On What Really Matters: Evidence from Alternative Well-Being Indicator in EU-28 Countries

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Abstract

As the traditional approaches to measure economic growth have been lately a subject to several criticisms, there is an urge to find more suitable indicators covering the environmental and social aspects of progress. The aim of this paper is therefore to construct an alternative, country-specific indicator of subjective well-being, the so-called adjusted happy planet index (AHPI) for 28 EU member states in years 2012 and 2017. The ordinary least squares regression reveals a weak negative correlation between AHPI and gross domestic product per capita (GDPpc), but since we analyze countries, it is appropriate to use spatial econometric methods, which revealed the spatial relationship between EU-28 countries. Furthermore, the spillover effects are observed as well. This holds especially for natural resources, the reduction of which decreases a level of AHPI in EU-28 countries.

Keywords	***DOI***	***JEL code***
AHPI, GDP, environment, spatial econometric model, subjective well-being	*https://doi.org/10.54694/stat.2021.39*	*C21, E23, I31*

INTRODUCTION

In recent times, an increasing attention has been paid to the crises arising from macroeconomic imbalances, instability of the global economy (see, e.g., Xafa, 2007; Blanchard and Milesi-Ferretti, 2011; Jordà et al., 2011; Obstfeld, 2012), inequalities (e.g., Saint-Paul and Verdier, 1996; Ostry et al., 2014; Berg et al., 2018), and other current challenges, including climate change (e.g., Martens et al., 2009).

As previous evidence suggests (NEF, 2009; Endres, 2020), the causes of these crises might be associated with the persisting preference for economic growth as a focal government goal that goes beyond all other goals. Gross domestic product (GDP) presents most familiar measure of economic activity developed in the 1930–40s, primarily in response to the Great Depression with a goal to improve planning of war

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production. Even though economic growth measured by GDP implies a desired creation of wealth, this indicator arose at a time when environmental and social problems were behind economic problems (Stockhammer and Fellner, 2009). To this end, it does not take into account the environment and the living conditions of the population, whose worsening may result into stress and health issues (Pircher, 2019; Endres, 2020).

Some economists even believe that the pursuit of growth is incompatible with such social and environmental goals as economies operate on a system in which meeting the needs has been replaced by creating the needs themselves (NEF, 2009; Pircher, 2019). Progressive growth could be destructive to the environment, for which new ideas of static or shrinking economy have also appeared (Heinberg, 2011). In addition, the benefits and losses of economic growth have so far been unevenly distributed across different areas of the world (Victor, 2011) which contributes to increasing inequalities as well.

Due to the limits and shortcomings of GDP, alternative approaches to measuring economic growth have been emerging lately, which also respond to environmental and social factors. Among them, a concept of well-being which according to New Economics Foundation (2009: 20) represents: "*the dynamic process that gives people a sense of how their lives are going through the interaction between their circumstances, activities and psychological resources or 'mental capital'*." While *the objective well-being* can be conceptualized in terms of material well-being, which is affected, *inter alia*, by a level and stability of income, educational opportunities, safety and security, *the subjective well-being* can only be understood as an inner subjective experience of each particular individual (Alatartseva and Barysheva, 2015). In this vein, life satisfaction formed by various socio-demographic factors can be considered as a key indicator of subjective well-being which should be increased (Eurostat, 2015) and combined with traditional measures of economic growth (Bleys, 2005).

The alternative indicators relying only on economic indicators, i.e., national accounts and GDP (such as the Index of Sustainable Economic Welfare, Genuine Progress Indicator, Green GDP, etc.) have certain limitations, including a lack of consensus on how to quantify the cost of depleting natural resources or which expenses are beneficial and should be added to the total amount and which are harmful and should be deducted. On the contrary, the other alternatives focused on measuring environmental or social aspects (e.g., Gross National Happiness, Ecological Footprint) miss the economic elements. To avoid such shortcomings, the alternative indicators in a form of the composite indicators (e.g., the Human Development Index, Happy Planet Index) should combine these aspects in order to offer the best prospects for policy making (Costanza et al., 2009). Moreover, since the previous studies have drawn the attention to the spatial aspects in determining economic growth (see, e.g., Abreu et al. 2005; Annoni et al. 2019), environmental issues (see, e.g., Anselin, 2001), and well-being (see, e.g., Brereton et al., 2006; Takeshi, 2020), the spatial dependences should not be omitted in the analyses of alternative indicators as well.

The aim of this paper is to calculate an alternative indicator, relying on previously mentioned factors – more specifically, subjective well-being, life expectancy, and ecological footprint reflecting the human impact on the environment, in particular on the productive area needed to secure the renewable resources used by mankind – and confront it with the traditional GDP measure. By doing so, we contribute to sparse evidence on exploring well-being at macroeconomic level. Besides that, in line with previous studies, in which only OLS is normally used and does not take into account spatial contexts, we estimate spatial econometric model to look at spatial dependences among considered countries.

The remainder of the paper is as follows; the next section provides a literature review of the existing alternative approaches to measure economic growth. In the second section, we describe data used to calculate our alternative indicator, so-called *adjusted happy planet index* (AHPI) and a methodology for spatial econometric analysis. The third section provides empirical results and discussion on the relationship between economic growth and AHPI, along with the discussion on the spatial dependences among considered 28 EU countries in the time period 2012–17. The final section concludes our findings. We also give recommendations for future research.

1 LITERATURE REVIEW

In the early 1970–1980s, intense discussions began on the environmental and social damages caused by the focus on economic growth. These discussions have resulted from the fact that GDP was not originally intended to measure well-being, however, it has become a normative and reference indicator of economic and social performance (Bleys, 2005). Gradually, it became clear that GDP does not represent an adequate indicator of prosperity since it systematically provides distorted information on the sustainable development of prosperity (Stockhammer and Fellner, 2009).

Schepelmann et al. (2010) agrees that GDP does not allow for social and environmental costs and benefits when measuring a country's economic prosperity. Moreover, it is difficult to make sustainable progress when growth is assessed from a purely financial point of view. To avoid this, Schepelmann et al. (2010) suggest supplementing GDP with environmental and social information. Adler (2009) also considers progress as more than economic growth measured through GDP; this category should reflect how the society has developed, but also individuals themselves. To achieve this, Adler (2009) proposes a discussion what progress means to inhabitants of particular country, based on which its indicators should be then created and implemented.

A more complex view is presented by Bleys (2005) who suggests that all alternative measures of welfare should be encouraged since each of them contains valuable information. According to this author, if economic, social, and subjective welfare indicators were combined, the best perspective would emerge.

The recent empirical literature does not provide consensus on the use of GDP as a good indicator of the prosperity of the country or other, suitable measure of progress or well-being. For instance, Patterson (2019) considers the Genuine Progress Indicator (GPI) to be more appropriate indicator of well-being than GDP, since GPI also implies a macro-scale analysis of costs and benefits of activities related to economic growth. Whereas consumption of goods and services can be viewed as a benefit, the social and environmental factors such as the income inequality or emission of greenhouse gases are treated as costs. For this reason, Patterson (2019) comes to conclusion that GPI reaches considerably lower values compared to traditional GDP.

Gallardo (2009) claims that the Human Development Index (HDI) presents a better way of measuring well-being than traditional GDP per capita and it has a potential to strengthen the paradigm of human development. According to Gallardo (2009), the analysis of three main components of HDI (long and healthy life, knowledge, and a decent standard of living) can identify areas that require political attention in considered economies.

In similar way, the Initiative "*Beyond GDP*" originated in 2007 encourages the creation of new, alternative indicators which compared to GDP should be clearly focused on the environmental and social aspects of progress, but more importantly, on the global challenges of the 21st century, such as climate change, battling poverty, resource depletion, health, and quality of life (European Commission, 2007).

On the other hand, Cohen (2018) states that GDP per capita in some way reflects welfare since it tends to correlate with well-being indices. The author argues that richer nations tend to be healthier, and the improving state of health is considered as a key indicator of increasing well-being. However, a high level of GDP does not necessarily lead to a high level of well-being or good health of the country's citizens. To accomplish this goal, Cohen (2018) emphasizes new technologies, equality of access to health, and preventive care which could have a positive effect on life expectancy and consequently, economic growth.

Similar opinion is provided by Norberg (2010) who does not support the view of full GDP replacement as it strongly correlates with economic security, education, health, life expectancy or poverty reduction. According to Norberg (2010), the amount of information available would be reduced if we replaced GDP with another indicator of well-being. Moreover, the unification of the term well-being would also be necessary, which would also tempt the governments to apply a one-size-fits-all approach with questionable results.

To avoid this, several authors suggest considering a combination of traditional and alternative aspects of prosperity. For instance, D'Acci (2011) proposes the idea of well-being and progress in balancing each other. The author creates a new index – the Well-being and Progress Index (WIP) which covers health well-being, economic well-being, happiness, human progress, and cultural progress. This indicator can thus provide global and balanced vision of prosperity because of a large number of variables considered in each category. In similar way, Drabsch (2012) agrees that focusing on GDP as the only measure of well-being is not the best solution and points out to its limitations such as the lack of a relationship between happiness and GDP per capita.

While the evidence at the microeconomic level suggests that the relationship between subjective well-being (SWB) and individual characteristics follows some homogenous patterns (Frey and Stutzer, 2002), the recent research of SWB stresses that there exists a substantial variation in the level of SWB across regions or countries (see, e.g., Aslam and Corrado, 2012; Takeshi, 2020; Hoogerbrugge et al., 2021). The rationale behind this matter comes from possible heterogeneities among regions/countries, but also from the psychological concept of *emotional contagion.* The emotional contagion can be defined as: "*the tendency to automatically mimic and synchronize expressions, vocalizations, postures, and movements with those of another person's and, consequently, to converge emotionally*" (Hatfield et al., 1992: 153–154). As the emotional states can be transferred (Fowler and Christakis, 2008), the person's SWB might determine the SWB of others. Thus, we can observe the spillover effects, whose identification requires spatial econometric approaches.

The contribution of the present study is threefold. Firstly, this paper proposes an alternative indicator of subjective well-being taking into account social and environmental aspects of growth, which we compare with the traditional GDP measure. Since majority of existing empirical studies is focused on the subjective well-being at the individual level (e.g., Helliwell, 2002; Grossi and Sacco, 2011; Kelley and Evans, 2017), we aim to address gaps in empirical literature and contribute to sparse evidence on exploring well-being at macroeconomic level. Secondly, we contribute to the literature on relationship between economic growth and subjective well-being. Our findings suggest that constant pressure to increase economic growth can lead to environmental problems, and later, to a deterioration in people's well-being. We therefore propose an indicator combining GDP with alternative sub-indicators, which we believe reflect domains neglected in existing empirical studies. Finally, an additional aim of this research is to examine whether the adjusted happy planet index (AHPI) proposed in this is spatially dependent; by doing this, we enlarge the empirical literature focusing on the spatial aspects in determining subjective well-being.

2 METHODOLOGY AND DATA

We build on the original *Happy Planet Index* (HPI) introduced by the New Economic Foundation (NEF) which measures the ecological efficiency that a country could maintain, while ensuring the well-being of the population. The basic formula of the index is as follows:

$$\text{HPI} \approx \frac{\text{SWB} \cdot \text{LE}}{\text{EF}}, \tag{1}$$

where *SWB* stands for a subjective well-being indicator,[3] *LE* stands for a life expectancy, and *EF* denotes ecological footprint. By including these variables, the index can be used to compare the countries' progress towards long-term prosperity with respect to the environment. However, the NEF does not provide an exact procedure on the variables transformation which is in this case necessary (such as data standardization, inequality adjustment, etc.). We created so-called *adjusted happy planet index* (AHPI), because the calculation of the initial HPI requires some adjustments in order to find out whether the constant pressure to increase GDP can result in a deterioration of subjective well-being.

Firstly, in line with the NEF, we calculate the Atkinson index to adjust subjective well-being and life expectancy for inequality. The Atkinson index *A(ε)* was firstly used to calculate income inequality (Atkinson, 1970). It represents a percentage of total income that a given society would have to give up, in order for citizens, to have a more equal share of income.

$$\mathrm{A}(\varepsilon) = 1 - \frac{\prod_{i=1}^{N} \left(y_i^{\left(\frac{1}{N}\right)} \right)}{\bar{y}}, \varepsilon = 1, \tag{2}$$

where y_i represents individual indicator, $\bar{y}$ denotes average income, *N* denotes population size and *ε* is the inequality aversion parameter. In our research, we followed the NEF (2016) steps, and we adjust the Atkinson index as follows:

$$\mathrm{A}(\varepsilon) = 1 - \left(\frac{\bar{x}_g}{\mu} \right), \tag{3}$$

where $\bar{x}_g$ represents geometric mean and μ represents simple arithmetic mean of measured values. In our case, we consider time period 2011–17.

The Atkinson index is then used to calculate the inequality-adjusted life expectancy (*IALE*) and inequality-adjusted subjective well-being (*IASWB*) for each country. The *IALE* and *IASWB* is the mean of *LE* and *SWB* of residents of a country, adjusted to reflect inequalities. The basic formulas are as follows:

$$\text{IALE} = (1 - \text{Atkinson index for LE}) * \text{Mean LE}, \tag{4}$$

$$\text{IASWB} = (1 - \text{Atkinson index for SWB}) * \text{Mean SWB}. \tag{5}$$

In order to compare IALE which is reported in years and IASWB which is expressed in points, we had to balance the data. We applied a Z-score, which is designed to convert data so that they are comparable. We applied the standard score method to both variables, where we focused on a standard deviation, which was much lower in the case of SWB than in the case of LE, so without this adjustment the variable on LE would have a more significant effect on the AHPI calculation than SWB. To adjust this, we include the median from converted SWB values (from Z-score of SWB) as constant (α) to the final formula.[4]

Not every country has the same biocapacity, so it would be incorrect to take into account only the net indicator of the ecological burden as the ecological footprint (EF) variable. We calculate EF as the share of a country's ecological burden on total biocapacity:

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[3] Life satisfaction (subjective well-being) is given as an answer to the question: *„Please imagine a ladder with a number of steps from 0 to 10. The upper part of the ladder represents the best possible life for you and the lower part of the ladder the worst possible life. Which stairway would you say you are on?"*

[4] In our dataset, median value for SWB (α) presents –0.079.

$$EF = \frac{\text{Ecological burden}}{\text{Biocapacity}}. \tag{6}$$

The final *adjusted happy planet index* then can be expressed as:

$$AHPI = \left(\frac{IASWB - (\alpha * IALE)}{EF + \beta} \right). \tag{7}$$

As we mentioned above, unadjusted LE would significantly affect the whole result, so we multiplied IALE by α, and then we subtracted it from the well-being (IASWB), by which we ensure that each of these two variables contributes equally to the variance. Thus, the AHPI should be equally sensitive to changes in life expectancy as well as in subjective well-being, which would not be possible by only including IASWB*IALE. In denominator, we add the constant β. We take the constant β from the Global Footprint Network organization. Since we calculate AHPI only for the EU countries and not the world sample, we adjust the EF variable using constant β, which represents use of natural resources in Europe; the value 2.89 suggests that Europe uses resources for almost three planets. (Global Footprint Network, 2021).

For better visualization, we scale the results and provide target values from the interval 0 to 100. The performance, where the score of AHPI will be equal to 0 and 100, is obtained at min/max values of other variables, which correspond to the target values given by New Economics Foundation (2006) in their report. So, theoretically, the best performance of the AHPI is, when the indicator equals to 100 and can be reached when LE = 85, SWB = 10 and EF = 0. On the contrary, the worst performance of the AHPI (AHPI = 0) can occur when LE = 25, SWB = 0, and EF = 16.

Due to the fact that we work with spatial data, we supplement the common analyzes of the OLS type with analyzes developed for spatial data, namely the Moran's test and spatial models, through which we are also able to estimate the so-called, spatial spillovers. In spatial analysis, our goal is to determine whether the AHPI indicator is spatially dependent. Firstly, we calculate the spatial autocorrelation between values of AHPI in EU-28 countries. Spatial dependence reflects a situation where the values observed within one country depend on the values of the neighboring countries. To examine the existence of spatial relationships, we use Moran's I test for spatial autocorrelation. The aim of this test is to determine if the distribution of the observed variable (AHPI) is positively or negatively spatially correlated in the EU area, or if there is no spatial dependence between regions/countries.

Secondly, we analyze the spatial impacts of AHPI within the EU countries, by what we want to find out whether AHPI in a given country depends on the determinants of that country or also on the characteristics of neighboring countries. With spatial econometric models, our goal is to examine the extent to which the AHPI indicator is associated with economic growth, as well as other factors such as education (D'Acci, 2011), natural resources (Buhl et al., 2017), and CO_2 emission (DEFRA, 2011).

We start by estimating a simple OLS regression model to exploring the relationship between AHPI and GDP. In the next place, we estimate three spatial econometric models – Spatial Autoregressive Model (SAR), Spatial Error Model (SEM), and Spatial Lag of X Model (SLX). Subsequently, we extend the SLX model to create the Spatial Durbin Error Model (SDEM) and then, the most general Spatial Durbin Model (SDM). We consider the key model to be the one, which the tests indicate us the best, the results of this model are presented in the outputs. In the order we wrote about the models above, we express the following formulas for these models:

$$Y = \rho Wy + X\beta + \varepsilon, \tag{8}$$

$$Y = X\beta + \varepsilon; \varepsilon = \lambda W\varepsilon + u, \tag{9}$$

$$Y = X\beta + WX\theta + \varepsilon, \tag{10}$$

$$Y = X\beta + WX\theta + \varepsilon,\ \varepsilon = \lambda W\varepsilon + u\,, \tag{11}$$

$$Y = \rho Wy + X\beta + WX\theta + \varepsilon\,. \tag{12}$$

For all models, Y denotes the dependent variable, the parameter θ represents the autoregressive parameter, β represents the vector of regression coefficients, X is the matrix of explanatory variables, WX is spatially lagged explanatory variables and ε the error term. In all models, W presents the spatial weights matrix where we consider queen contiguity-base spatial weights. In this case, it does not matter on the length of the common border, since we consider countries to be neighboring when they have at least one common point. For SDEM (see Formula 11), λ expresses the spatial dependence, i.e., the spatial error coefficient and u is the error component. For SDM model (see Formula 12), ρ and θ represent spatial autoregressive coefficients and Wy spatially lagged dependent variable.

All model estimations in our research were performed using R and primary packages, e.g. "spData", "spatialreg", "sp". After estimating and comparing these models with each other, based on criteria as the highest Log Likelihood, the lowest AIC criterion and total p-value, we consider the optimal model, the SLX model, which we will work with in the main part of the article.

In Tables 1 and 2, we provide descriptive statistics for considered variables used as inputs for the calculation of AHPI for years 2012 and 2017. At the same time, we supplement table with GDP per capita, which we use in econometric analysis. We work with data that were available for the period from 2011 to 2017 for the 28 countries of the European Union.[5]

Table 1 Descriptive statistics for EU countries, 2012

	Min	Mean	Median	Max	S.D.	Target value
LE (years)	73.78	79.02	80.38	82.43	2.82	85.00
SWB (points)	4.22	6.19	6.12	7.56	0.93	10.00
GDPpc (PPS)	47.00	99.00	89.00	263.00	42.02	–
Biocapacity (gha)	0.33	3.17	2.28	12.97	3.11	–
EB (gha)	2.83	5.28	4.93	13.95	2.06	l.80
AHPI (points)	13.85	47.62	51.68	79.62	17.46	100.00

Note: Data for SWB are available for each 28 countries from year 2011. Data for ecological burden and biocapacity are available only till year 2017.
Source: Authors' calculations based on data from World Bank, Eurostat, Human Development Index, Global Footprint Network, and World Happiness Report

Table 2 Descriptive statistics for EU countries, 2017

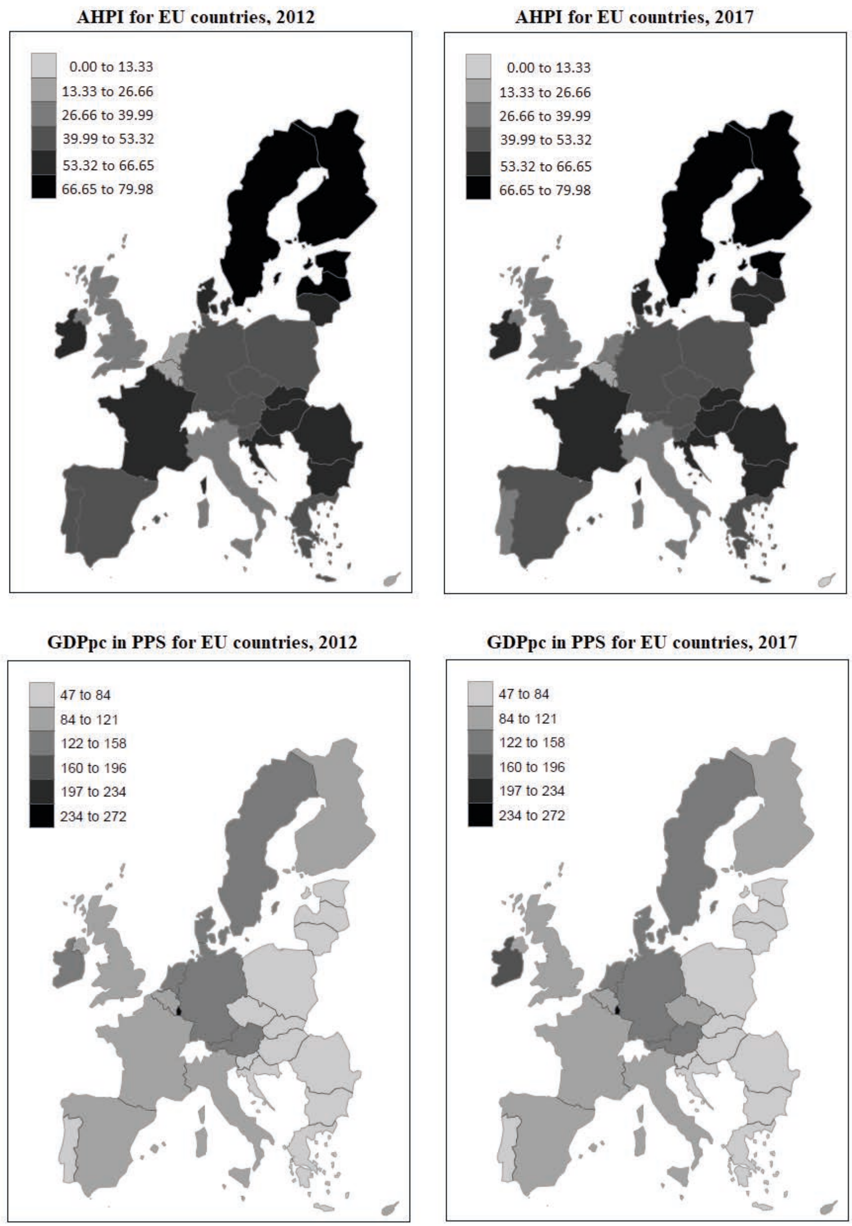
	Min	Mean	Median	Max	S.D.	Target value
LE (years)	63.29	79.88	81.14	83.28	2.80	85.00
SWB (points)	4.84	6.35	6.24	7.66	0.76	10.00
GDPpc (PPS)	50.00	101.00	92.00	263.00	42.87	–
Biocapacity (gha)	0.24	3.22	2.44	12.45	3.10	–
EB (gha)	3.40	5.26	4.81	12.79	1.81	1.80
AHPI (points)	10.15	47.63	50.38	79.80	17.76	100.00

Source: Authors' calculations based on data from World Bank, Eurostat, Human Development Index, Global Footprint Network, and World Happiness Report

5 Due to the Atkinson index, where the arithmetic and geometric mean are used in the calculation, and due to the unavailability of ecological footprint data after 2017 and well-being data before 2011, the calculations of AHPI are only possible for years 2012–2017.

The data are selected from several sources, namely from the World Bank, where we use data on LE reported in years or from Eurostat where we use GDP per capita in Purchasing Power Standards (EU-28 = 100). Ecological burden and biocapacity data, which are reported in global hectares per person (gha), are taken from the Global Footprint Network. The subjective well-being data are taken from World Happiness Report database.

Figure 1 AHPI and GDP per capita for EU countries – 2012, 2017



Source: Authors' calculations based on data from World Bank, Eurostat, Global Footprint Network, and World Happiness Report

3 RESULTS AND DICUSSION

In Figure 1, we depict values for our alternative indicator AHPI and traditional measure, GDP per capita in EU-28 countries. To illustrate time dimension, we compare year 2012 with year 2017 for which we have last available observations. Overall, we can observe a decreasing trend of the AHPI indicator in time. The AHPI reached the maximum of 79.62 points in 2012, while the maximum for 2017 was 74.62 points, in. Decrease of AHPI occurred is in countries such as France, Austria, Cyprus, Malta, Bulgaria and also the Slovak Republic.

Whereas Luxembourg presents the country with the highest GDP per capita among the EU-28 group, this country gains the second lowest value for AHPI. This situation can be explained by the ecological footprint of Luxembourg which is up to 9 times higher than its biocapacity allows. We can therefore expect that persisting economic growth of Luxembourg may have a negative effect on the environment which may later adversely affect the level of SWB of the population. On the other hand, we can observe countries which are economically strong and at the same time, achieve high AHPI scores – e.g., Sweden, Finland, or Denmark.

To examine the relationship between the AHPI and GDP per capita more closely, we firstly calculate a simple Pearson correlation which is available in Table 2.

Table 3 Correlation between AHPI and GDP per capita – 2012, 2017

	2012	2017
Correlation	–0.341	–0.305
t-value	–1.847	–1.631
p-value	0.076*	0.115

Note: Level of significance 0.1*, 0.05**, 0.01***.
Source: Authors' calculations based on data from World Bank, Eurostat, Global Footprint Network, and World Happiness Report

In Table 3, the relationship between the variables is statistically significant and negative for year 2012, so in this case, if one variable tends to increase (GDPpc), the other should decrease (AHPI) and vice versa. In the case of 2017, the values are not statistically significant, but there is an indication of a negative relationship. Similar results are provided by Campus and Porcu (2010) who analyzed the composite indicator HPI, as an alternative measure to GDP in assessing the welfare of countries. The authors do not find substantial correlation for analyzed 178 countries since HPI does not reflect the same reality as GDP. We can see that the correlation between AHPI and GDPpc in our sample is modest, almost unproven, which however, does not mean that there is no relationship between these variables. We therefore continue with the regression analysis and examine this relationship in detail. As mentioned, the correlation between these two variables is very weak, so it's possible that the AHPI indicator is also affected by other factors than just by GDP. Similar to study by D'Acci (2011) and study by DEFRA (2011), we decided to include other aspects, i.e., control variables – in particular, education, natural resources, and CO_2 emissions, and estimate the OLS regression. By doing this, we eliminate potential omitted variables bias. The variable education is defined as % of 20–24 years old students in tertiary education, natural resources as total natural resources rents (% of GDP), and CO_2 emissions reported as metric tons per capita. At the same time, there may be a certain limit for the level of GDP after which the AHPI decreases. We will now look at how this relationship between AHPI and GDP behaves with the addition of the control variables mentioned above.

After estimating the OLS model, we can notice that in both years, 2012 and 2017, the p-value is lower than the level of significance, so we can claim that this model is statistically significant. Based on the estimated GDPpc coefficient for year 2012 and 2017 in Table 4, we can see that GDPpc has a positive effect on AHPI, but the results are not statistically significant.

Table 4 Relationship between AHPI and GDP per capita – 2012, 2017 (OLS)

	Dependent variable: AHPI	
	2012	**2017**
Constant	17.015	12.474
	(22.548)	(19.807)
GDPpc	0.096	0.152
	(0.149)	(0.117)
Natural resources	8.648	39.275***
	(5.325)	(10.496)
Education	0.793	0.610
	(0.468)	(0.426)
CO_2	–1.490	–1.958
	(1.579)	(1.476)
N of observation	28	28
R	0.163	0.369
p-value	0.088*	0.005***

Note: Level of significance 0.1*, 0.05**, 0.01***.
Source: Authors' calculations based on data from World Bank, Eurostat, Global Footprint Network, and World Happiness Report

In addition to OLS, we will look at the results, where we work with models designed specifically for spatial data. These models also allow us to explore spillover effects. We contribute to the existing literature by estimating spatial models, which unlike simple OLS are more appropriate to use because of the character of our data. The economic development of individual EU countries is different due to the impact of climate change, historical differences, different approaches of government, etc. While in some countries the situation in terms of both GDP and AHPI is significantly better, there are countries that may face economic and social problems. There are countries that suffer significantly not only in terms of economic strength, but also because of poverty in then reflected in the health and overall well-being of the population. If we try to find out whether the community of EU countries is influenced by each other or whether there are neighborhood influences to increase/decrease the indicators, it is possible to estimate this using spatial econometric models. When monitoring AHPI, countries that are more developed or achieve higher AHPI scores can positively or negatively affect neighboring countries. By ignoring this, our results could be skewed.

Table 5 Moran's I test of AHPI

Year	Moran's I	p-value
2012	0.397	0.035**
2017	0.393	0.035**

Note: Level of significance 0.1*, 0.05**, 0.01***.
Source: Authors' calculations based on data from World Bank, Eurostat, Global Footprint Network, and World Happiness Report

Based on the calculated p-values from Moran's I (see Table 5), we claim that a statistically significant spatial autocorrelation exists. At the same time, in both cases the Moran index (I) was positive, which indicates a positive spatial autocorrelation. This means that the level of AHPI in one country has a positive effect on the level of AHPI in a neighboring country, in other words, if one country shows certain properties (values) from the AHPI indicator, it is likely that neighboring countries will show similar characteristics.

Based on the results, we claim that the variables are spatially autocorrelated, so in the final, it makes sense to estimate spatial models. As mentioned above, in order to avoid possible bias of the results, when estimating spatial models, we add three other determinants of AHPI to the relationship – education, natural resources and CO_2. At the same time, it is important to look at the direct and indirect effects of AHPI determinants. Based on the estimation of all models and on criteria such as Log Likelihood, AIC criterion and LR tests, we came to the conclusion that the most suitable model for our sample is the SDM model for year the 2012 and SLX model for year the 2017.[6]

Table 6 Estimation results – the SDM and SLX model

	Dependent variable: AHPI	
	2012 SDM	**2017 SLX**
Constant	24.790	6.851
	(15.521)	(17.172)
GDPpc	0.050	0.158
	(0.123)	(0.106)
Natural resources	2.417	21.964**
	(3.784)	(10.211)
Education	0.051	0.431
	(0.381)	(0.372)
CO_2	–2.043*	–3.033**
	(1.154)	(1.309)
Lag. GDPpc	0.338**	0.349***
	(0.140)	(0.123)
Lag. natural resources	15.384***	35.521***
	(5.894)	(12.193)
Lag. education	0.001	0.270
	(0.345)	(0.416)
Lag.CO_2	–4.643**	–4.470**
	(1.938)	(2.223)
AIC	231.625	225.780
Log likelihood	–104.812	–102.890
p-value	0.041**	0.001***

Note: Level of significance 0.1*, 0.05**, 0.01***.
Source: Authors' calculations based on data from World Bank, Eurostat, Global Footprint Network, and World Happiness Report

Based on the results provided in Table 6, we confirm that the final score of AHPI in a particular country depends not only purely on the values that are produced within that country, but also on the values of production in neighboring countries. At the same time, we can see that some estimates of coefficients are statistically significant, and therefore we can say, that these variables affect the total AHPI (negative/positive) in one, monitored country, as well as the level of AHPI in its neighboring countries. The advantage of the SLX model is that direct and indirect effects are already included directly in the model output. Direct effects are estimates of coefficients (β) and indirect effects are those related to spatially delayed explanatory variables (θ).

[6] We do not report in our research the spillover effects of SDM model, because they are similar to the spillovers of the SLX model (available upon request).

The spillover effects are positive for GDPpc, natural resources and in year the 2017 also education, which means that if these variables increase in one country, it will have a positive effect on AHPI in that country as well as in neighboring countries. The loss of natural resources can be caused by the fact that large companies consume huge amounts of water for their production, or e.g., by interfering with nature through further construction of buildings. If we look at the variable CO_2, we see that this variable shows negative values and is statistically significant. In the case of indirect effects, this means that an increase in carbon dioxide in a country will lead not only to a reduction in AHPI itself in that country, but also to a reduction in AHPI in neighboring countries.

Based on all the tests performed, taking into account the spatial correlation in explaining AHPI within the EU countries ultimately seems necessary and correct. If we did not take space into account for this indicator, we would lose information about the interdependence of countries. In our case, based on LR tests, it would be the best choice to choose the SDM model for the year 2012, and because that in year the 2017 is Rho coefficient statistically insignificant, the most suitable model for this year is SLX model. Spatial econometrics models have allowed us to take into account the spatial relationships of the AHPI, and at the same time it has been possible to find out that there are clusters of countries in the EU community that influence each other.

CONCLUSION

GDP indicator is increasingly criticized for its shortcomings and for the fact that it does not actually measure what really matters. On this basis, many alternative indicators have been developed that either want to complement or replace GDP, focusing mainly on environmental and social aspects. The aim of this paper was to construct such alternative indicator, the so-called the adjusted happy planet index (AHPI), which combines the environmental factor in form of the ecological footprint, the social factor in form of the average life expectancy, and finally, the subjective well-being.

We confirm spatial dependence among the EU-28 countries with regard to the AHPI, which means that AHPI in one country is affected by neighboring countries, and also affects the situation in these neighboring countries. To consider spatial dependences, we estimate spatial econometric models. For the observed year 2012, the most suitable model for our data sample is SDM and for 2017 the SLX model. The AHPI is mainly negatively affected by CO_2, i.e., the more carbon dioxide is released into the atmosphere, the greater the global warming, which results in a decrease of AHPI. Natural resources have positive impact of the selected variables on AHPI, so if the extraction of these resources were reduced, the Earth would have more resources at its disposal, which would have a positive effect on AHPI.

Increasing GDP is not the only factor that can result in an environmental crisis. The cause of environmental problems is not only companies that produce significantly more than in the past, but also the population itself, which pollutes the environment through its own activities, and which is not yet aware of the problems caused by climate change. Combining GDP with such indicators could reveal useful relationships between economic activity, environmental impact, and quality of life. One solution could be for governments to target the public as well, to make their citizens aware of the need to move towards sustainable growth and sustainable future. Technologies that do not cause damage to the environment could be introduced, on the contrary, renewable resources would be drawn. There are many other factors that can have a major impact on the environment, subjective well-being, or AHPI itself, for which a more comprehensive analysis is needed that can be further investigated.

ACKNOWLEDGMENTS

This work was supported by the Scientific Grant Agency VEGA under Grant No. 1/0394/21.

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