Iwona Laskowska[*]

HEALTH CAPITAL AND REGIONAL DEVELOPMENT A PANEL DATA APPROACH[**]

Abstract. The recent studies of economic growth have shown increasing interest in the potential economic profits that improved health condition of populations could bring. The World Health Organization's reports *Macroeconomics and Health: Investing in Health for Economic Development* of 2001 and *The Contribution of Health to the Economy in the European Union* of 2005 significantly contributed to the promotion of health as a factor of economic growth. Both of them suggest that investing in health as a vehicle of economic growth is necessary not only in countries at a low level of economic development, but also in the developed ones.

This recommendation arises from the fact that education and health are one of the basic determinants of the quality of human capital. On a micro scale, health is treated as a prerequisite for personal development, enabling the achievement of a satisfactory economic status. In terms of the entire economy, the beneficial influence of good health can manifest itself thorough growing productivity of labour, lower costs of absenteeism caused by sick leaves, and limited costs of medical interventions that altogether may improve social well-being and reduce poverty.

Variations in economic results caused by health inequalities can be analysed for the entire economy, a region or with respect to individuals. The presented investigation aimed to verify a hypothesis, according to which the health condition of the regional population can be one of the factors determining regional development. The investigation used a panel sample comprising particular voivodeships as they were between 1999 and 2008. Application of dynamic panel data models allowed identifying a relationship between different health indicators and GDP variations.

1. INTRODUCTION

Recent investigations into economic growth testify show increasing interest in economic benefits that better population health could provide. In the past, health was typically viewed only as a cost item, but this attitude is being replaced by a new one, where funds allocated to the improvement of population health are considered an investment (Suhrcke et al., [2006]; Bloom, Canning and Sevilla, [2004]; Commission on Macroeconomics and Health, WHO, [2001]).

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[*] PhD, Department of Spatial Econometrics, University of Lodz.

This change comes from the realization that health and education belong to the major factors determining human capital quality. For individuals, health is an important condition of personal development, enabling them to attain the economic status they pursue. On the other hand, the entire economy can benefit from labour productivity growth arising from workers' better health and the related lower sick absenteeism. Better health is therefore capable of boosting the competitiveness of enterprises, the economy and particular regions. Regional development, including its spatial variations, is one of the major topics of economic analyses today. Considerable differences between regional economies provide a rational argument for running investigations at this level.

The degree of regional development is largely determined by the resource of human capital available in the region[1]. The presented investigation attempted to verify a hypothesis about population health being possibly one of the factors driving regional development. The investigation utilized a panel data sample covering Polish voivodeships in the years 1999-2007.

2.   HEALTH AS AN ELEMENT OF HUMAN CAPITAL AND ITS POTENTIAL EFFECTS ON THE ECONOMY – A THEORETICAL DISCUSSION

Following human capital theory that has been developing since 1960s, the contemporary world treats human capital as one of the key drivers of development. The theory has played a role in the research on economic growth. Numerous studies pondering the relationships between human capital and economic growth generally confirm that such relationships exist and the quality of the human factor is commonly accepted as an element strongly contributing to the effects of economic activity.

However, investigations into the relationships between economic growth and health are still relatively new. Although the role of health was already recognised by the authors of the human capital theory (Schultz, [1961]), researchers were of the opinion that the quality of human capital was actually determined by education and accumulation of professional experience. The person who largely contributed to viewing health as an inherent component of human capital was Grossman [1972], who noticed the duality of the asset called health. On one hand, health can be treated as a consumer good, the consumption of which directly influences the utility function – healthy individuals demonstrate rising levels of satisfaction. It can be also perceived as a capital

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[1] Especially, when the spatial mobility of workers is relatively low.

asset – good health makes people more productive[2], thus contributing to better economic results (Suchecka, [2010]; Hnatyszyn-Dzikowska et al., [2008]).

The National Health Declaration[3] defines health as one of the fundamental rights of a human being, but the modern perception of health goes further. Poor health produces economic consequences for individuals and households, as well as the entire economy (Maciąg, [2008]).

According to the economic literature, health can shape economic results in many ways. Researchers analyze its potential direct impacts (healthy people are more productive, they can work longer hours and harder) as well as indirect ones. Good health may encourage an individual to seek better education. Further, the extending life expectancy makes people think about making savings for the post-retirement periods of their lives (Suhrcke, [2006]). Figure 1 illustrates the main channels through which health can influence economic results.

Fig. 1. Potential mechanisms linking health and economic results
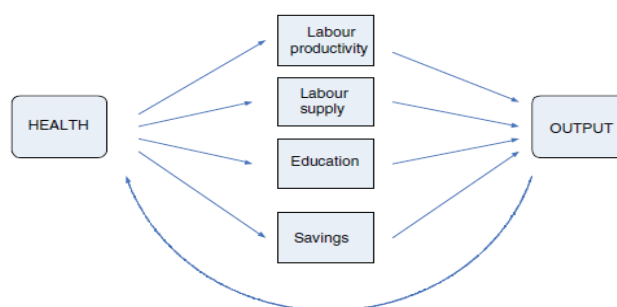
Source: Suhrcke M., et al., [2006], The contribution of health to the economy in the European Union, Public Health, Vol. 120, No. 11.

In the recent years we have witnessed many attempts at understanding how health and the economy are interrelated. The hypothesis about health having a favourable influence on both the economy and economic growth has frequently undergone empirical verification. The available findings confirm that such a relationship does exist. Notwithstanding different time-space frameworks, the variety of variables used for describing health and their definitions, and different estimation techniques, the findings demonstrate that health capital (measured with life expectancy, for instance) improves economic growth (Barro, [1997]; Bhargava, Jamison, Murray, [2001]; Bloom, Canning, Sevilla [2001]; Jamison,

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[2] The following factors are behind productivity decline: temporary absenteeism, permanent or long-term disability, premature mortality. See: Maciąg A., [2008], *Szacowanie kosztów pośrednich leczenia w perspektywie społeczno-ekonomicznej w wymiarze krajowym i europejskim,* [in]: Ryć K., Skrzypczak Z. (eds.), *Ochrona Zdrowia i Gospodarka*, Warszawa.

[3] National Health Declaration, p.10.

Lau, Wang, [2004]) and the volume of savings (Bloom, Canning, Graham, [2003]), as well as boosting productivity growth (Bloom, Canning, Sevilla, [2004]).

Although there are more and more studies in this field, relatively few of them deal with the new EU member states, where both population health status and its well-being expressed as GDP *per capita* are different from their EU-15 levels.

The health situation in Poland is definitely less favourable than in many European countries, as illustrated by the shares of the disabled persons in the working age population (Chart 1).

Chart 1. Shares of disabled persons in the total working-age population in 2005 (in %)
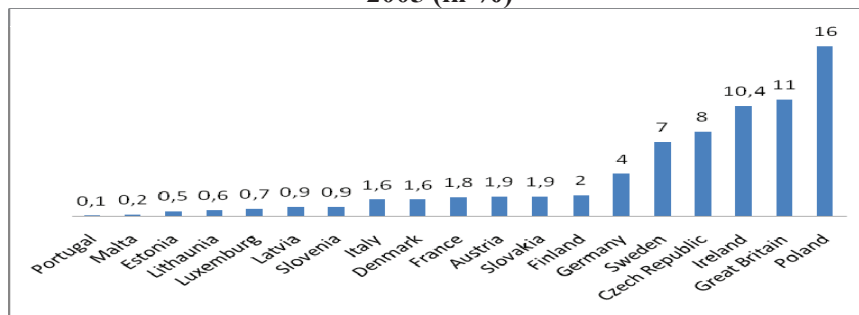
Source: Wojtyniak B., Goryński P. (eds.), [2008], Sytuacja zdrowotna ludności Polski (Health Situation of Polish Population), Narodowy Instytut Zdrowia Publicznego, Państwowy Zakład Higieny, Warsaw, p. 173.

There is a two-way relationship linking population health and its well-being (Fig. 1). As shown by international research, population health status depends, at least partially, on the level of economic development. More favourable health indicators in the developed countries can be attributed to larger investments in their healthcare systems (advanced medical technologies) and to patients having better access to health services. Research methodology has to allow for the reciprocal nature of the relationship.

3. METHODOLOGY OF THE RESEARCH

A regional investigation may consider both economic growth and economic development. The first notion has a narrower meaning, usually associated with growing GDP *per capita*, while economic development is viewed through changes in the various aspects of the living standard, including the non-quantifiable aspects. Growth is a key measure of regional development.

The common part of empirical investigations into health influence on economic growth is regression. Many studies aimed at capturing the effects of human capital, including health, are based on the so-called growth regression[4]. The explained variable in a regression model is the rate of economic growth, while variables characterizing human capital, naturally together with other factors, stand for the explanatory variables.

Growth regression is frequently estimated using the regional data, where the analysed object is regional variations inside a country. Another type of regional research involves international investigations focusing on regions within a range of individual economies. The second approach is often criticised due to the incomparability of the institutional and legal environments of the analysed objects[5]. This type of criticism has not been raised against studies exploring regions inside a single economy.

The most frequent problem that the investigations into the dependence of economic growth on health capital have to struggle with is the endogeneity of health caused by the possible existence of a two-way relationship between growth and health (Fig. 1). Other problems arise from fact that health is not directly observable, because many factors may concurrently determine how an individual feels mentally and physically.

As far as the new Polish voivodeships are concerned, there is also the problem of insufficient numbers of observations, which prevents the use of methods typical of time-series analyses.

In the next part of the presented empirical investigation, the growth models will be estimated using panel data. This approach makes it possible to verify statistical hypotheses that could not be verified if the cross-section samples or time series were used.

The investigation starts with a growth model frequently used within convergence research:

$$\ln\left(\frac{y_{it}}{y_{i,t-1}}\right) = \alpha - \beta \ln(y_{i,t-1}) + \mathbf{X}_{it}\boldsymbol{\delta} + (\alpha_i + \varepsilon_{it}), \qquad (1)$$

or:

$$\ln y_{it} = \alpha + (1-\beta)\ln y_{i,t-1} + \mathbf{X}_{it}\boldsymbol{\delta} + (\alpha_i + \varepsilon_{it}), \qquad (2)$$

where:

y_{it} - GDP *per capita* in the *i*-th voivodeship in year *t*,

$\mathbf{X}_{it}$ - a vector of explanatory variables,

$\alpha, \beta, \boldsymbol{\delta}$ – structural parameters being identical for all *i* and *t*,

α_i – group effects,

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[4] Herbst M. (ed.), [2007], *Kapitał ludzki i kapitał społeczny a wzrost regionalny*, Wydawnictwo Naukowe Scholar, Warszawa.

[5] Ibidem.

ε_{it} – error term.

Equations (1)-(2) are dynamic panel data models. This type of models needs special estimation methods, different from those applied under static models. Their key representatives proposed in the contemporary literature of the subject are based on the Generalized Method of Moments (GMM). GMM is particularly useful for estimating models with endogenous or predetermined explanatory variables, where the time-series generating process cannot be fully specified[6].

The dynamic panel models are usually estimated by the Arellano and Bond first-differenced GMM (FDGMM) and the Blundell and Bond system GMM estimator (GMM-SYS).

Two tests are especially worth considering when the correctness of a GMM-estimated model is to be analysed: the Arellano-Bond test for autocorrelation and the Sargan test of over-identifying restrictions.

For the GMM method to provide consistent estimators the first-difference autocorrelation of order greater than one must be absent. If the autocorrelation order were greater than one, then the instruments used in the GMM estimation should be interpreted as incorrect. Arellano and Bond proposed a test for the second-order autocorrelation, where the null hypothesis assumes that such autocorrelation does not exist.

The Sargan test checks if the over-identifying restrictions omitted from the estimation process were correct. Its null hypothesis states that the applied instruments are correct in the sense of their being uncorrelated with the error terms of the first difference model.

Among the desirable properties of a time series, stationarity is frequently given a prominent place. The Levin-Lin-Chu test was applied to test for the presence of the unit root in residuals of the model based on a panel data sample[7]. The null hypothesis is that the series contains a unit root, and the alternative is that the series is stationary.

4.   STATISTICAL DATA

The presented investigation aiming to verify whether the formulated hypothesis was true used statistical (panel) data characterizing the 16 Polish voivodeships between the years 1999-2007. The economic variables were analysed by means of statistical data made available by the Central Statistical

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[6] Dańska- Borsiak B., [2010], *Panelowe modele dynamiczne,* Łódź.
[7] Kluth K., [2007], *Konwergencja gospodarcza w zakresie kryteriów Traktatu z Maastricht – analiza ekonometryczna*, Dynamiczne Modele Ekonometryczne X Ogólnopolskie Seminarium Naukowe, 4–6 września 2007, Toruń.

Office[8], while information on population health was examined using data provided by the Centre for Healthcare Information Systems[9].

In the literature of the subject, alternative health measurement methods can be found. Investigations into the contribution of health to the economic development of the mature countries require health measures (indicators) that are different from those commonly applied to regressions involving the multi-country data (usually on the better and less developed countries at the same time), which is due to different the characteristics of health hazards[10].

Comparative analyses usually reach for negative measures (accounting for poor health) to describe population health. The most popular of them are based on mortality, including average life expectancy and mortality from selected causes of death.

The discussion below presents population health status by voivodeship in two ways:

– as a standardized mortality rate for the population aged 18-64 years (per 10 000 persons). Compared with the EU-27 average, Poland has a big problem with premature deaths among the working-age persons. This measure seems particularly useful considering the already mentioned economic consequences of health status. Moreover, an approximation of this type will facilitate making comparisons with countries for which similar research is available,

– as a synthetic variable (Q_i^t) providing comprehensive pictures of health in particular voivodeships. Because of the heterogeneous nature of health, methods suitable for complex, multidimensional phenomena must be used to evaluate health status in the region. This approach will enable a single measure to account for several health dimensions.

An important stage in constructing the synthetic measure Q_i^t showing population health status in the *i*-th voivodeship is selection of appropriate variables, so-called diagnostic variables, so that the status can be described in a possibly comprehensive manner. Their choice determines the correctness of the research findings, regardless of research methods applied. The final set of the diagnostic variables depends on the quantifiability of the variables, the availability of statistical data and the completeness of data on all objects[11] (Panek, 2009).

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[8] www. stat.gov.pl.

[9] www.csioz.gov.pl.

[10] In the developed countries, unlike the developing ones, the most burdensome are non-contagious diseases (circulatory system diseases, neoplasm, diabetes, accidents and mental disorders).

[11] Panek T., [2009], *Statystyczne metody wielowymiarowej analizy porównawczej*, SGH, Warszawa.

The wide range of factors characterizing health and sometimes the impossibility of measuring some of them caused that only the most important were ultimately used in the investigation.

Therefore, the following diagnostic variables were selected to account for various health aspects:

<u>positive measures – stimulants</u>
- average male life expectancy,
- average female life expectancy,

<u>negative measures – destimulants</u>
- a standardized mortality rate for the population aged 18-64 years (an approximation of working age) per 10 000 persons,

mortality from:
- diseases of the circulatory system,
- neoplasm,
- diseases of the respiratory system (per 10 000 persons).

Other epidemiological parameters, e.g. infant mortality, were omitted from the investigation for their weaker relationship with economic consequences.

To ensure variable uniformity, the following unitarization formulas were applied[12]:

- for the stimulants:

$$z_{ik}^t = \frac{x_{ik}^t - \min_t \min_i \{x_{ik}^t\}}{\max_t \max_i \{x_{ik}^t\} - \min_t \min_i \{x_{ik}^t\}} \; , \tag{3}$$

- for the destimulants:

$$z_{ik}^t = \frac{\max_t \max_i \{x_{ik}^t\} - x_{ik}^t}{\max_t \max_i \{x_{ik}^t\} - \min_t \min_i \{x_{ik}^t\}} \; , \tag{4}$$

where:

z_{ik}^t – value of a normalized *k-th* diagnostic variable for object *i* at time *t*,

x_{ik}^t – value of the original *k-th* diagnostic variable for object *i* at time *t*,

$k \in \{1,2,...,K\}$ - set of indexes for the diagnostic characteristics,

$i \in \{1,2,...,N\}$ - set of indexes for the objects,

$t \in \{1, 2, ...,T\}$ - set of indexes for the periods.

The aggregate variable Q_i^t for object *i* at time *t* is an unweighted sum of individual diagnostic characteristics after normalization:
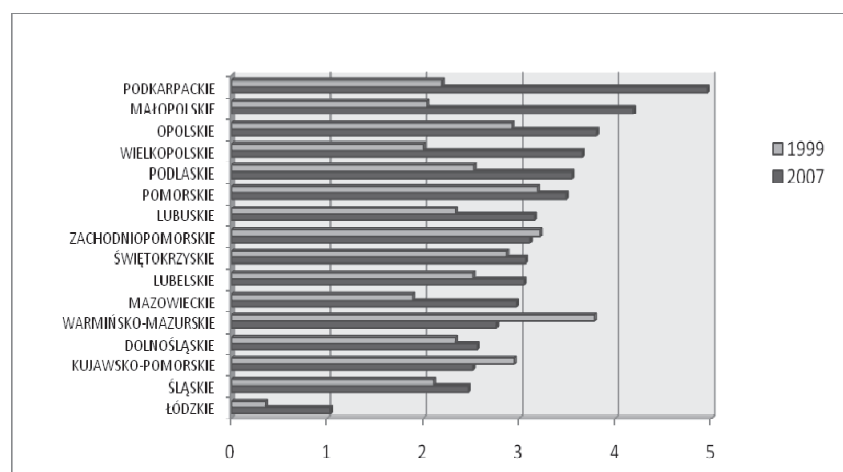
[12] Uramek K., [2006], *Taksonomiczne wskaźniki kapitału ludzkiego w wybranych krajach OECD,* Wiadomości Statystyczne nr 2.

$$Q_i^t = \sum_{k=1}^{K} z_{ik}^t \; , \tag{5}$$

The higher value of the variable Q_i^t, the better population health status.

Chart 2 presents variable Q_i^t values for the years 1999 and 2007.

Chart 2. Aggregate variable Q_i^t values for the years 1999 and 2007

Source: calculated by the author.

Between 1999 and 2007, population health status (as measured by the selected indicators) improved in all voivodeships. In the last year of the period, it was the most favourable in the Podkarpackie, Małopolskie and Podlaskie voivodeships, while the Śląskie, Dolnośląskie and Łódzkie voivodeships were at the bottom end of the scale. The Łódzkie voivodeship has been known for many years to have the highest mortality rates among the working-age population in the country.

5. RESULTS OF THE EMPIRICAL ANALYSIS

The formulated hypothesis was verified using model (2). The model's explained variable is GDP *per capita* (in thousand zloty, constant prices of 1999). Economic growth in the voivodeships was related, above all, to the rate of investment measured by a share of investment outlays in GDP. As already mentioned, the investigation used two different approximations of health:

–   a standardized mortality rate for the population aged 18-64 years (per 10 000 persons) - (Table 1, Model 1),

–   a synthetic variable Q_i^t providing a comprehensive description of population health in particular voivodeships (Table 1, Model 2).

In the literature of the subject, educational attainment is also frequently proposed as one of the human capital measures. A relatively solid indicator of educational attainment is the share of persons with tertiary education.

Model (2) parameters were estimated with the STATA v.10 package using two different estimation methods: the Arellano-Bond GMM and the system GMM estimator. Because the GMM-SYS-estimated model provided a greater statistical value as measured by the results of the Arellano-Bond and Sargan tests, the GMM-SYS estimates were chosen for presentation.

The estimates are compiled in Table 1. The parenthesized values are the standard errors of parameter estimates and the last four lines contain:

–   *AR(1), AR(2)* – the Arellano-Bond statistic testing for the presence of the first or second order autocorrelation, respectively, in the first difference model,

–   *the Sargan test* – the Sargan statistic testing for correctness of the over-identifying restrictions.

–   *LLC* – the Levin-Lin-Chu statistic testing for the presence of the unit root in residuals of the model based on a panel data sample.

Tab. 1. Results provided by the GDP *per capita* models taking account of health capital [a)]

EXPLANATORY VARIABLE	MODEL 1 (GMM-SYS)	MODEL 2 (GMM-SYS)
GDP per capita$_{(t-1)}$	0.910 (0.042)***	0.879 (0.035)***
Standardized mortality rate for population aged 18-64 years	-0.046 (0.022) **	
Investment rate	0.069 (0.013)***	0.084 (0.012)***
Synthetic variable Q_i^t		0.039 (0.019) **
Share of persons with tertiary education	0.169 (0.015)***	0.174 (0.015)***
Const	0.114 (0.043) **	0.315 (0.060)***
AR(1) test (*p*-value)	-2.394 (0.016)	-2.390 (0.001)
AR(2) test (*p*-value	1.030 (0.302)	0.890 (0.373)
Sargan test (*p*-value)	12.318 (0.990)	13.450 (0.990)
LLC test (*p*-value)	-11.904 (0.000)	-9.05 (0.000)

[a)] *All variables are in the form of the logarithm.*
* Significant at the 10% level.
** Significant at the 5% level.
*** Significant at the 1% level
Source: computed by the author.

Because the parameter estimates for the variables characterising population health status are statistically significant, the hypothesis being verified is true. The number of deaths among the working-age population falling by 1% is likely,

ceteris paribus, to make GDP *per capita* grow by 0.04%. Because the variable Q_i^t is an aggregate, the estimate of its parameter cannot be provided with a direct economic interpretation.

Nevertheless, the signs of the parameter estimates for the variables describing health (positive for the synthetic variable Q_i^t and negative for mortality among the population aged 18-64 years) indicate that improvement in each of the considered dimensions of health could boost regional growth.

The Arellano-Bond test for autocorrelation provides no grounds for rejecting the null hypothesis, meaning that the second-order autocorrelation is absent. The Sargan test that was used to verify the hypothesis about the instrument matrix being correct gives no arguments for rejecting the hypothesis.

The Levin–Lin–Chu statistic is significant at all the usual testing levels. Therefore, we reject the null hypothesis and conclude that the series is stationary.

6.   DISCUSSION

Irrespective of what health status approximation was used in the investigation, the major conclusion still is that the Polish economy could significantly benefit from better health of her population. The results obtained for other CEE countries are similar (Bloom, Canning, Sevilla, [(2001]); WHO, [2006]).

The presented investigation concentrated on analysing mortality decline, while omitting the impact of lower morbidity, because Polish health statistics generally accounts only for serious diseases leading to patient hospitalization or death and contagious diseases. There is an obvious deficiency of information on the less dramatic ailments. The influence of health considered together with morbidity rates (e.g. incorporated into the aggregate variable) is likely to be stronger.

7.   CONCLUSION

The presented investigation into the Polish regions shows that poor population health may act as a brake on economic growth. This seems to provide a clear indication that health-improving measures are necessary. Population health as a factor in socio-economic development has been partly addressed in the Healthcare Development Strategy 2007-2013.

The measures contained in the document are expected to increase the number of the economically active persons by reducing mortality among the working-age population, by decreasing the number of persons who withdraw

from the labour force because of their disabilities, and by extending the period of economic activity. This gives hope that the health status of the Polish population will be steadily improving.

Poland has one of the lowest shares of healthcare spending in GDP in Europe. The recognition of the vital role of population's health condition in the economy should result in increases in the healthcare spending and its rational spatial distribution, but also more intensive health-promoting activities launched under public health policy. It follows from the earlier studies[13] that the availability of healthcare services (of medical personnel, the number of hospital beds) in the region is one of the major factors determining the health condition of its population.

Therefore, all central and regional entities in charge of healthcare should undertake activities to improve the availability of medical services, particularly in these parts of the country, where the health condition of the populations is especially worrying (Łódzkie, Śląskie, Kujawsko-pomorskie and Dolnośląskie voivodeships).

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KAPITAŁ ZDROWOTNY A ROZWÓJ REGIONALNY
PODEJŚCIE PANELOWE

W prowadzonych w ostatnim czasie badaniach nad wzrostem gospodarczym zaobserwować można rosnące zainteresowanie potencjalnymi korzyściami Ekonomicznymi wynikającymi z poprawy stanu zdrowia populacji. Duży wkład w prace nad upowszechnieniem roli zdrowia jako czynnika rozwoju gospodarczego wniosły raporty Światowej Organizacji Zdrowia *Macroeconomics and health: Investing in health for economic development* z 2001r oraz *The contribution of health to the economy in the European Union* z 2005 roku. Z obydwu wynikała konieczność inwestowania w zdrowie jako nośnika wzrostu gospodarczego nie tylko w krajach o niskim poziomie rozwoju gospodarczego, lecz także w krajach rozwiniętych. Zdrowie, obok edukacji, stanowi bowiem jeden z podstawowych wyznaczników jakości kapitału ludzkiego.

W skali mikro traktowane jest jako warunek konieczny rozwoju osobistego, dający możliwość zapewnienia odpowiedniego statusu ekonomicznego.   W skali całej gospodarki natomiast, pozytywne oddziaływanie zdrowia może przejawiać się jego wpływem na wzrost wydajności zatrudnionych, redukcję kosztów związanych z absencją chorobową, obniżenie kosztów interwencji medycznych, co w konsekwencji prowadzić może do podniesienia poziomu społecznego dobrobytu i redukcji ubóstwa.

Analiza różnic w wynikach ekonomicznych wynikających z nierówności zdrowia może być prowadzona na poziomie całej gospodarki, na poziomie indywidualnym, jak i na poziomie regionalnym. W prezentowanych badaniach podjęta została weryfikacji hipotezy, iż jednym z wyznaczników rozwoju regionu może być stan zdrowia jego mieszkańców. Badanie przeprowadzono na próbie panelowej obejmującej poszczególne województwa w latach 1999-2008. Zastosowanie dynamicznych modeli panelowych pozwoliło na określenie związku między zróżnicowaniem wskaźników zdrowotnych i różnicami w poziomie PKB.