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## Can the Ecological Price Paid for Economic Growth be Cut

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### Abstract

*The ecological price of economic growth is a heavily debated issue, where ideologies often neglect factual information. In this paper, through the relationship of the ecological footprint and GDP, we're examining the tendencies of eco-efficiency in the first decade of the 21st century. We have concluded that the average ecological footprint intensity of the countries have improved significantly in the given period. In 2009, 50 percent less area was needed to produce a unit of GDP. Many countries could reach the so-called strong decoupling, meaning that in these countries, GDP increased while the ecological footprint decreased in absolute terms. Based on a scientific article published in 2004, and by updating its data, we managed to identify ecologically positive tendencies; in ten years, the average of the world's ecological footprint intensity has significantly improved, it halved in this period. The methodology was completed with the examination of the phenomena of decoupling; according to the results, in several countries, the GDP growth was accompanied by the reduction of the ecological footprint. This change is considered to be very positive because it means that the average of the eco-efficiency has greatly improved and 90 percent of the countries started to move forward to the direction of a more sustainable development. But as a word of caution we'd call attention to the limitedness of the applied method; sustainable development is still far from being realized. In many cases, the background of the apparent improvement is provided by money from oil producing, so usually success stories are backed by the growth of the ecological footprint, which actually appears in another country. According to our results, by substituting the rounded data into the IPAT formula: during the test period, the population increased by 13%, the GDP per capita increased by 110%, the intensity is reduced by 53%, resulting in a 12% increase of the environmental load. The study deals with the phenomena above, by showing the degree of decoupling of countries of the world.*

Keywords: GDP, IPAT, sustainable development, ecological footprint, economic growth

## 1. Introduction

The crisis of the developed world's financial markets forced the introspection of economics, which has been strongly criticized by the representatives of the alternative and heterodox schools, as well as the media, the general public and economic decision-makers (Bod 2013). The relations, contradictions or compatibility of economic growth and sustainable development can be seen as the most important questions to which theoretical answers and practical solutions must be found. One of the most well-known analyses on this issue can be found in the report to Club of Rome (The Limits to Growth) outlining a number of questionable scenarios for the mankind (Meadows et al., 2005). A detailed evaluation of the relationship between GDP, ecological footprint and happiness can be read in the article of Kocsis (2010), which estimating the effects and highlighting the consequences of different development approaches for Hungary. In our study, we're investigating the appearance of Jevons paradox and the compatibility of economic growth as well as the ways of reducing the ecological footprint. We would also like to also raise awareness of the dangers of a developing new trap.

## 2. Literature review

Traditional macroeconomic statistical methods are not able to treat the structural heritage of individual regions with a distinguished approach. For the measurement of spatial densification, as an indicator, inter alia, GDP is used, which can also show or hide significant regional differences (Szabo and Pintér, 2015). As a result of a number of criticisms, corrections have been made in the accounting system; one of the changes has been mainly made for the enumeration of illegal activities, which were integrated in the 2005 annual calculations. The rest of the changes are related to household activities (HCSO 2010). Gianetti et al. show that if mankind is concerned with the sustainable development of the planet as a whole, then progress indicators measured only in monetary or social terms are limited and restricted to the weak or the medium sustainability model, and must be complemented by biophysical indicators (2015). Despite of the corrections, a lot of criticism can be formulated in relation to financial-based indicators, but GDP can be still seen as a benchmark of economic analysis of the size and growth of the market (Kovács, 2014). In addition to the GDP, among other alternative indicators, ecological footprint index (hereinafter referred to as EF) stands out, by a number of researches highlighting its applicability, limitations and strategic importance (Csutora and Zsóka, 2011; Harangozó et al, 2015, Kerekes 2013). According to this concept, the EF indicator consists of six main categories of land use: cropland, grazing land, forest, fishing ground, built-up land and the land area required to absorb carbon dioxide emissions from use of fossil fuel. The EF takes into account the total use of different types of land, and by the use of Equivalence Factors (EQF), these will be converted to the world average, measured in standardized global hectares, by using a weighting system in order to take into account the fact that different types of land varying in terms of productivity. Because of the high multiplier of arable land, the actual and hypothetical land use structure is significantly different from each other. Between economic development and the size of ecological footprint, based on the correlation between GDP and EF, a significant correlation can be found (York et al., 2004). A correlation can be also observed at the micro level; the relationship between the income and the ecological footprint persists at the level of individual consumers; typically consumers with a lower-income have a smaller, while individuals with a higher income have a larger than average ecological footprint (Csutora, 2014).

The relationship between the impact on the environment and economic development can be described by the concept of the decoupling. By using it, the quantification of the qualitative

relations between the environmental impacts and economic activities would be made possible at national or regional levels, too. Decoupling is the rate of relative change of both environmentally and economically important variables that are in a relation of cause and effect. The growth of the variable, representing the environmental impact can be compared to the growth rate of GDP at macro or national levels, as well. The separation of environmental deterioration in the economic growth occurs when in a given period, the growth rate of the environmentally important variable is smaller than the GDP. Decoupling can be seen as strong (absolute), if the GDP shows the signs of growth, while the environmentally important variable does not increase or decreases. Decoupling can be seen as weak (relative), if the environmentally important variable is increasing, while it is lower than the growth rate of GDP (Szabó, 2006).

Theoretically, the increase of the size of the economy can be separated from the degree of the conversion of the biosphere, however, according to the ecological economics, in practice there are no evidences for this so far. In fact, based on the available empirical data, rather the opposite can be experienced (Stern, 2004). In the literature or political and public debates or in general, about sustainability, the perception of the role of innovation and technological change varies on a very wide scale. In some aspects, the principle of technological change makes it possible to move towards sustainability. However, according to others, technological change can be seen as the problem and not part of the solution (Bajmócy - Málovics 2011).

Jevons (1865) described the most well-known paradox of ecological economics in his book *The coal question*. Jevons observed that although the coal industry had become more efficient – thus it became possible to produce more volume of products per a unit of coal - the total coal consumption increased: "*It is wholly a confusion of ideas to suppose that the economical use of fuel is equivalent to a diminished consumption. The very contrary is the truth.. (...) As a rule, new modes of economy will lead to an increase of consumption*". According to York (2008), the reason for that, is that with a more efficient use of coal decreases the carbon cost of a product; as a result, there will be an increasing demand for coal, thereby other energy sources will be replaced, or invested in technologies utilizing coal.

Generally, savings gained by increasing eco-efficiency can almost never be fully realized. This can be particularly true for resources that are be widely used, and in case of a strong dependence, by the technologies related to them, the absolute resource consumption of the given resources or even the entire economy will be expected to actually grow. In terms of the rebound effect it can be also expected, that the increase of eco-efficiency alone is not sufficient enough to increase sustainability or in some cases, even the opposite effect will be triggered (Málovics and Bajmócy, 2009). Several observations confirmed that the specific increase of efficiency (such as the increase of eco-efficiency) will increase the transformation of the biosphere in absolute terms (Málovics, 2009). Sebestyén (2013) demonstrates that the rebound effect is an existing phenomenon, which can be observed in Hungary, too. Thus, the measures of energy efficiency will contribute to the savings of the available energy to a lesser extent than expected, in parallel with the increase of energy efficiency, energy savings and a limited use of energy should be pursued.<sup>1</sup> According to Tóth (2003), there are limitations to eco-efficiency (laws of thermodynamics), and it can be only increased to its potentials. With a growing population and consumption, they cannot be sufficient alone for the achievement of sustainable development.

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<sup>1</sup> It's also worth to consider the extent of not sufficiently utilized development that can be explained by the legal and institutional environment. The strength of various lobbies affecting legislation can be found in the study of Pinter (2014).

Figge et al. (2014) develop an 'Eco-efficiency-sufficiency matrix' to logically order eco-efficiency and sufficiency measures to attain lower resource consumption and emissions.

The popularity of this topic is shown by several studies (Alcott, 2005; Missemer, 2012; Schneider, 2010; Sorrel, 2009), and books (Polimeni et al., 2008), describing the manifestations and the validity of the Jevons Paradox and the rebound effect, and possible solutions for them. The studies are typically examining the issue from the aspect of energy saving - energy efficiency (Sebestyén 2013), but it could be also verified by the example of water consumption (Dumont et al., 2013). The Jevons paradox was mentioned by Daly (2013) among the major discrepancies related to economic growth. According to Jaeger (1995), Jevons's theory also shows the different point of views of economists and environmentalists formulated on the issues of sustainability and economic growth. The study of Bunker (1996) reveals that the global economy has been showing a significant improvement in terms of resource efficiency for a long time (natural resources per unit of economic output), the total resource consumption of the global economy, however, continues to grow. Similarly, York et al (2004) showed that at the levels of nations, financial abundance of economies is associated with both larger ecological footprint per capita (per unit "ecological footprint" GDP release) and higher eco-efficiency per capita. This suggests that the empirical conditions of the Jevons paradox could often be used at higher levels.

Sustainability issues are typical phenomena of the modern age; while members of traditional societies are directly confronted with the consequences of their actions, in order to learn the environmental impacts of processes taking place in their environs, people of the 21st century need to be aware of statistics and reports (Lazányi, 2010). However, with the changes of processes, the everyday people of the modern age are forced to face the changes of the environment of i.e. the changes in the weather, which is a result of climate change, as well. The effects of climate change also affect daily business processes, such as the distribution logistics in the delivery of goods (Kovács and Pató, 2014). One of the central issues of sustainability is the harmonization of the dynamics of economic systems with the ecological systems (York, 2008). The improvement of eco-efficiency can be a solution for this, which means that the value added would increase, while the intensity of the use of resources would decrease, i.e. the increase of resource efficiency would be achieved by realizing business benefits at the same time (Szabó, 2006). The increase or decrease of the economy' size is rarely considered as an end in itself, so it can hardly be argued that the improvement or the deterioration of eco-efficiency should be merely considered to be good or bad. The experts of sustainability often welcome the improvement of eco-efficiency, however its causes are so complex that without further information it cannot be seen as an improvement under all circumstances (Kocsis, 2012).

According to Kerekes, the improvement of eco-efficiency is partly a result of price competition. Everyone is trying to produce their products more cheaply. This provides a demand for new industries and service providers and in this sense, plays an important role in economic growth. In a sense, it can be also seen as a paradox, because as a result of improvement of eco-efficiency improvement, the growth of GDP should slow down, but in reality, instead of slowing down, the growth has been accelerating. The improvement of eco-efficiency could lead to changes in GDP growth in a favorable way, if savings from eco-efficiency improvement would be spent on structural growth. (Kerekes, 2012).

### 3. Materials and methods

The so-called IPAT formula (1) could serve this purpose by providing a widely known and clear analytical framework, developed for the concept of eco-efficiency. Since its original form, the context (Ehrlich - Holdren 1971) described for more than forty years had a considerable impact on the international (Alcott 2005) and the Hungarian literature, as well (Takács-Sánta 2008, Kocsis 2010).

The formula is as follows

$$(1) I = P \times A \times T$$

I = impacts of human activities on the natural environment,

P = population,

A = economic output per capita,

T = technology, indicating the impact of production of economic goods on the environment (Bajmócy and Málovics, 2011).

One of the most complex factor of the IPAT formula is the variable of technology (T); it can be only quantified indirectly by knowing the other three elements of the formula. The way we determine the impact (I) also affects the way we interpret the factor of technology (T). Currently, the most common index of impacts is ecological footprint, so it (T) can be calculated on this basis (Kocsis, 2010). GDP is the most often used index for the measurement of economic performance and regionally differentiated development (Borzán, 2015). One of the main objections against this index is that it judges all kinds of economic activities the same way, regardless of their effects on the consumption or their social usefulness (Márki-Zay, 2005). The economic subsystems are not all-powerful or unlimited, and if we forget about these, we can encounter devastating social and ecological consequences. Thus, the linkage of various data (macro-economic, government, etc) to the GDP can result in a lot of distortion (Csiszárík-Kocsir and Medve, 2015).

The article of York et. al. with the title of “The Ecological Footprint Intensity of National Economies” was published in 2004 in the Journal of Industrial Ecology. The authors – based on theories industrial ecology, ecological modernization theory and the environmental Kuznets curve - examined the question of whether technical development could actually take to the supposed absolute improvement of the environment. On the basis of the GDP of 1998 and the ecological footprint data of 1999, they examined the EF intensity of countries, covering 97 percent of the world’s population in their statistical analysis (139 countries). The article received a large number of citations, and the interest in the topic has increased continuously since then<sup>2</sup>. Ten years later, since the GDP and EF data are available from 2009, it is worth examining the medium-term trends.

Thus, following the research of York et al. (2004), 10 years after the first examination presented by authors, we were interested whether a high level of national GDP per capita would be associated with both large ecological footprint and an improvement in eco-efficiency. The

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<sup>2</sup> The Google Scholar alone has 90 registered citations (read: on 13.03.2015.).

relationship between GDP and EF were examined using scatter plot charts (Figure 1 and 2) for both years. After examining the distribution, Pearson's correlation coefficient ( $r$ ) was calculated, the  $r$  squared values were indicated in the figures.

For the research, the data table of The Global Footprint Network, (hereinafter: GFN) edited in 2014 was used, which includes the values of the ecological footprint data for each type of land use categories for each countries in the year 2009. The database contained information for 154 countries. The GDP data per capita, calculated in purchasing power parity came from the database of the World Bank, which - along with the summary rows - contained data for 222 countries for the year 2009. For such a large database, the creation of a multi-dimensional model for the illustration of the problem could also come up, however, since the data were homogeneous, the research did not require that (Pató, 2014).

#### 4. Results and discussion

Intensity indicators are widely used for comparative economic analyses of countries or a group of countries (Török, 2006). The intensity of the ecological footprint was calculated by dividing the EF values (converted into global square meters of land) by the GDPs (calculated in dollars and purchasing power parity) for each countries, and they are denoted by  $T$ , with a unit of measurement of global square meters / dollar. York et al (2004) found that countries with low EF intensity can be characterized by high eco-efficiency. The ratio were calculated for 143 countries, because many countries did not give the EF data. In the research of York et al. (2004) the data of 139 countries were studied, the data for two years could be found for 131 countries. The reference numbers in the study apply to the 131 comparable countries, the median of the intensity for the 2009 data were calculated from the data of 154 countries. The basic data of the research is summarized in Table 1.

Table 1.

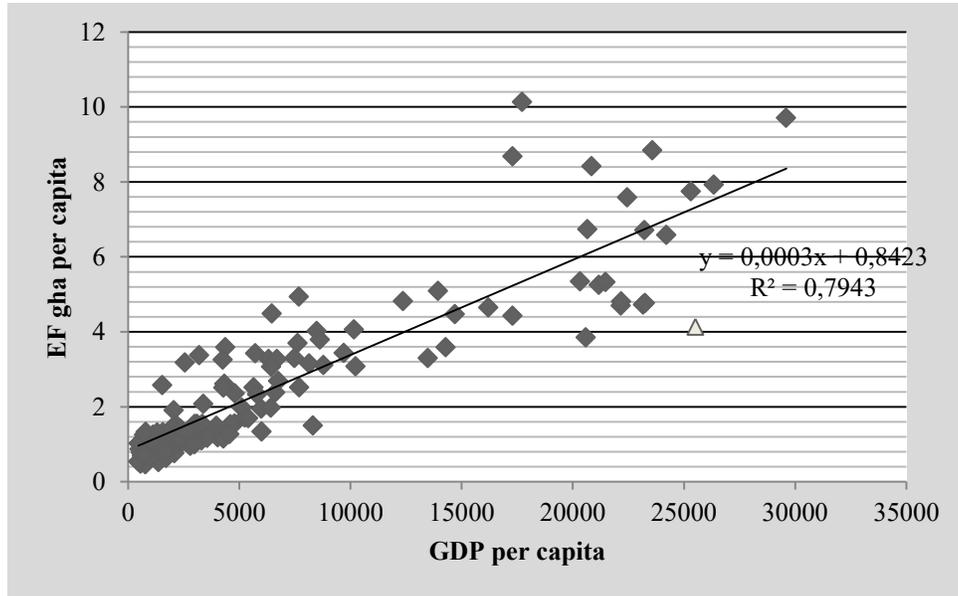
	<i>York et al (2004)</i>	Present research
GDP data	139 countries (1998)	222 countries (2009)
EF/ GDP ratio ( $T$ )	139 countries	143 countries
$T$ median ( $M_d$ )	4.86	2.27
Average GDP (dollar per capita)	6920	14588

Source: YORK et al (2004); GFN (2014), World Bank (2015)

#### 4. Results and discussion

Examining the relationship between GDP and EF, we can see that countries with higher-incomes typically tend to have a larger size of the ecological footprint per capita. In both years, we found countries that significantly differed from the average, featuring low ecological footprints combined with high GDPs. In figures 1 and 2, the gray triangle symbolizes Switzerland; in Figure 2 the white quadrant symbolizes Norway.

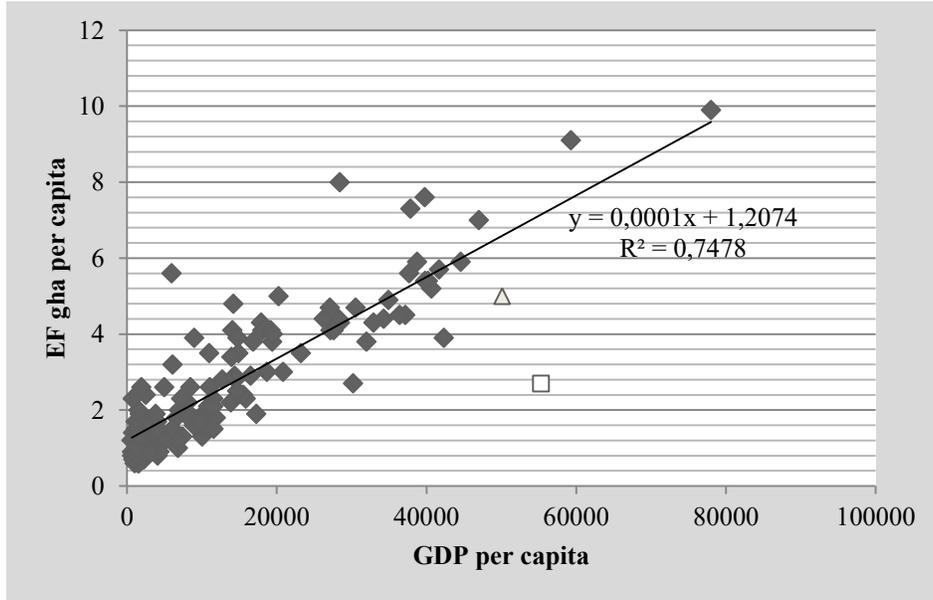
Figure 1:  
GDP and ecological footprint of countries in 1999<sup>3</sup>



Source: YORK et al (2004); World Bank (2015)

<sup>3</sup> The 1998 GDP and 1999 EF data are hereinafter referred to as the 1999 data.

Figure 2:  
GDP and ecological footprint of countries in 2009



Source: GFN (2014), World Bank (2015)

Searching for the reasons from divergence from the general tendency, we examined the degree of decoupling. Table 2 contains the data of 10 countries with the largest footprint intensity. The data rows of the year 1999 are taken from the study of York et. al., while the 2009 data are derived from our calculations. For the intensity of the ecological footprint we consider it to be favorable, if the ratio is as low as possible, meaning that a smaller land is required for the production a unit of GDP.

Table 2.

Ten countries with the lowest EF / GDP ratio and the EF intensity and GDP of Hungary in 1999 and 2009

Ranks	Countries	1999			Ranks	Countries	2009		
		T	T/Md	GDP (\$/pc)			T	T/Md	GDP \$/pc
1	<b>Switzerland</b>	1,62	0,33	25512	1	Norway (22)	0,49	0,22	55297
2	Mauritius	1,81	0,37	8312	2	New Zealand (75)	0,89	0,39	30236
3	Italy	1,87	0,38	20585	3	Saudi Arabia (52)	0,92	0,41	42324
4	<b>Austria</b>	2,04	0,42	23166	4	<b>Switzerland (1)</b>	1,00	0,44	50107
5	<b>Japan</b>	2,05	0,42	23257	5	Cuba (46)	1,10	0,49	17280
6	<b>Germany</b>	2,12	0,44	22169	6	<b>Japan (5)</b>	1,19	0,52	31994
7	Netherlands	2,17	0,45	22176	7	<b>Germany (6)</b>	1,21	0,53	37209
8	Columbia	2,23	0,46	6006	8	United Kingdom (14)	1,24	0,55	36422
9	Korea, Republic of	2,45	0,5	13478	9	Kuwait (24)	1,27	0,56	78013
10	France	2,48	0,51	21175	10	<b>Austria (4)</b>	1,28	0,56	40679
20	Hungary	3,01	0,62	10232	21.	Hungary (20)	1,44	0,63	20879

Source: York et al (2004); GFN (2014), World Bank (2015)

In the top ten list from 2009 only four countries (Switzerland, Japan, Germany and Austria) are present, which were among the countries with the best EF intensity in 1999. The degree of rearrangement can be seen as high; in the column of 2009, next to the name of the country, a number shows their position on the list from 1999. It can be seen that New Zealand, found in the second trimester in the data rows from 1999, was among the top ten countries in 2009. On the list of showing the results of 131 countries, Hungary was the 21st in 1999, and 20th on the list in 2009. Each of the countries showed the signs of decoupling, since the EF variable has a lower growth rate than the GDP's. Strong decoupling could be observed for 6 countries, where the GDP was growing, while the environmentally important EF remained to be unchanged or even

reduced. The column of the EF change in Table 3 shows that actual ecological footprint reduction could be found in three countries (Norway, New Zealand, Japan, and United Kingdom). Decoupling can be seen as weak (relative), if the environmentally important EF variable's value is increasing, while it has a lower growth rate than the GDP. In other countries (Cuba, Switzerland, Austria and Kuwait) the improved results can be traced back clearly to the strong growth of GDP. In case of Hungary, also has a strong decoupling can be found, the growth of GDP was accompanied by a decrease in the value of the EF index; from this point of view, the direction of the development can be seen as better than in the neighbor country, Austria, which belongs to the most eco-efficient countries. Our country is in the best position among the Visegrad countries in terms of eco-efficiency (in 2009, Slovakia was the 26th the Czech Republic 41st, Poland had the 60th position in that list).

It is worth to consider the other end of the list, to see the least eco-efficient countries. Typically, poor African countries have the worst intensity indicators (Table 3). In these countries, GDP per capita was very low, sometimes having a value which is lower than a thousand of dollars / person. There is also a concern that the difference between the countries having the best and worst situation is growing. In 1999, the T ratio of Tanzania was thirteen times more than the T indicator of Switzerland which was in the best position, while this difference between Niger and Norway was sixty-fold in 2009.

Table 3.

The EF intensity and GDP of countries with the ten highest EF / GDP ratio in 1999 and 2009

Ranks	Countries	1999			Ranks	Countries	2009		
		T (gnm/\$)	T/Md	GDP (\$ per capita)			T (gnm/\$)	T/Md	GDP \$ per capita
122	Burkina Faso	13,56	2,79	870	122	Malawi	11,59	5,12	690
123	<b>Ethiopia</b>	13,63	2,8	574	123	Uganda	12,26	5,41	1224
124	<b>Niger</b>	15,55	3,2	739	124	<b>Ethiopia (123)</b>	12,57	5,55	955
125	Rwanda	16,09	3,31	660	125	<b>Mali (129)</b>	12,74	5,62	1570
126	Malawi	16,68	3,43	523	126	Burundi	12,86	5,68	700
127	Nigeria	16,69	3,44	795	127	Papua New Guinea	13,41	5,92	1938
128	Mongolia	16,72	3,44	1541	128	Guinea	14,71	6,49	1156
129	<b>Mali</b>	16,81	3,46	681	129	Central African Republic	16,79	7,41	834
130	Zambia	17,49	3,6	719	130	Liberia	19,29	8,51	622
131	Tanzania	21,44	4,41	480	131	<b>Niger (124)</b>	29,47	13,01	780

Source: York et al [2004]; GFN [2014], World Bank [2015]

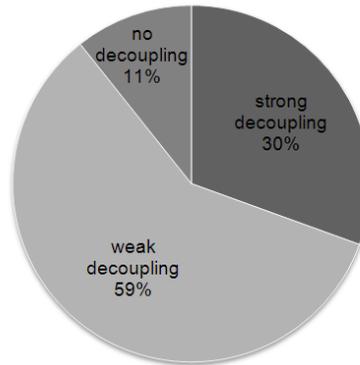
Table 4:  
Decoupling in the most and least eco-effective countries and in Hungary

Countries	The change of GDP (%)	The change of EF <sup>4</sup> (%)	Cross-national variation
<b>Norway</b>	110	-66	strong
<b>New Zealand</b>	75	-69	strong
Saudi Arabia	317	-4	strong
Switzerland	96	21	weak
Cuba	336	28	weak
<b>Japan</b>	38	-20	strong
Germany	68	-4	strong
<b>United Kingdom</b>	79	-16	strong
Kuwait	208	28	weak
Austria	76	10	weak
Hungary	104	-3	strong
<b>Malawi</b>	32	-8%	strong
<i>Uganda</i>	14	42%	none
<i>Ethiopia</i>	66	53%	weak
<i>Mali</i>	130	75%	weak
<i>Burundi</i>	23	88%	none
<i>Papua New Guinea</i>	-18	83%	none
<i>Guinea</i>	-35	40%	none
<i>Central African Republic</i>	-25	12%	none
<i>Liberia</i>	-26	32%	none
<i>Niger</i>	6	100%	none

Source: York (2004), GFN (2014), World Bank (2015)

<sup>4</sup> The EF values of the calculation were not included in the article of York et al. (2004) (however these values can be calculated from the intensity values). The national ecological footprint values are continuously adjusted by the GFN retroactively, so there may be differences between the calculated values and the currently available time-series data sets of GFN (2012). In the cited article the GDP data for 1999 was compared to the 1998 EF data.

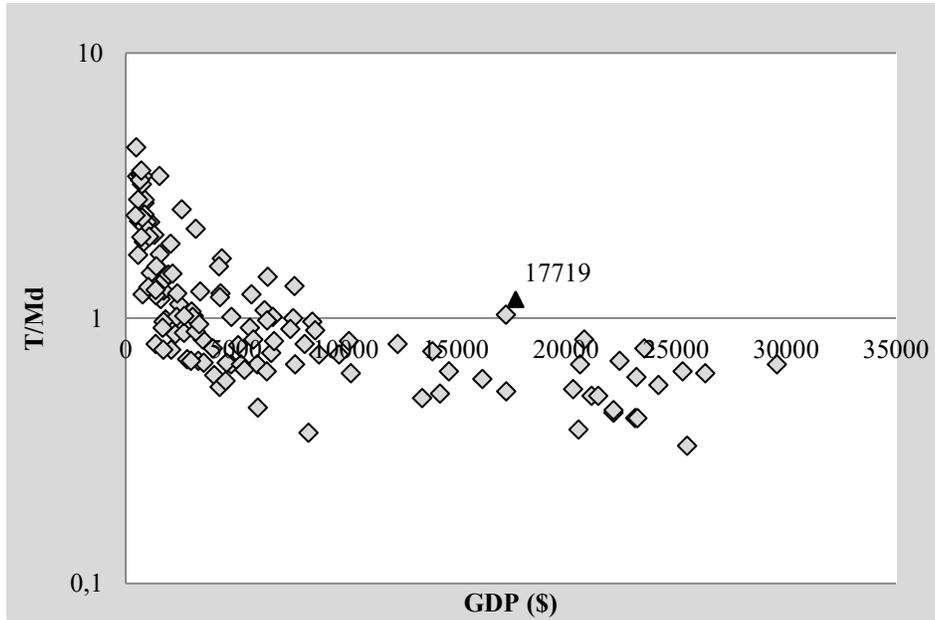
Figure 3: Distribution of the cross-national variations



Source: own calculations

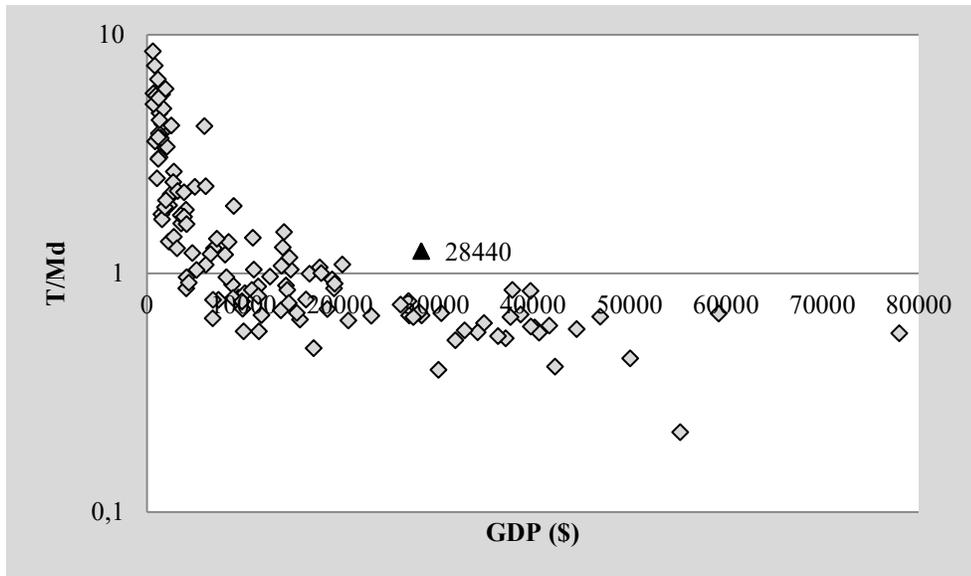
The intensity data of 131 countries is shown in the coordinate system (Figure 4 and 5). The horizontal axes show the GDP per capita values, the values of the vertical axis represent the intensity data weighted by the medians. The osculation of the vertical axis is set to 1, so the 50 % of the countries with higher eco-efficiency can be found below the axis, while countries with lower eco-efficiency can be seen above the axis. Table 1 shows that the value of the median has halved in the last ten years, i.e. the ecological footprint intensity significantly improved (decreased) in the countries of the world. Figure 4 and 5 shows that there are countries with favorable and unfavorable eco-efficiency among poorer ones; however all countries with higher GDP can be found in the favorable part of the coordinate system. High GDP was defined as GDP per capita in countries with ecological footprint intensity with a value of less than 1. This border is represented by the black triangles in both figures, with a value of \$ 17,719 in 1999, while in 2009 this value was \$ 28,840. During the examination of individual customers, Csutora (2014) came to similar conclusions; the "brown" (environmentally uninterested) groups of consumers are not present among high-income families. These brown consumers seem to disappear above a monthly net income of 350 thousand HUF, which indicates that higher-income families can be considered to be environmentally more conscious, or at least to have an average willingness to act in the field of environmental protection.

Figure 4:  
EF intensity (1999)



Source: YORK (2004)

Figure 5 :  
EF intensity (2009)



Source: GFN (2014), World Bank (2015)

Table 4 shows the details of countries with high GDP and highlighting the ten most eco-efficient countries (Table 2). There were 7 countries in 1999 among the 18 countries with the highest GDP, which were also featured among the most eco-efficient ones. In 2009, nine of the 24 richest countries can be seen as prominent in terms of eco-efficiency. The ranks in Table 5 show the top 10 EF intensity ranks (Table 2).

Table 5.

## The world's richest countries

		1999			2009				
		T	T/Md	GDP			T	T/Md	GDP
	USA	3,28	0,67	29602	9.	<b>Kuwait</b>	1,27	0,56	78014
	Norway	3,01	0,62	26342		United Arab Emirates	1,53	0,68	59291
1.	<b>Switzerland</b>	1,62	0,33	25512	1.	Norway	0,49	0,22	55297
	Kuwait	3,06	0,63	25314	4.	<b>Switzerland</b>	1,00	0,44	50107
	Denmark	2,72	0,56	24218		USA	1,49	0,66	47001
	Canada	3,75	0,77	23582		Netherlands	1,32	0,58	44576
5.	<b>Japan</b>	2,05	0,42	23257	3.	<b>Saudi Arabia</b>	0,92	0,41	42324
	Belgium	2,89	0,6	23223		Ireland	1,37	0,60	41710
4.	<b>Austria</b>	2,04	0,42	23166	10.	<b>Austria</b>	1,28	0,56	40679
	Australia	3,38	0,69	22452		Australia	1,34	0,59	40209
7.	<b>Netherlands</b>	2,17	0,45	22176		Sweden	1,36	0,60	39819
6.	<b>Germany</b>	2,12	0,44	22169		Denmark	1,91	0,84	39774
	Ireland	2,48	0,51	21482		Canada	1,52	0,67	38745
10.	<b>France</b>	2,48	0,51	21175		Belgium	1,93	0,85	37883
	Finland	4,04	0,83	20847		Finland	1,49	0,66	37688
	Sweden	3,26	0,67	20659	7.	<b>Germany</b>	1,21	0,53	37210
3.	<b>Italy</b>	1,87	0,38	20585	8.	<b>United Kingdom</b>	1,24	0,55	36422
	United Kingdom	2,63	0,54	20336		France	1,40	0,62	34942
						Italy	1,28	0,57	34299
						Spain	1,31	0,58	32931
					6.	<b>Japan</b>	1,19	0,52	31994
						Greece	1,54	0,68	30544
					2.	New Zealand	0,89	0,39	30236
						Korea, Republic of	1,51	0,67	28481

The world's largest producers of crude oil, like Saudi Arabia, Kuwait (11) and Norway (13) can be found among the most eco-efficient countries, as well as largest big oil consumers, too, like Japan (3) Saudi Arabia (7) and Germany (8).

Table 6.:

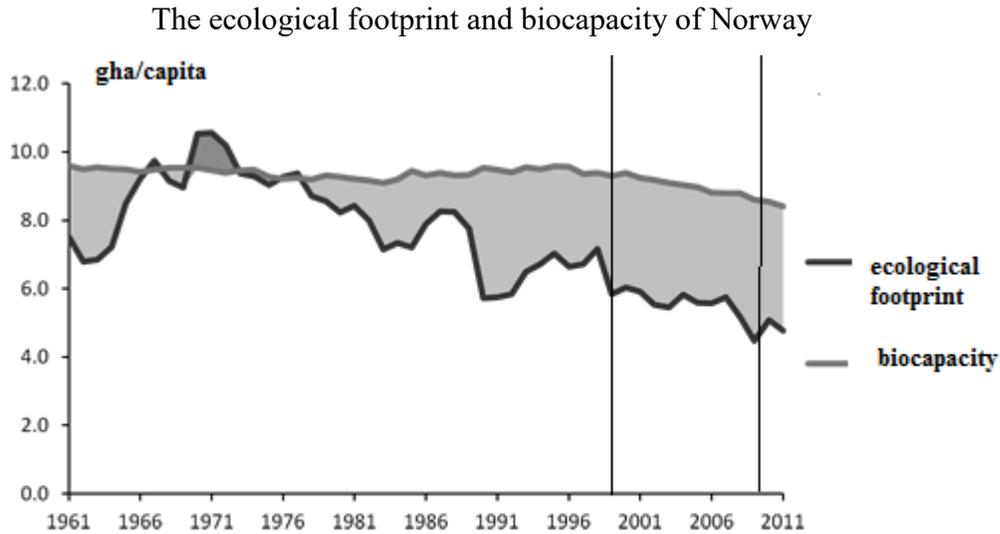
The World’s most eco-efficient countries among the major oil producers and consumers

The most eco-efficient countries of the world (2009)	Their ranks on the list of the largest oil producers’ list (2009)	Their ranks on the list of the largest oil consumers (2009)
Norway	13.	53.
New Zealand	56.	66.
Saudi Arabia	1.	7.
Switzerland	100.	47.
Cuba	63.	60
Japan	46.	3.
Germany	44.	8.
United Kingdom	51.	14.
Kuwait	11.	36.
Austria	71.	46.

Source: US Energy Administration (2014)

The case of the most eco-efficient country (Norway) has been proven to be a clear success story. In 2009, among 178 countries, it been ranked as the tenth best country according to the EPI ranking, reaching 77.81 points. By currently having 78.04 points and 10<sup>th</sup> place in the ranking, it has retained its position, among the political domains, it has an outstanding (100 points) situation in terms of child mortality and access to water. The quality of the air also scored well (98.83 points). Problematic areas are the forestry (32.52 points), fishing (20.08 points) and agriculture (46 points). In terms of agricultural policy, it was ranked among the last countries (161. from 178). The climate policy of the country, strongly affecting its ecological footprint (75.65 points) received the 10 best scores (Yale – Columbia, 2014).

Figure 6.:



Source: GFN (2014)

The size of the carbon footprint of Norway was continuously and significantly reduced during the examined and for a longer period, too. The country was able to meet the emerging needs (Figure 6) within the ecological framework of its own (biocapacity). Producing and exporting crude oil can serve as the economic basis for the excellent environmental policy, the decrease of the environmental impact and the improving eco-efficiency which contributes to the growth of other countries' carbon footprint. This observation draws the attention to a new trap situation; the improvement of eco-efficiency, the avoidance of the Jevons paradox that in itself cannot guarantee that the development will actually start in a more sustainable direction. In the background of the favorable trends in Norway, together with the carbon footprint, the export of oil also appears.

## 5. Conclusions

The correlation between GDP and EF was found to be stronger than moderate in both years; in higher-income countries the ecological footprint is usually also higher. This conclusion is supported by the results of our previous studies (Szigeti et al 2013, Szigeti- Tóth 2014) and by the literature York et al. (2004) as well. This correlation can be observed on the level of individual consumers, too (Csutora, 2014).

It can be considered as a favorable trend that in the studied ten years, the average of the world's ecological footprint intensity significantly decreased; in 1999 4.86 global square meter was required for the production of \$ 1, while in 2009, this area was only 2.27 global square meter. This change is considered to be highly positive because it means that the average eco-efficiency improved.

There are a number of countries among the most eco-efficient ones in which a strong decoupling occurred. Norway and New Zealand stands out among them, since in these countries the GDP growth was accompanied by a significant decrease of the EF. During this period, in more than

30% of the studied countries, a strong decoupling occurred while in nearly 60% of them a weak decoupling could be found, which shows that nearly 90% of the countries moved towards a more sustainable direction of the development.

It is important to take into consideration the sources of the eco-efficient developments in each country. As one of the world's biggest oil-exporting countries, Norway can be presented as a positive example; the extraction and distribution of the large amounts of fossil fuel contributes to the growth of the global carbon footprint, even when the consumption clearly shifted in a positive, sustainable direction in the examined period. This observation is an important methodological problem, which calls attention to the used analytical framework, which should be complemented by examining the resources of the development.

Despite of the favorable trends, it gives a cause for caution that the limit of the positive (lower than 1) ecological footprint intensity increased from \$ 17.7 thousand to 28.4 thousand dollars. In some countries, weak decoupling means the growth of the environmental footprint (EF), which couldn't be seen as a step forward to an absolute level, only to a certain proportion of the GDP ratio. By substituting the rounded data into the IPAT equation, we can see that between 1999 and 2009 the population increased by 13%<sup>5</sup>, the GDP per capita increased by 110% and the intensity is reduced by 53%, which represents a 12% increase in the environmental load. In several countries (Saudi Arabia, Kuwait, Norway), the background of eco-efficient innovations is the income from fossil fuels, which causes an increase of the ecological footprint in oil importing countries.

There is a concern that the improvement of eco-efficiency will increase the disparity between countries having the best and worst situation. In reality, a sustainable direction of development is only possible for developed countries. The fundamental question for African countries is whether they can start in the right development directions in the coming decades or not.

## **6. Limitations and Need for Further Research**

During our research we studied the results of two years, from which long-term and general conclusions cannot be drawn. The trend of change can be seen as positive, but the results still need to be clarified in terms of the examination of other time frames and intervals.

Being an abstract index-number, GDP – in spite of the applied purchasing power parity - cannot completely eliminate the different price and wage situation of countries. We can conclude that although in richer countries the eco-efficiency is higher, but this also is partly due to the higher denominator (GDP). It would be more correct to compare the carbon footprint data to the given natural units of production, instead of their monetary values. On the one hand, this data are not available, on the other hand, to ensure comparability, we followed the methodology of the original article of York.

Presumably, in less developed countries, basic needs (agriculture and industry) make up a much larger share of GDP serves than the production of luxury goods and services. The overall picture, by using the provided data, is distorted by the different contribution of the primary, secondary and tertiary sectors to the GDP. Speculation can also not be filtered out, i.e. one hectare of biologically productive land area can not necessarily produce more, however, our ability of selling the products at better prices, generating more cash value and by selling the products more

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<sup>5</sup> Calculated at 6 billion people in 1999 and 6.8 billion people in 2009.

times also improved. The general enrichment increased the consumption everywhere, e.g. the emergence of the oil wealth of Arab countries in the GDP clearly cannot be called ecologically sustainable.

## References

- Alcott, B., 2005. Jevons' paradox. *Ecological Economics* 54 (2) 9 – 21.
- Bod Péter Á., 2013. Heterodox gazdaságpolitikák korszaka? [Era of heterodox economic policies?] *Közgazdaság* 2013(2) 89-101.
- Bajmócy Z., Málovics Gy., 2011. Az ökológiai hatékonyságot növelő innovációk hatása a fenntarthatóságra. Az IPAT formula dinamizálása [The effect of eco-efficiency increasing innovations on sustainability. Dynamization of the IPAT formula]. *Közgazdasági Szemle*, 890–904.
- Borzán, A., 2015. "Nyugat és Kelet", avagy Románia területi differenciáltsága [„West and East”, or the regional differences in Romania]. *Journal of Central European Green Innovation* 3:(1) 81-96.
- Bunker, S. G. 1996. Raw material and the global economy: Oversights and distortions in industrial ecology. *Society and Natural Resources* 9, 419–429.
- Csiszárík-Kocsir, Á., Medve, A., 2015. Germany sneezes, Hungary catches a flu – Is it true?, MEB 2015 – 13th International Conference on Management, Enterprise and Benchmarking - Proceedings, Budapest, 2015. május 29-30., Óbudai Egyetem
- Csutora, M., 2014. Összegződnék-e az egyéni törekvések? A cselekvés és az eredmény közötti szakadék problémája [Do the individual efforts add up? Problem of the gap between the action and the result]. *Közgazdasági Szemle*, 609–625.
- Csutora, M., Zsóka, Á., 2011. Maximizing the Efficiency of Greenhouse Gas Related Consumer. *Policy Journal of Consumer Policy* 1., 67-90.
- Daly, H., 2013. A further critique of growth economics. *Ecological Economics* 88., 20–24.
- Dumont, A., Mayor, B., López-Gunn, E., 2013. Is the rebound effect or Jevons paradox a useful concept for a better management of water resources? Insights from the irrigation modernisation process in Spain. *Aquatic Procedia* 1., 64 – 76.
- Ehrlich, P. R., Holdren, A. H., 1971. Impact of Population Growth, *Science*, 171 (3977) 1212–1217.
- Figge, F., Young, W., Barkemeyer, R. 2014. Sufficiency or efficiency to achieve lower resource consumption and emissions? The role of the rebound effect. *Journal of Cleaner Production* Vol. 69, 216–224.
- Giannetti, B.F., Agostinho, F., Almeida, C.M.V.B., Huisingh, D. 2015. A review of limitations of GDP and alternative indices to monitor human wellbeing and to manage eco-system functionality. *Journal of Cleaner Production* Vol. 87, 11-25.
- Global Footprint Network, 2012. National Footprint Accounts, 2011 <http://www.footprintnetwork.org>
- Global Footprint Network, 2014. National Footprint Accounts, 2012 Edition. <http://www.footprintnetwork.org>.
- Harangozó, G., Széchy, A., Zilahy, G. 2015. Corporate Sustainability Footprints – A Review of Current Practices. In: Schaltegger, Zvezdov, Alvarez, Csutora, Günther (eds.) (2015): *Corporate Carbon and Climate Accounting*. pp. 45-76. Springer International Publishing, Cham.

- Jaeger, W. K., 1995. Is sustainability optimal? Examining the differences between economists and environmentalists. *Ecological Economics* 15., 43-57.
- Jevons, W. S., 1866. *The Coal Question. An Inquiry concerning the Progress of the Nation, and the Probable Exhaustion of our Coal-mines.* London, Macmillan and Co., 2. edition 5.08.2014. [http://oll.libertyfund.org/?option=com\\_staticxt&staticfile=show.php%3Ftitle=317&Itemid=27](http://oll.libertyfund.org/?option=com_staticxt&staticfile=show.php%3Ftitle=317&Itemid=27)
- Kerekes S., 2012. A fenntartható fejlődésről válság idején. Fenntartható fejlődés, élhető régió, élhető települési táj 1. Budapesti Corvinus Egyetem, Budapest, 15-36. o.
- Kerekes, S., 2013. Happiness, environmental protection and market economy. *Society and Economy* 33, 1, 5-13.
- Kocsis, T., 2010. „Hajózni muszáj!” A GDP, az ökológiai lábnyom és a szubjektív jóllét stratégiai összefüggései["We have to sail!" The strategic contexts of GDP, ecological footprint and subjective well-being. ]. *Közgazdasági Szemle*, 57. évf. 6. sz. 536–554. o.
- Kocsis, T., 2012. Looking through the dataquadrant: characterizing the human–environment relationship through economic, hedonic, ecological and demographic measures *Journal of Cleaner Production* Vol 35, 1-15
- Kovács, N., 2014. A piaci erő közvetett mérése a biztosítási piacon [The indirect measurement of market power in the insurance market]. Pécs; Győr: Idresearch Kft. - Publikon Kiadó. Regionális - és gazdaságtudományi kismonográfiák; 2014/1. 159
- Kovacs, Z., Beata Sz. G. Pató, 2014. Impacts of extreme weather in supply chains. *Időjárás Quarterly Journal of the Hungarian Meteorological Service*, Vol. 118, No 3, July – September, 283-291.
- KSH, 2010. GNI Inventory. 2009. 2.1 (2015. 02.07.)  
[https://www.ksh.hu/docs/hun/xftp/modsz/gni\\_inventory\\_ver2.1hun.pdf](https://www.ksh.hu/docs/hun/xftp/modsz/gni_inventory_ver2.1hun.pdf)
- Lazányi, K. 2010. Tudásmenedzsmenttel a vidékfejlesztésért [Using knowledge management for rural development.]. In: *Lifelong Learning Magyarország Alapítvány (szerk.) Tanulás, tudás, gazdasági sikerek avagy a tudásmenedzsment szerepe a gazdaság eredményességében: tudományos konferencia kiadványa, Lifelong Learning Magyarország Alapítvány, Budapest. 407-411.*
- Málovics, Gy., Bajmócy Z., 2009. A fenntarthatóság közgazdaságtani értelmezései [Interpretations of sustainability from the perspective of economics]. *Közgazdasági Szemle*, május, 464–483.
- Márki-Zay, P., 2005. Magyarország 20. századi fejlődésének összehasonlító elemzése [Comparative analysis of the development of 20th-century Hungary]. PhD értekezés <https://btk.ppke.hu/db/06/0A/m0000160A.pdf> 2014. aug. 21.
- Meadows, D., Randers, J., Meadows, D. 2005. A növekedés határai harminc év múltán [The Limits to Growth, thirty years later]. Kossuth Kiadó, Budapest
- Missemer, M., 2012. William Stanley Jevons' *The Coal Question* (1865), beyond the rebound effect. *Ecological Economics* 82., 97–103.
- Pintér, T., 2014. Az Európai Unió jogalkotási és válságkezelési gyakorlatának morális hiányosságai – a monetáris unió példája [Moral shortcomings of the EU's legislative and crisis management exercise - the example of monetary union]. In: Tompos A., Ablonczyné Mihályka L. (szerk.) *Növekedés és egyensúly. A 2013. június 11-i Kautz Gyula Emlékkonferencia válogatott tanulmányai.* 53-64.

- Pató, G. Sz. B., 2014. A model consisted of 5 tetrahedral network, as a scientific research appliance. Social Educational Project of Improving Knowledge in Economics, Journal L'Association 1901 "SEPIKE", Vol. 4. pp. 63-68.
- Polimeni, J. M., Mayumi, K., Giampietro, M., Alcott, B., 2008. The Jevons Paradox and the Myth of Resource Efficiency Improvements. London, Sterling, VA.
- Sebestyénné, Sz. T., 2013. Energiahatékonyság: áldás vagy átok [Energy efficiency: a blessing or a curse]? Területi Statisztika, 1., 54–68.
- Sajtos, L., Mitev, A., 2007. SPSS kutatási és adatelemzési kézikönyv [Handbook for research and data analysis using SPSS]. Alinea Kiadó
- Schneider, F. 2010: The Jevons paradox and the myth of resource efficiency improvements. Journal of Cleaner Production, Vol. 18, No 6. 600-602.
- Sorrell, S., 2009. Jevons' Paradox revisited: The evidence for backfire from improved energy efficiency. Energy Policy 37., 1456–1469.
- Stern, D. I., 2004. The Rise and Fall of the Environmental Kuznets Curve. World Development, Vol. 32. No. 8. 1419–1439. o.
- Szabó, D. R., Pintér, T., 2015. A policentrikus térstruktúra mint a kiegyensúlyozott társadalmi-gazdasági szerkezet alapja [The polycentric spatial structure as the basis for a balanced socio-economic structure]. Vezetéstudomány 46 (4) 2-13
- Szabó, E., 2006. A környezetterhelés és a gazdasági fejlődés szétválása [The decoupling of the environmental load and economic development]. Területi Statisztika (9) 4. 393-410.
- Szigeti, C., Tóth, G., Borzán, A., Farkas Sz., 2013. GDP Alternatives and their Correlations. Journal Of Environmental Sustainability 3:(3) 35-46.
- Szigeti, C., Tóth G., 2014. Történeti ökológiai lábnyom becslése a mezőgazdaság kialakulásától napjainkig [Historical estimates of ecological footprint from the formation of agriculture till today]. GAZDÁLKODÁS 58(4) 353.
- Takács-Sánta A., 2008. Bioszféra-átalakításunk nagy ugrásai [Large jumps in the transformation of our biosphere]. L'Harmattan Kiadó, Budapest.
- Tóth, G., 2003. Evaluation of Environmental Performance of Companies. Society and Economy DOI: 10.1556/SocEc.25.2003.3.7
- Török, Á., 2006. Elmaradottság, felzárkózás és innováció az Európán kívüli, nem OECD országokban [Underdevelopment, convergence and innovation in non-European, non-OECD countries]. Közgazdasági Szemle, LIII. évf. 1005–1022.
- US Energy Administration, 2014. Total Petroleum and Other Liquids Production <http://www.eia.gov>
- World Bank, 2015. International Comparison Program database downloaded: 2015. 02. 07. <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD>
- York, R., 2008. Ökológiai paradoxonok - William Stanley Jevons és a papírmentes iroda [Ecological paradoxes - William Stanley Jevons and the paperless office]. Kovász 1., 5–15. <http://unipub.lib.uni-corvinus.hu/108/1/2008york.pdf> (2014. aug. 5.)
- York, R., Rosa, E. A., Dietz T., 2004. The ecological footprint intensity of national economies. Journal of Industrial Ecology 4., 139–154.