INCOME-HEALTH NEXUS: PANEL COINTEGRATION AND CAUSALITY EVIDENCE

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Abstract

This study examines the relationship between the GDP per capita and infant mortality rate in 13 CEE countries over the period from 1995 to 2017 by means of panel cointegration and causality methods. We find that there is a cointegration when the infant mortality rate as dependent and GDP per capita as independent variable. Our estimates indicate that a 1 percent increase in GDP per capita leads to 0.19 percent reduction in infant mortality rates in the long run. However, we don't find any evidence for a cointegrating relationship when the GDP per capita is the dependent and infant mortality rate is the independent variable. Finally, there is a unidirectional causality running from GDP per capita to infant mortality rate. Therefore, this study highlights the importance of income to reduce the infant mortality rate and present evidence for the argument that wealthier is healthier in a sense.

Keywords: Health-Income nexus, CEE countries, Panel cointegration and causality

JEL Codes: *I15, O10, O47*

Gelir-Sağlık ilişkisi: Panel Eşbütünleşme ve Nedensellik Analizi

Öz

Bu çalışmada 13 Merkezi-Doğu Avrupa ülkesiyle ilgili 1995-2017 dönemi verileri ve panel eşbütünleşme ve nedensellik yöntemleri kullanılarak kişi başı GSYİH ve bebek ölüm oranları arasındaki ilişki incelenmektedir. Bebek ölüm oranı bağımlı, kişi başı GSYİH bağımsız değişken olarak kabul edildiğinde bir eşbütünleşme ilişkisinin olduğu, kişi başı GSYİH'deki yüzde 1'lik bir artışın bebek ölüm oranlarında yüzde 0.19 oranında düşmeye yol açtığı tahmin edilmektedir. Diğer yandan Kişi başı GSYİH bağımlı, bebek ölüm oranları bağımsız değişken olarak modellendiğinde bir eşbütünleşme ilişkisinin olmadığı sonucuna ulaşılmaktadır. Ayrıca, kişi başı GSYİH'den bebek ölüm oranlarına giden tek yönlü bir nedensellik ilişki olduğu görülmektedir. Bu nedenle ampirik bulgularımızın bebek ölüm oranlarını düşürme konusunda gelirin önemine işaret ettiği ve bir anlamda daha zenginlerin daha sağlıklı oldukları argümanına destek verdiği düşünülmektedir.

Anahtar Kelimeler: Gelir-Sağlık İlişkisi, Merkezi-Doğu Avrupa Ülkeleri, Panel eşbütünleme ve nedensellik

JEL Sınıflaması: *I15, O10, O47*

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1. Introduction

One of the most popular topics in economics is to determine whether there is a signficant link between health indicators, such as life expectancy or mortality rates, and income. In theory, health and income would affect each other via several channels. Earlier studies pay more attention to the impact of income on health (Preston, 1975). Higher income levels or growth rates would potentially have some positive effects on health. However, some factors other than changes in income could be more effective to improve the health (Becker et al., 2005; Deaton, 2006; Soares, 2007).

Since 1990s, there has been a growing research interest in examination of the income impact of health indicators. The literature provides some primary channels through which health would exert an impact on economic growth and well-being (Bloom and Canning, 2000; WHO, 2001; Bhargava et al., 2001; Weil, 2007; Turan, 2020). Health indicators would both directly and indirectly influence the economic growth and development. In this context, the effect of health on productivity, education, saving-investment decisions, and demographic changes would be crucial for economic development. On the other hand, some studies point out that the impact of health on income and economic growth would be insignifcant or even negative under some conditions (Acemoglu and Johnson, 2007; Asrhaf et al., 2009; Bloom et. al. 2018).

These arguments indicate that there would be an unidirectional causality running from health to income, income to health or even a bi-directional causal relationship. More interestingly, since both health and income are multidimensional concepts (Arora, 2001), they might not be closely linked with each other. Some other factors could drive both health outcomes and income. This suggests that there would be no causal relation between these two variables.

It might be difficult to solve the exact relationship and causality between health and income on only theoretical grounds. In other words, more empirically oriented studies are deeply needed on this issue. There is no doubt that this relationship matters and bears some important policy implications as well. For example, an improvement in health enables people to enjoy having a higher level of life standards. Therefore, improving health status is one of the most important goals for policy makers regardless its effect on economic growth. However, if improvements in health lead to a higher growth then it is easier to convince decison makers that more resources must be allocated for health, based on economic reasoning. This can be interpreted as there is no trade off between having a better health status and higher economic growth rates or income level.

This paper examines the relationship between GDP per capita and infant mortality rates in 13 Central and Eatsern European Countries (CEE) by means of Westerlund (2007) cointergation and Dumitrescu and Hurlin (2012) Granger non-causality tests. As far as we know, no previous study particularly focused on this issue in CEE countries. Average GDP per capita in sample countries has increased from almost 7000 to 15000 (constant 2010 US$) while average infant mortality rates have declined from 13 to 4 (per 1000 live births) during the period examined. Therefore, it is interesting to examine the relationship between GDP per capita and infant mortality rate in these countries. There exists a cointegration when we employ GDP per capita as independent and infant mortality rate as the dependent varianble. Moreover, the results of Dynamic Ordinary Least Squares (DOLS) and Augmented Mean Group estimators indicate that a 1 percent increase in GDP per capita leads to almost 0.19 percent decline in infant mortality rates. However, we don't find a cointegration when we use the GDP per capita as dependent and infant mortality rate as independent variable. Finally, we provide evidence for a unidirectional causality running from GDP per capita to infant mortality rates.

We review the literature in section 2, explain the econometric methods used in this study in section 3, report and discuss the empirical results in section 4, and finally conclude in section 5.

2. Literature review

There is a vast literature trying to shed light on the relationship between the health and income. In the past, researchers paid more attention to the effect of income on health outcomes, such as life expectancy, nutrition, mortality, and survival rates (Preston, 1975; Pritchett and Summers, 1996; Kalyoncu, 2008; Erdil and Kalyoncu, 2010). The arguments for a positive health effect of income are relatively simple. Higher income simply enables governments and people to direct more resources aiming to improve the health status. In this context, for example an increase in income would lead to higher calori intake, better medical care, stronger and effective health care institutions (Weil, 2014; Barro, 2013; Cole, 2019). Some studies, such as Preston (1975), Pritchett and Summers (1996), Easterley (1999), Mehmood et al. (2014), Mehrara and Musai (2011), Erdil and Yetkiner (2009), Cole (2019) provide empirical evidence for a positive impact of income or growth on chosen health indicators.

However, it would be misleading to argue that the income is necessarily the main driver of improvement in health observed around the world (Deaton, 2006; Acemoglu and Johnson, 2007; Weil, 2014; Turan, 2020). Several factors other than income, for example technological advancements in medical sector and public health programs, could play a major role for improvements in health indicators. In a seminal study, Becker et. al (2005) point out that poor countries experienced a higher reduction in the mortality of some causes of death than rich countries and also poor countries benefitted from technology and knowledge available in rich countries at low costs. Similarly, Deaton (2006) and Cutler et al. (2006) indicate that many countries have experienced a considerable improvement in health with little or no economic growth.

On the other hand, somewhat surprisingly, the effect of health on income and economic growth is recognized more recently. It is worth highlighting that some early studies, such as Schultz (1961), point out the importance of human capital for economic growth. In an important contribution to the literature Mankiw et al. (1992) incorporated the human capital in the form of education to the otherwise standard Solow model. Moreover, in seminal studies, Romer (1986) and Lucas (1988) develop endogenous growth models with increasing rather than diminishing returns, positive externalities and spillover effects, and human capital formation. Endogenous growth models first focused on the education as a proxy for human capital. This is not surprising. However, it is clear that health is also a main, if not the most important, component of human capital (Mushkin, 1962; Erdil and Kalyoncu, 2009; Barro, 2013).

The literature identifies several primary channels through which health would affect the income or growth (Bloom and Canning, 2000; Bharvaga et al. 2001; Weil, 2007; Aghion et al., 2011; Swift, 2011; Barro, 2013; Bloom et al., 2018). It is possible to classify these channels as direct and indirect ones (Turan, 2020). Direct channel operates via labor and total factor productivity. Healthy workers are more productive (Strauss and Thomas, 1998; Cole and Neumayer, 2006; Weil, 2007), with a lower level of absenteesim and shirking behaviour at work. Higher labor productivity leads to more capital accummulation and this further reinforces the increase in marginal productivity of labor. Health also would affect decisions regarding the participation in labor force and labor supply (Fogel, 1994; Straus and Thomas, 1998). Main indirect channels include but not limited to the effects of health on education, saving-investment decisions, and demograpich transition (Turan, 2020). When people expect to live longer, then they have more powerful incentives to invest in both physical and human capital (Lorentzen et al., 2008). Consistent with this argument, many studies, among others Zhang and Zhang (2005), Jayachandran and Lleras-Muney (2009), show that an increase in health indicators positively influences education. Moreover, since healthy people would better concentrate on educational activities and tasks they would benefit more from a given level of schooling (Narayan et al., 2010). Like human capital, good health also matters for saving (Zhang and Zhang, 2005; Lorentzen et al., 2008) and physical capital investment. In this way, health would encourage higher capital accummulation, productivity, and hence economic growth. Additionally, Becker et al. (1990) point out that when capital stock is high, the demand for children will decline, implying another positive growth impact of capital accummulation.

Furthermore, health is closely related to demographic changes as well (Bloom and Canning, 2000; Zhang and Zhang, 2005; Acemoglu and Johnson, 2007; Ashraf et al. 2008). In this context, a reduction in infant mortality would lead to a decline in fertility, lower population growth and boost the economic growth rate. As is a well-known fact that a reduction in mortality rate leads to an increase in the share of working age population, a process is called “demographic dividend” by Bloom et al. (2004) who highlight the importance of this channel to explain the successful growth experience of some East Asian countries. Moreover, lower infant mortality rate would cause parents to have fewer children but invest more in their education (Becker et al., 1990). Many studies provide strong evidence for a positive impact of health on economic growth (see among others Barro, 1996; Bhargava et al. 2001; Mayer, 2001; Bloom et al. 2004; Weil, 2007; Narayan et al., 2010; Wang, 2011; Turan, 2020).

Despite some strong arguments, income or growth impact of health might be rather weak or even non-existent (Bhargava et al, 2001; Deaton et al., 2006; Acemoglu and Johnson 2007; Ashraf et al., 2008; Suhrcke and Urban, 2010; Hartwig, 2010; Hansen and Lønstrup, 2015; Bloom et al., 2018). Several arguments are put forward to explain why this impact would not be robust or strong. Since life expectancy doesn’t show much variation in especially for developed countries, it is unlikely that increases in life expectancy accounts for changes in income (Swift, 2011). Additonally, if there is a delay in response of fertility to reductions in morality rates, resulting higher population hampers economic growth (Acemoglu and Johnosn, 2007). Moreover, Deaton (2006) argues that some countries, like China and India, grow rapidly with no significant improvements in health whereas some other countries experienced a considerable improvement in health with no acceleration in economic growth.

Afermentioned arguments suggest that a two-way relationship between health and income is more likely. Indeed, there is no compelling reason to accept that there must be only a one-way relationship running from health to income or vice versa. Therefore, it is not surprising to see that some studies empricially confirm this two-way relationship between the health indicators and economic growth (Devlin and Hansen 2001; Erdil and Yetkiner, 2009; Swift, 2011).

3. Data and Econometric Methods

In this study, follwing the literature we use GDP per capita in constant prices (Y) and infant mortality rates (MI) for 13 CEE countries over the period 1995-2017[3]. The sample countries and time period are dictated by data availability. Data obtained from World Bank World Development Indicators (WB, 2019). Both variables are in natural logarithm.

In the literature several variables, such as life expectancy (Barro, 1996), mortality rates (Lorentzen et al., 2008), survival rates (Bhargava et al., 2001), health care expenditures (Devlin and Hansen), are used as a proxy for health status. There is no agreement on the best proxy for health (Lorentzen et al, 2008; Swift, 2011). In this context, we decide to employ the infant mortality rates as an indicator for health. First, this indicator is available for our sample countries. Second, there is a greater variation in mortality rates than in life expectancy. Additionally, changes in life expectancy would have a limited effect on the income after some values. Third, infant mortality would directly reflect or capture the improvements in overall health status.

To avoid biased and misleading results it is important to deal with cross sectional dependence in panel studies (Pesaran, 2004; De Hoyos and Sarrafidis, 2006). Several tests for cross sectional dependence are available. Since our data have more T (time periods) than N (units) then we use Lagrange Multipler (LM) test suggested by Breusch and Pagan (1980) and its scaled version by Pesaran (2004). Testing the cross sectional dependence is also crucial in deciding on which unit root test must be used. First generation unit tests assume the cross sectional independence while second generation tests pay attention to the this issue. In an influential study, Pesaran (2007) suggests a new unit root test, so called CIPS test, which explicitly allows for the cross sectional dependence. Pesaran (2007) estimates cross sectionally augmented Dickey Fuller (CADF) tests for individual units and then take their simple average to obtain cross sectionally augmented IPS (CIPS) statistics.

After testing for cross sectional dependence and unit root, we employ a cointegration test to see whether there exists a long run relationship between variables. Westerlund (2007) develops an error correction based model to test the absence of cointegration which allows for heterogeneity and cross sectional dependence. The key idea is to examine whether the error-correction term in a conditional panel error-correction model is equal to zero or not (Persyn and Westerlund, 2008). This test provides four (Ga, Gt, Pa, Pt) statistics for performing a cointegration test. Two statistics (Ga and Gt) test whether there exists a

[3] The list of CEE countries in this study: Albania, Bosnia and Herzegovina, Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovak Republic, and Slovenia.

cointegration in the panel units or groups, while other two statistics (Pa and Pt) test the null hyopthesis of no cointegraton in the panel as a whole. Westerlund (2007) test is applied to series with I(1). If our cointegration test confirm the existence of a relationship between Y and MI then we can estimate the long run coefficients. In this context, we employ Dynamic Ordinary Least Square Estimates (DOLS) and Augmented Mean Group Estimator (AMG). Several studies such as Saikonen (1992), Stock and Watson (1993), Pedroni (2001), and Mark and Sul (2003), make important contributions to the development of DOLS. In this paper, we employ grouped mean DOLS estimates. We also use a relatively new estimation method (AMG) proposed by Eberhardt and Teal (2008, 2010) and Eberhardt and Bond (2009), which accounts for cross section dependence by including a common dynamic effect.

Although cointegration tests reveal whether there is a long run relationship between the variables, they don't imply causality or the direction of causality in the short term. To figure out the causal relationship, we need to carry out a causality analysis. To this end, we employ a panel Granger non-causality test proposed by Dumitrescu and Hurlin (2012). This causality test, applied to stationary variables, has certain advantages, such as allowing for cross sectional dependence and heterogeneity. Dumitrescu-Hurlin (2012) Granger non-causality test can be written as follows:

$$y_{it} = \alpha_i + \sum_{k=1}^{K} b_i^{(K)} y_{i,t-k} + \sum_{k=1}^{K} \beta_i^{(K)} x_{i,t-k} + \epsilon_{i,t} \quad (1)$$

x and y denote stationary variables, lag orders (K) are identical for cross sectional units, individual effects (α_i) are fixed in time dimension. Additionally, autoregressive parameters ($b_i^{(K)}$) and coefficient slopes ($\beta_i^{(K)}$) allowed to differ across groups and also $b_i^{(K)}$ and $\beta_i^{(K)}$ are constant in time. The null hypothesis of Dumitrescu-Hurlin Granger non-causality test can be shown in the following form:

$$H_0: \beta_i = 0, \forall i = 1, ..N,\ \beta_i = (\beta_i^1, \beta_i^2 \dots \beta_i^{(K)})$$

Alternative hypothesis is:

$$H_1: \beta_i = 0, \forall i = 1, \dots, N_1$$

$$\beta_i \neq 0, \forall i = N_1+1,\ N_1 + 2 .., N$$

This approach first estimates Wald statistics for each panel units and then takes the averages to construct the panel test statistics (panel W statistics). Namely panel W statistics are estimated with the formula:

$$W = \frac{1}{N} \sum_{i=1}^{N} W_{i,t}$$

$W_{i,t}$ shows the individual Wald statistics for the ith cross-section unit which is corresponding to the individual test $H_0: \beta_i = 0$.

4. Empirical results and discussion

We report the results of Lagrange Multiplier test for cross section dependence and Pesaran (2007) CIPS test for unit root in Table 1. It is clear that we strongly reject the null hypothesis of no cross-section dependence. CIPS test indicates that our variables are non-stationary in levels but stationary in first differences.

Table 1. LM and CIPS Tests

Variables	LM Test		Scaled LM Test		CIPS Test
	Statistic	p-value	Statistic	p-value	Statistic
Y	1634	0.000	124	0.000	-2.60
MI	1741	0.000	133	0.000	-2.33
ΔY					-3.780***
ΔMI					-3.648***

Note: *** show the significance at 0.01 level.

Having examined the cross section dependence and stationarity issues, we perform Westerlund (2007) cointegration test and summarize its results in Table 2. Since economic theory predicts that there might exist a two way relationship between health indicators and income, we use both GDP per capita (Y) and infant mortality rate (MI) as dependent and independent variables in the cointegraton analysis. Some studies ignore that Westerlund (2007) cointegration test assumes variables to be non-strictly or weakly exogenous. Using Y and MI as both dependent and independent variables enables us to test whethere our variables meet this condition, as implemented by Dematriades and James (2011) and Herzer and Donaubauer (2018). Moreover, in the presence of cross section dependence, it is advised to consider robust p-values (Persyn and Westerlund, 2008). Therefore, our anaylsis is based on the robust (bootstrapped) p-values.

Table 2: Westerlund (2007) Panel Cointegration Test Results

	Dep. Var: Y		Dep var.: MI	
Test İstatistiği	Z-değeri	p-values	Z-değeri	p-values
Gt	-4.356	0.255	-5.512	0.100
Ga	1.654	0.970	-29.378	0.000
Pt	0.202	0.590	-2.396	0.125
Pa	0.609	0.675	-13.902	0.000

Not: Lag orders are based on AIC. p-values denote the robust values.

The results in Table 2 suggest that there exists a cointegration when infant mortality rate is the dependent and GDP per capita is the independent variable but not vice versa, implying weak exogeneity assumption holds. We conclude that GDP per capita has a long term impact on the mortality rate while the oppsite is not true.

Since we have a cointegrating relationship between Y and MI, we can estimate the long run coefficient of Y on MI by means of DOLS and AUG methods. In Table 3, our results indicate that the effect of Y on MI is almost the same in DOLS and AUG. It seems that a 1 percent increase in GDP per capita leads to almost 0.19 percent decline in infant mortality rate.

Table 3. The Long Run Coefficient of Y on MI

	DOLS		AUG	
Independet Var.	Coefficient	p-value	Coefficient	p-value
Y	- 0.197	0.000	-0.192	0.03

Notes: Constant and trend included in the estimations but not reported here. DOLS estimates are based on grouped option.

To disentangle the causal relationship, we carry out Dumitrescu and Hurlin (2012) heteregounes panel non-causality tests and report the results in Table 4. Since our variables are stationary in first difference, we use them in this form in the causality analysis. As suggested in Dumitrescu and Hurlin (2012) and Lopez and Weber (2017), in the presence of cross sectional dependence, robust p-values must be considered. Therefore, we consider robust p-values. We reject the null hypothesis of GDP per capita does not Granger cause infant mortality rate. On the other hand, we don't reject the null hypothesis of infant mortality rate does not Granger cause GDP per capita. We conclude that there exists a unidirectional causality running from GDP per capita to infant mortality rate.

Table 4: The Results of Dumitrescu-Hurlin (2012) Non-causality Tests

Null hypothesis	W statistic	Z statistic	p-values
ΔY does not Granger cause ΔMI	12.162	8.168	0.075
ΔMI does not Granger cause ΔY	1.3434	0.875	0.46

Not: Lag orders are determined based on AIC. p-values denote robust values. **Δ** shows the first difference operatör.

It seems that our empirical findings are consistent with some previous studies, such as Preston (1975), Pritchett and Summers (1996), Easterley (1999), Mehmood et al. (2014), Mehrara and Musai (2011), Erdil and Yetkiner (2009), Cole (2019), providing empirical evidence for a positive impact of income on health indicators. Additionally, our findings are also in line with some studies, like Deaton et al. (2006), Acemoglu and Johnson (2007), Ashraf et al. (2008), which report an insignificant effect of an improvement in health on income or economic growth.

5. Conclusion

This study examines the relationship between GDP per capita and infant mortality rates in 13 CEE countries by means of Westerlund (2007) cointegration and Dumitrescu and Hurlin (2012) Granger non-causality methods with a special attention to the issue of cross sectional dependence. It seems that we have a cointegrating relationship when we employ the infant mortality rate as dependent and GDP per capita as independent variable. To obtain the long run coefficient of GDP per capita on infant mortality rate, we use Dynamic Ordinary Least Squares (DOLS) and Augmented Mean Group (AUG) estimators. Both methods give almost the same coefficient values, implying a 1 percent increase in GDP per capita leads to 0.19 percent reduction in infant moratality rates. However, our cointegration results indicate that there is no evidence for a cointegrating relationship when the infant mortality (GDP per capita) is the dependent (independent) variable.

The results of panel Granger non-causality tests suggest a uniderectional causality running from GDP per capita to infant mortality rates. Therefore, we conclude that in CEE countries GDP per capita significantly affects infant mortality rates in the long and short terms. On the other hand, we don't find any supporting evidence for the argument that an improvement in health indicators causes a higher income. A caveat is in order. Our sample covers 1995-2017 period. Admittedly, this might not be long enough for the effects of an improvement in the health on the income to take place. Identified channels in the literature through which the health indicators would affect the income might require a longer time period. Indeed, Ashraf et al. (2008) suggest that it would take several decades to see the income impact of an improvement in health. Our empirial findings imply that it is possible to detect the health impact of income in relatively short time periods.

The most important policy proposal coming from our empirical findings is an increasing income leads to a better health outcome with other possible benefits and prosperity. Since reducing the infant mortality rate is a priority, our results imply that an increase in income would be really helpful to reach this goal. In other words, policy makers have another and powerful motivation to focus on and implement economic policies which boost the income. Our empirical findings lend evidence for the argument that wealtiher might be healthier (Pritchett and Summers, 1996) at least for CEE countries examined in this study.

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