of productivity express in money. In societies where participation in preventive treatments is relatively higher and patients are more likely to follow the instructions of professionals, a higher proportion of CVD patients will be able to continue to participate in production beside maintainment of drug treatment and loss of health function. In the case of the success of preventive therapies, productivity loss due to mortality does not occur. My primary goal is to base the misconception of negative consumer preconceptions on prevention by demonstrating that the shift towards a lifetime – which has several expenditures from an individual point of view – can be offset througout a reduction in the cost of future care and an indirect burden on the economy. Therefore, to verify the correctness of the fourth and fifth hypotheses, it was necessary to use a secondary, international database that summarizes the cardiological surveyed costs and health loss indicators. Although the latter two hypotheses are separate from the previous ones in terms of the scope of the database and the methodology of its analysis, in my view it necessary to show whether and how the presumed change in the composition of the patient population (the ratio of those entering the late stage) influences cost implications of the CVD therapeutic treatment which based on globally applied medical standards.

2. MATERIAL AND METHODS

2.1. Database and methods used for primary research

2.1.1. Primary data collection

There were no previous data available to examine the first three research hypotheses, and the primary data collection for this purpose was based on a public questionnaire survey. I used the internet-based questioning method, CAWI (Computer Assisted Web Interview), as a target group to look at the Internet-enabled and accessible parts of the middle-aged urban population living in Hungary, and in particular to distinguish between heart and non-heart patients. Although the use of the Internet has narrowed the range of potential respondents, this group can also have access to information on disease prevention more quickly, so that it can more easily identify their relationship.

The number of subjects completing and returning the questionnaire was 433. The aim of the research was not to provide a representative sample of the entire population, but to compare the groups of the same age group and the disease-separated groups (so that the groups had to be representative of some of the characteristics). The survey focused on urban population in the ages of 30 to 60 years because of the better access to preventive services and a higher risk of morbidity in cities or in the capital. This age group was even less threatened by the risk of reduced physical function, which is already limiting the possibility of lifestyle changes, but has a more secure, existential existential background. The narrowing of the scope of the research to this extent was primarily explained by the effort to minimize the explanatory variables to a low number of elements. In both target groups - in different proportions - representatives of both sexes participated, the majority of those who completed the questionnaire were female respondents. In the sample population, cardiac and non-cardiac patients, as well as subgroups of men and women, did not fall below 50 in either case. It took 30 days to complete the primary data collection with preparation, fieldwork, data gathering and systematization of the data in the SPSS data file.

2.1.2. Methodology of primary research

The starting point for the analysis of a database compiled with primary data collection is segmentation of the surveyed consumers based on the assumption that there is a group of healthy and heart patients who estimate the cost-benefit of CVD prevention high.

As a result, the criteria for segmentation, on the one hand, on the one hand, are whether a health care professional has previously identified some cardiovascular disease (yes or no), and on the other hand the use of indication (at first and third Hypothesys) and judging the cost-benefit of primary prevention (at second Hypothesys).

Under primary prevention, I meant the following – in the questionnaire – throughout the research: daily exercise; avoiding excessive salt and fat consumption and smoking and stress; consuming a low-sugar diet rich in fruits, vegetables and fish *together*. The verification or refutation of the first three hypotheses is based on the statistical method of multivariate regression analysis. According to MONTGOMERY et al. [2012] the purpose of regression is to examine the effect of one or more (independent) variables on the result variable. Model of multivariate regression function:

$$Y = f(X) + \varepsilon = \alpha + \beta_1 X_1 + \beta_2 X_2 + \cdots + \beta_i X_i + \varepsilon \qquad (1)$$

where Y is a dependent or result variable, the $X_1, X_2, \dots, X_n$ represent the values of each independent or explanatory variable, $\beta_1, \beta_2, \dots, \beta_n$ represent the partial partial regression coefficients, and i the number of explanatory variables, ε the role of random in the equation the residual or error element (residual), while α constant indicates the value of the result variable at which all the explanatory variables are 0.

I applied Kolmogorov-Smirnov non-parametric test to test the normality of residuals, and was previously performed using a similarly non-parametric Chi-square test to test the correctness of the integration of low-level explanatory variables into the model, checked the multicollinearity with the variance inflation factor (VIF) values, and calculated with a 95% confidence interval for each model calculation. The characteristics of the variables used in the first three hypotheses are shown in *Table 1*, and the methodological analysis of the third hypothesis is presented in *Tables 2 and 3*.

Table 1: Characteristics of variables of multivariate regression models.

Examined hypothesis	*Variable*			*Reason for incorporation into the model*
	Name	*Type**	*Definition*	
1, 2, 3	Health status	E	Existence of disease = 1, health = 0	Highly investigated key explanatory variable
3	Health awareness	E	Existence of awareness = 1, lack of it = 0	Highly investigated key explanatory variable
1, 2, 3	Gender	E	Women = 1, men = 0	In the segments the gender distribution is different.
1, 2, 3	Actual consumer expen-diture	E	Average mouthly actual consumer expenditure	Besides health the estimating optimal expenditures can be influenced by the actual living standards of the consumer
1, 2, 3	Optimal expen-diture	R	Minimum cost for the highest, available quality of life	Fulfillment of research objectives, elimination of different consumer income limits

**E – Explanatory variable, R – Result variable*

Source: own editing.

Table 2: Methodological examination of the first part of hypothesis 3.

Regression model	**Model 1**		**Model 2**	
Purpose of investigation	**<u>Measurement of the estimated additional expenditure</u>**		**<u>Measurement of the actual additional expenditure</u>**	
Examined segment	Not conscious, healthy	Not conscious, healthy	Not conscious, healthy	***Conscious***, healthy
Key explanatory variable: health awareness (0,1)	**0** (based on a response to a questionnaire)	**1** (modified)	**0** (based on a response to a questionnaire)	**1** (based on a response to a questionnaire)
Result variable	Estimated opt. expenditure for his own case	Estimated opt. spending in *case of* ***prevention***	Estimated opt. expenditure for his own case	Estimated opt. expenditure for his own case

Source: own editing.

Table 3: Methodological examination of the second part of hypothesis 3.

Regression model	**Model 1**		**Model 2**	
Purpose of investigation	**<u>Measurement of the estimated additional expenditure</u>**		**<u>Measurement of the actual additional expenditure</u>**	
Examined segment	Not conscious, healthy	Not conscious, healthy	Not conscious, healthy	Not conscious, ***not healthy***
Key explanatory variable: health status (0,1)	**0** (based on a response to a questionnaire)	**1** (modified)	**0** (based on a response to a questionnaire)	**1** (based on a response to a questionnaire)
Result variable	Estimated opt. expenditure for his own case	Estimated opt. spending in *case of* ***disease***	Estimated opt. expenditure for his own case	Estimated opt. expenditure for his own case
Difference in expenditure	Difference between estimated optimal expenditures**		Coefficient of the key explanatory variable	
Weight of difference in expenditure	Estimated disease probability**: without prevention – beside prevention		Higher objective risk of disease beside prevention: 10%*	

* Based on literature (Framingham Heart Study)

** Subjective estimation per consumer, based on quantitative responses to the questionnaire

Source: own editing.

2.2. Database and methods used for secondary research

2.2.1. Secondary data collection

The examination of the fourth and fifth hypotheses required the analysis of the data of an already existing, wider international database. CVD care expenditures data directly and indirectly disaggregated (with productivity losses in the latter) for all member states of the European Union and on the basis of disease-specific studies by the Health Economics Research Center of the Institute of Public Health at the University of Oxford published in its periodical publications that are not published regularly (European Cardiovascular Disease Statistics). In addition, I collected the necessary data from the following sources:

- World Health Organization (WHO.Stat and WHO Mortality Database)
- Eurostat

- Institute for Health Metrics and Evaluation (IHME) – Global Health Data Exchange (GHDx)
- Organisation for Economic Co-operation and Development (OECD.Stat).

The analyzed panel database shows the cost data for CVD in thousands of euros for inpatient care in cardiology in 23 European countries and for the loss of productivity caused by CVD diseases. Inpatient cost data and productivity losses expressed in euros, while the GDP per capita at current prices, current purchasing power parity were available in dollars, thus eliminating the distorting effect of the change in the dollar-euro exchange rate over the years examined. The processing and evaluation of the quantitative data of the international database was performed with the help of the STATA mathematical-statistical analysis program version 13.0.

2.2.2. Methodology of Primary Research

Since the international database contains both cross-sectional and time series data, I confirm or refute the correctness of the fourth and fifth Hypothesys using the panel regression analysis method. Panel regression equation based on WOOLDRIDGE [2002]:

$$y_{it} = \beta_0 + \sum_{j=2}^{k} \beta_j X_{jit} + c_i + \delta t + u_{it} \qquad (2)$$

where β_0 is constans, t the dummy of the years, u_{it} the error factor, i the number of units observed, c_i the non-observed, permanent effect in time.

BALÁZSI-DIVÉNYI et al. [2014] sees the benefits of analyzing the panel database compared to simple time series or cross-sectional data that the temporal, non-observable characteristics of the observed units (endogenous distortions) and aggregated trends, without specifying them, which may affect the dependent variable can be controlled and thus controllable. The variables incorporated into the panel regression model are detailed in *Table 4*. In some countries, unit resources for inpatient care (inputs) produce operational outputs in varying degrees. At the same time, in the regression model, the dependent variable should be assumed such the cost that would be incurred if the efficiency of the country's inpatient care system did not differ in any way from the best practice, thus it is on the efficiency line.

Table 4: Characteristics of variables in panel regression models.

Examined hypothesis	Variable			Reason for incorporation into the model
	Name	**Type***	**Definition**	
4	Case-related hospital costs	R	Cost of cardiology inpatient care at maximum efficiency[1] / CVD case numbers	Fulfillment of research objectives, verification of hypotheses after eliminating the difference in case numbers
5	GDP loss	R	Productivity loss caused by CVD [2] / CVD case numbers	
4, 5	Lifestyle risk level	E	DALY filtered to lifestyle risks[3] and CVD, standardized for 100,000 people and ages	Key explanatory variable which express the lack of health awareness
4, 5	GDP per capita	E	GDP / person in the given year and country	Different income generating ability is also influancing factor (controlling the cross-sectional effect)
4, 5	Years	E	At 3-year intervals (with one exception): 1,2,3,5	Controlling the time-changing factors (eg. change in price and wage levels)

** E – Explanatory variable, R – Result variable*

Source: own editing.

This was corrected by multiplying an efficiency rate that is calculated by using the non-parametric, deterministic Data Envelopment Analysis (DEA) method because of several inputs and outputs that provide a more reliable overall picture of the actual situation of the inpatient care system. DEA was also prepared for hospitals in Hungary (DÓZSA, 2010) and for the provision of complete inpatient care (CSÁKVÁRI-TURCSÁNYI et al., 2014), while at international level it was also used to compare the efficiency of care systems (LINNA et al., 2006). As LAPID [1997] notes, in the course of the optimization to be carried out in the DEA analysis – depending on the input or output orientation – two linear target functions can be set up, of which I used the input-oriented analysis method starting from the following basic model when calculating the result variable of the regression:

[1] Assuming that the cost-effectiveness of inpatient care systems in all countries is equivalent to the highest level of efficacy.
[2] Based on the data available in the annexes to disease-specific periodical publications, the monetary value of production loss due to illness or premature death, which can also be considered a GDP loss
[3] Differences in age composition and population numbers of comparable populations should be eliminated

$$H = max\left\{\frac{\sum_{r=1}^{s} U_r Y_{rj}}{\sum_{i=1}^{m} V_i X_{ij}}\right\} \quad (3)$$

where $0 \leq H \leq 1$, and $0 \leq U_r$ és $0 \leq V_i, X_{ij}$.

Table 5: Factors used for DEA efficiency rates.

Role	Definition	Notation[4]	Calculation
Input[5]	The number of publicly funded hospitals[6] per 1 million inhabitants	K_{ij}	*Number of hospital / Population (billion fő)*
	The cost of active and chronic cardiologic inpatient care in proportion of GDP	R_{ij}	*Inpatient cost (€) / GDP (€)*
Output	The rate of CVD inpatient case numbers adjusted for DALY[7]: how many CVD cases would be dismissed if the CVD contribute to the health loss to the same extent[8]	B_{ij}	$\frac{\frac{Case\ number_{CVD}}{\sum Case\ number}}{\frac{DALY_{CVD}}{\sum DALY}}$
	Frequency of total patient turnover: how many patients have been hospitalized in a cardiology department in 1 year	F_{ij}	$\frac{365\ days}{Average\ hospital\ days}$
	Non-CVD-induced standardized mortality rate (SMR)	M_{ij}	$1 - \frac{SMR_{CVD}}{SMR_{Total}}$

Source: own editing.

Thus, the calculation of the result variable of the regression model set up for the fourth Hypothesis is described in *Equation 4*:

$$Y = \frac{\frac{C_F}{Esetszám_{CVD}}}{max\left\{\frac{\sum_{i=1}^{s} \alpha_{ij} B_{ij} + \beta_{ij} M_{ij} + \gamma_{ij} F_{ij}}{\sum_{i=1}^{M} \tau_{ij} K_{ij} + \varphi_{ij} R_{ij}}\right\}} \quad (4)$$

[4] See *Equation 4*.

[5] Although the a technical efficiency analysis would require to consider of number of hospital beds reserved for cardiology cases and the number of specialists specialized in CVD, these were not taken into account due to lack of data and territorial overlaps.

[6] Since the number of cardiologic inpatient classes is not registered, I further assume that all publicly funded hospitals have such a class, so the minimum number of the latter can be estimated by the number of hospitals.

[7] When considering hospital admissions, I did not calculate from their absolute value since – as noted by ÁDÁNY [2011] – the data provided by inpatient care providers are less reliable due to territorial overlaps, regionally differing usage habits, documentation problems, and financing interest aspects, thus the elimination of the resulting distortionary factors becomes justified.

[8] The latter technical correction was justified by the elimination of the distortions of patient release data issued by hospitals and the realistic estimation of cost efficiency, but it is not the same as the DALY value among the dependent variables filtered for lifestyle risks.

where C_F financial resources for inpatient care expressed in euros, optimized weights for inputs and outputs are $\alpha_{ij}, \beta_{ij}, \gamma_{ij}, \tau_{ij}, \varphi_{ij} \geq 0$; inputs are K_{ij}, R_{ij}, outputs are B_{ij}, M_{ij}, F_{ij} detailed in *Table 5*, *i* the examined year, while *j* the number of examined country.

In the case of Hypotheses 4 and 5, the relationship can be described with *Equation 5*:

$$ln\, Y = \beta_0 + \beta_1 t + \beta_2\, ln\, DALY(risk) + \beta_3\, ln \frac{GDP}{capita} + \varepsilon \qquad (5)$$

Since in the model, set up in *Equation 4*, no explanatory variable is constant in time, both a fixed and a random model could be used: Based on result of test created by HAUSMAN [1978], which tested the correlation of the unobserved effect with explanatory variables, I decided which one – the result of fix or random effect model – was relevant.

3. MAIN STATEMENTS OF THE DISSERTATION

3.1. Main statements of primery research

The database contains data from 433 completed questionnaires. From the descriptive statistical analysis of the actual and optimum spending of all respondents on a monthly basis, that the highest quality of life could be achieved at a level of spending more than twice as high as their actual circumstances actually allow them. The average amount of pharmaceutical expenditure was approximately one tenth of the expenditures so that the heart medicines are also included in the value of that, and almost 10% of the respondents do not spend any medication at all. The scale of optimum spending was on an extremely high scale due to its subjectively appreciated nature, while in the case of actual consumer spending it was no longer significant – the high extent of variations in pharmaceutical expenditures was mainly explained by the fact that a respondent's own pharmaceutical expenditures far above the average at HUF 63,000 per capita. It is noteworthy that half of the respondents would be able to ensure the quality of life by spending a maximum of HUF 50,000 or even lower on their lifespan, the maximum of which would be the most common both the optimal and the actual spending data. Based on the outputs of multivariate regression analysis performed separately for lifestyle segmented consumer groups, it can be determined that the change that can be caused by the diagnosis of CVD, such as complex drug therapy or, in more severe cases, hospitalization or the start of long-term rehabilitation, does not significantly affect the minimum cost of the highest quality of life. So the first hypothesis must be rejected. This can be partly explained by the fact that

- on the one hand, the role of the state in risk-sharing is such that the proportion of the co-payment represents only a small fraction of the minimum spending requirements ensuring the highest standard of living,

- on the other hand, heart patients have already defined their over-treatment needs at a lower level compared to healthy ones, so the difference between them has evened out.

The outputs of regression models that have been separately organized for segmented consumer groups according to the judgment of prevention have not shown any difference compared to the results of the first hypothesis: the development of heart disease does not

affect the optimal levels of expenditure in this case either, however, due to differences in correlations and coefficients of actual expenditures, it can be excluded that there would be a complete overlap between the segments grouped under the two criteria. Based on the latter, I also rejected the second hypothesis.

Table 6: Summarized results of multivariate regression analyzes.

Examined hypothesis		**Hypothesis 1**				**Hypothesis 2**			
Basis for segmentation of consumers		**Use of primary prevention**				**Judging the cost-benefit (U) of primary prevention**			
Regression model		**Model 1**		**Model 2**		**Model 1**		**Model 2**	
Consumer segment		***Applying***		***Not applying***		***U > 1,00***		***U ≤ 1,00***	
Significance of F value		<0,001		<0,001		<0,001		<0,001	
R^2		0,332		0,204		0,290		0,141	
Adjusted R^2 (*Standard error*)		0,311 (*0,957*)		0,197 (*0,903*)		0,281 (*0,935*)		0,126 (*0,885*)	
Constans		4,209*		5,505*		4,196*		6,625*	
Coefficients of explanatory variables *and VIF values*	Health status (0,1)	0,122	*1,016*	0,009	*1,007*	0,043	*1,012*	0,051	*1,003*
	Gender	-0,360	*1,087*	-0,035	*1,032*	-0,148	*1,040*	-0,034	*1,058*
	Actual consumer expenditure *log*	0,702*	*1,100*	0,560*	*1,029*	0,689*	*1,028*	0,450*	*1,061*
Dependent variable		Optimal expenditure *log*							

* The values shown in the table are statistically significant at 95% confidence level.

Source: own editing.

The third assumption was divided into two further sub-hypotheses. In examining how non-health conscious people overestimate the cost of life-time prevention, I have come to the conclusion, based on the coefficient parameters of multivariate regression models run on original and estimated optimum variations, that while lifestyle changes actually increase the level of spending to achieve maximum living standards non-health conscious people do not considered significant this increment. Assuming rational decision-makers, this would not explain their way of life, but if we consider all the underlying factors that make individuals' decisions not rational, then it can be stated with certainty that the lifestyle of non-health conscious people is

- on the one hand, the lack of information on health preservation, or the lack of availability,
- on the other hand, if the latter information reaches them, it can be attributed to their self-control problems, whether they are aware of them or not.

Table 7: Summarized results of multivariate regression analyzes.

Examined hypothesis		**First part of Hypothesis 3**				**Second part of Hypothesis 3**			
Key explanatory variable		**Use of primary prevention**				**Health status**			
Regression model		**Model 1**		**Model 2**		**Model 1**		**Model 2**	
The purpose of measurement:		***Estimated change***		***Actual change***		***Estimated change***		***Actual change***	
Significance of F value		<0,001		<0,001		<0,001		<0,001	
R^2		0,175		0,235		0,198		0,204	
Adjusted R^2 (*Standard error*)		0,169 (*1,089*)		0,227 (*0,981*)		0,192 (*0,947*)		0,197 (*0,903*)	
Constans		5,184*		4,963*		5,688*		5,505*	
Coefficients of explanatory variables *and VIF values*	Key variable	-0,181	*1,000*	0,176	*1,010*	-0,025	*1,000*	0,009	*1,007*
	Gender	0,072	*1,017*	-0,116	*1,028*	-0,053	*1,017*	-0,035	*1,032*
	Actual consumer expenditure *log*	0,585*	*1,017*	0,619*	*1,024*	0,551*	*1,017*	0,560*	*1,029*
Dependent variable		Optimal expenditure *log*							

* The values shown in the table are statistically significant at 95% confidence level.

Source: own editing.

The respondents, who's lifestyle create according to the indication, do not considered significant the effect of the change associated with the possible deterioration of the health condition on the optimal expenditures. This may be partly due to their low level of morbidity risk, partly due to the ex ante moral hazard: the risk-sharing on the demand side of the health insurance market – as it also covers the risk of non-lifestyle change – makes consumers less interested in health provision, since they think that a significant part of the costs that might arise later would be borne by the insurer as a result of the insurance relationship. Although it could be logically assumed - which is also formulated in the hypothesis - that due to the former assumptions the cost savings of lifestyle change are

underestimated, this does not actually happen: the extra costs of the disease in the actual situation do not play a decisive role in the development of the available standard of living.

3.2. Main statements of secondary research

The international secondary database contains data from 23 European countries, covering four years of the 12-year period, totaling 92 observations. Based on the descriptive statistical analysis of the data, it can be concluded that an average of 638 euros for cardiology inpatient care was provided for a heart disease case, while the loss in economic performance due to heart diseases was already close to 2 million on average. The inpatient costs adjusted by DEA for prevalence did not reach 406 euros in half of the observations, while the standard deviation of 83% refers to an extremely inhumane, inhomogeneous population.

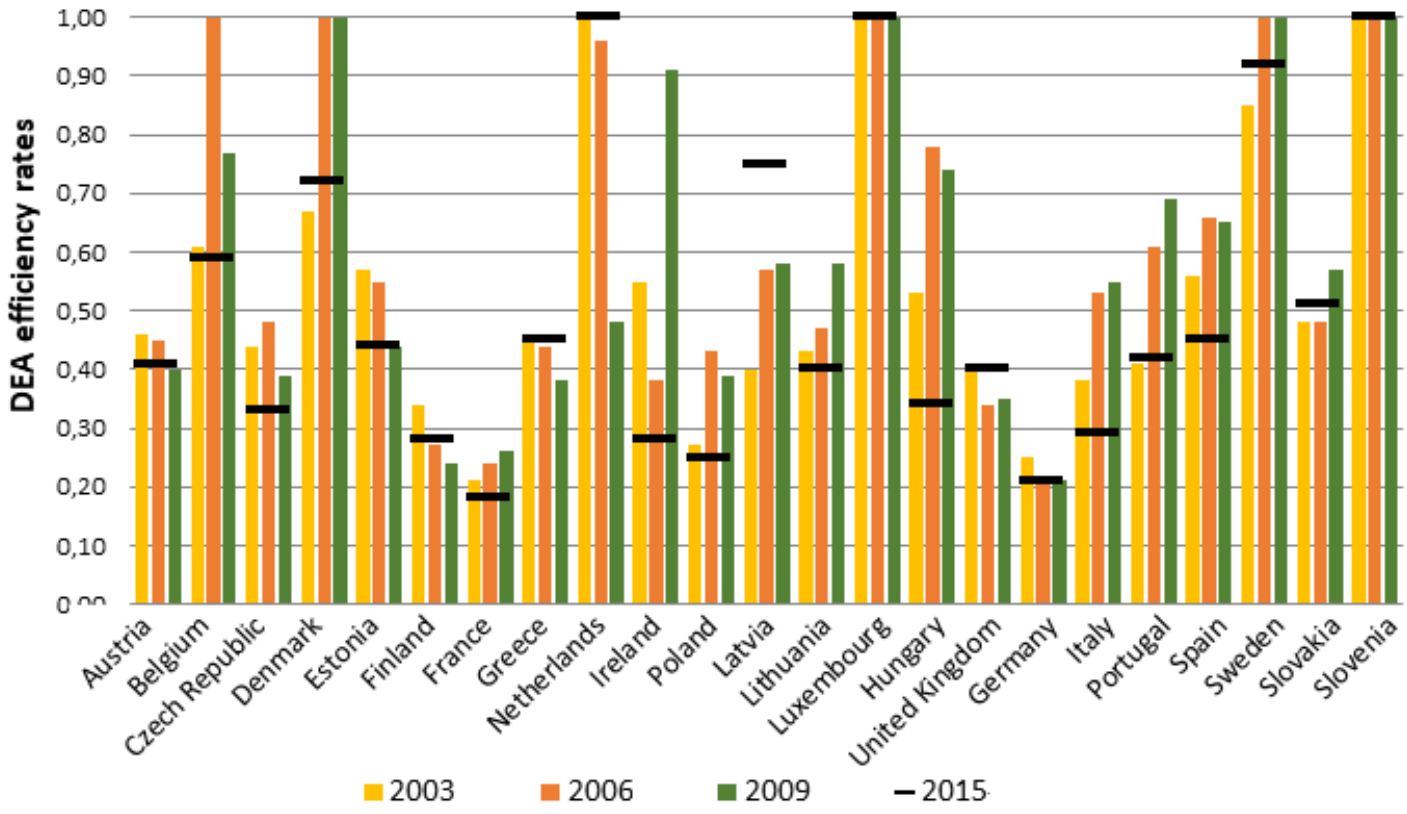

Figure 2: Development of relative efficacy rates in the cardiological inpatient care system in the countries examined from 2003 to 2015.

Source: own edition based on results of DEA efficiency analysis

The productivity loss due to the loss of function and early deaths affecting working-age population was over 720,000 euros in 50% of the observations, and already over 1 900,000 euros in the top 25%. For half of the countries in the sample, the GDP per capita did not

exceed EUR 25,000, while their standard deviation was close to 50%, thus showing a lower volatility. The cost implications of tracking health-conscious consumer patterns at population level can only be distinguished if the distorting effects of diverging efficiencies in the inpatient care systems are eliminated in advance. Although more developed countries typically spend more on treating heart disease compared to their economic performance, this is not necessarily coupled with a higher rate of faster and more successful patient care (irrespective of the future health of potential patients).

Table 8: Results of a Fixed and Random Effect Model for Panel Regression between Lifestyle risks and Inpatient costs adjusted by DEA

Examined hypothesis		**Hypothesis 4**	
Regression model		**OLS**	**GLS**
Dependent variable		Case proportional inpatient cost *log*	
Group variable		EU *and* OECD member states	
R^2	within groups	0,293	0,012
	between groups	0,245	0,221
	overall	0,107	0,128
corr (u_i, X_b)		-0,977	(feltételezett) 0
A statistical test of the model's goodness		F test	Wald chi square
Significance of F value		<0,001	0,141
Statistical test for the coefficients		t test	z test
Constans		-74,012*	-7,345
Coefficients of explanatory variables	Years (proxy)	0,811*	-0,143
	Lifestyle risk level *log*	8,068*	0,012
	GDP per capita *log*	0,789	1,327
sigma_u		4,241	0,682
sigma_e		0,755	0,755
Idiosyncratic effect		3,075%	55,034%
Cross-sectional effect		96,925%	44,966%
Result of Hausman test		p < 0,001	

* The values shown in the table are statistically significant at 95% confidence level.

Source: own editing.

Overall, considering the DEA efficiency rates of the 23 European countries examined, it can be stated that the two most developed economies in continental Europe, Germany and

France, were characterized with the lowest values, such as the highest efficiency reserves, notwithstanding the fact that in France the total number of hospital per 1 million remained outstandingly high, while in Germany there is a higher share of budgetary resources in the field of cardiology inpatient compared to the per capita GDP per capita. The results of panel regression showed that inpatient care expenditures adjusted by DEA, do not increase even if a country has a higher specific GDP indicator, but the relation – with especially low correlation – already exists if their residents prefer prevention during their lifestyle, although this meant a relatively small increase. If the related burden of illness increased by one order of magnitude, the cost increased by about € 8 and the number of years increased by nearly € 1. This is mainly explained by the fact that the higher proportion of patients with higher lifestyle risk requires inpatient care and longer hospital care due to the absence or failure of previous preventive interventions. Due to the late detection of the disease, the majority of patients registered in cardiology departments can only start treatment in such a severe state that is less likely to enable to perform fully effective interventions at low resource- and cost requirements. So I consider Hypothesis 4 to be justified.

Based on the output of panel regression on Hypothesis 5, it can be concluded that the loss of productivity cannot be described as a function of the affected disease burden, so the loss due to the absence of one person is mostly influenced by the level of development of the economy; if the patient does not become ill and does not need long-term healing therapy. If the performance of national economies were assumed to be the same, productivity losses would not differ significantly between countries. Since higher levels of lifestyle risks can be attributed to premature deaths and loss of function, because of those non-influential role it is likely that the majority of premature deaths occurs either not in working age or after a longer absence from working. Furthermore, those who have not suffered from such a severe loss of function as a heart disease, which would have resulted in their inability to work, are approximately as effective in generating GDP as their fully healthy counterparts in the same country. Consequently, I rejected the fifth hypothesis.

Table 9: Results of a Fixed and Random Effect Model for Panel Regression between Lifestyle risks and Productivity losses.

Examined hypothesis		**Hypothesis 5**	
Regression model		**OLS**	**GLS**
Dependent variable		Case proportional GDP loss *log*	
Group variable		EU *and* OECD member states	
R^2	within groups	0,426	0,410
	between groups	0,321	0,383
	overall	0,305	0,390
corr (u_i, X_b)		-0,713	(feltételezett) 0
A statistical test of the model's goodness		F test	Wald chi square
Significance of F value		<0,001	<0,001
Statistical test for the coefficients		t test	z test
Constans		-1,558	-5,122
Coefficients of explanatory variables	Years (proxy)	-0,074	0,023
	Lifestyle risk level *log*	-0,491	0,166
	GDP per capita *log*	1,213*	0,975*
sigma_u		0,549	0,335
sigma_e		0,282	0,282
Idiosyncratic effect		20,909%	41,501%
Cross-sectional effect		79,091%	58,499%
Result of Hausman test		p > 0,05	

* The values shown in the table are statistically significant at 95% confidence level.

Source: own editing.

4. NEW AND NOVEL RESULTS OF THE DISSERTATION

The main results of the research can be summarized in the following theses:

Thesis 1: Beside the same standard of living, the extra costs associated with heart disease are statistically negligible for both users of prevention and non-users.

Thesis 2: Beside the same standard of living, the extra costs associated with heart disease are statistically negligible for both the high and low judgment of prevention.

Thesis 3: Beside the same standard of living, non-conscious and non-cardiac consumers are not considered to be significant at an individual level, as can be seen in the actual situation. Creating a lifestyle for non-health conscious consumers is not based on weighing of costs and benefits of prevention, but mostly on tracking non-rational behavior patterns.

Thesis 4: If there is a higher disease burden caused by lifestyle risks in a country, namely the population are less health consciously, then the cost of inpatient care for an average heart patient will be statistically higher, assuming the same cost-effectiveness of cardiologic inpatient care departments.

Thesis 5: If the deviations of the GDP per capita of the examined countries are eliminated, the value of the productivity loss due to an average heart patient is not significantly influenced by the (non) health awareness of the given population. There is no significant difference between the productivity of those who are still in production, and those who are already treated, as well as between the effects on the economic productivity of life expectancy before death.

5. PRACTICAL USE OF THE RESULTS

Following the theses, the general examination of the topic discussed in the dissertation requires complex solutions. The first three theses of the research focus on two sources of problems: the importance of the role of self-control problems and the distorting effect of risk sharing. Because of the latter, the consistency of prevention marketing campaigns have paramount importance: all government or non-government-sponsored programs that call for the importance of prevention, while providers take no distinction between insured people with different risk lifestyles when setting the insurance premium. Due to the third thesis, emphasis should not be placed on reducing the contribution of health-conscious people to risk-sharing (since it would not motivate the affected consumer group, which does not have significant financial implications), but to increase detectable the contribution which can pay people have more risky lifestyle and / or to narrow the range of publicly funded care available to them. The resulting necessity

- giving opportunity to consumers to place their decision on their lifestyle on a more rational basis, while
- the measure would reduce - but not eliminate - the ex ante moral hazard, due to the future incremental costs that already would incure in the present
- encourage employers to initiate further workplace health promotion programs, employees to participate in them, indirectly increase competitiveness, and
- provide additional resources for public financing of the health care system.

The results of the research can be applied primarily in the planning and implementation of public health intervention programs. For those who consider the prevention itself to be unnecessary, irrespective of its cost implications, it is advisable to convey the message that the probability of illness and premature death would be significantly higher than without it. However, persuading the target group, who are aware of the latter, but due to the length of time between the immediate expense and the health gain, is highly uncertain about the return of prevention, can be successful if

- on the one hand, in order to achieve a higher level of utility in the short term, extra incentive or motivating factors built into the programs;

- on the other hand, if, in line with the long-term goals of the health care government, recognizing the costs of later higher morbidity risks in the present, the above-mentioned stronger differentiation will happen, increasing the interest of the latter target group towards health preservation.

In addition to revision of insurance risk sharing, it is also possible to propose

- the development of a primary care primary care system capable of laying the foundation for the success of prevention programs, reducing the administrative burden related to its operation,
- encouraging the use of health mobile applications, and
- due to the dominant role of non-rational behavior patterns, administrative and marketing support for state-owned civil societies and networks which aiming for lifestyle change online and organized.

6. PUBLICATIONS IN THE SUBJECT OF THE DISSERTATION

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Candidate: Gergő Tömöri
Neptun ID: AYSWPB
Doctoral School: Károly Ihrig Doctoral School of Management and Business
MTMT ID: 10045972

List of publications related to the dissertation

Articles, studies (6)

1. **Tömöri, G.**, Herczeg, A.: A prevenció hatása egy egészségügyi terület költség- és teljesítménycontrollingjára.
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The Candidate's publication data submitted to the iDEa Tudóstér have been validated by DEENK on the basis of the Journal Citation Report (Impact Factor) database.

14 February, 2019

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