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Decoupling of Greenhouse Gas Emissions from Economic Growth in V4 countries

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Abstract

The growing concern of climate change has made greenhouse gas emissions, mostly as a result of anthropogenic activities, an important matter of research. The aim of the paper is to perform quantitative evaluation on the relationship between economic development and production of greenhouse gas emissions based on decoupling model theory. The paper focuses on the case of V4 countries in the period of 1991 – 2012. Throughout the more than 20 years examined, the countries spread out into many different forms of decoupling. The results of analysis suggest that in most observed partial variables occurs the strong decoupling of economic growth and greenhouse gas emissions, what can be considered as positive trend. Though decoupling elasticity convey a positive message, data indicate that, in order to meet its 2050 ambitious objectives to reduce greenhouse gas emissions, the V4 countries will need to accelerate their implementation of new policies, while restructuring the ways how they meet their demand for energy, food, transport and housing.

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*Keywords:*Economic growth; Greenhouse gas emissions; Decoupling; Decoupling elasticity.

1. Introduction

The emergence of resource and energy efficiency as well as the low-carbon economy as European policy priorities is grounded in a recognition that the prevailing model of economic development — based on steadily growing material consumption and production of harmful emissions — is not sustainable from the long term point of view. That is the reason why these issues have emerged as central themes in global discussions on the transition to

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a green economy (OECD, 2014; UNEP, 2014). The fundamental importance of these issues to future prosperity is likewise reflected in Europe's medium- and long-term planning. For example, one of the priority objectives of the 7th Environment Action Programme emphasizes the need to „turn the Union into a resource-efficient, green, and competitive low-carbon economy“ (EU, 2013).

At the strategic level, EU policy sets out a broad framework for resource efficiency and climate change policy, including a variety of long-term (non-binding) objectives. For example, the Roadmap to a Resource Efficient Europe (EC, 2011) includes a vision for 2050, wherein 'the EU's economy has grown in a way that respects resource constraints and planetary boundaries, thus contributing to global economic transformation. These are complemented by policies addressing specific pressures and sectors. The EU's 2020 targets on greenhouse gas emissions and energy consumption (EC, 2010) are prominent examples.

2. Material and Method

The relationship between economic growth and the state of the environment has been widely discussed since the second half of last century. Many authors argue that continued economic growth in a finite world is not possible, therefore the use of material resources to produce economic growth cannot go on forever (e.g. Daly, 1997; Stern, 2004; Anderson, 2010; Hronec, Huttmanova, Chovancova, 2009; Huttmanova, Adamisin, Chovancova, 2013).

Different indicators have beenused for measuring both the economic and environmental variables (Huttmanova, 2011; Adamisin & Vavrek, 2015; Chovancova & Rusko, 2008). The economic variable is usually GDP, either in absolute or per capita form, though many authors has noted, that GDP has some shortcomings, as it clusters diverse resources by weight, obscuring huge differences in scarcity, value and associated environmental impacts. It also provides a distorted picture of resource demands from overseas, because it includes only net imports of resources, rather than encompassing the raw materials consumed in producing imports (Anderson, 2010; Kotulic, Adamisin, 2012).

Many different environmental indicators have been used, and the results depend on the chosen indicator. Among environmental indicators can be included total CO_2emissions, wastes, GHG emissions,sulphur dioxide and particulate matter etc.

Since most of the world’s economies are striving towards economic growth, ways to achieve it with less environmental harm are being sought for. There have been several concepts proposed for this. These include increased eco-efficiency, de-materialisation, immaterialisation, de-linking and decoupling. The drawback in these approaches is to get more from less, which means using resources more efficiently to produce the same value with less material. The environmental impact remains the same, but only the economy grows faster. This is called the rebound effect (e.g. Binswanger, 2001).

Within environmental research these approaches has been applied to several areas, e.g. de-linking of material resources from economic growth (Vehmas, Luukkanen and Kaivo-oja, 2007), decoupling of GDP from traffic volume and CO_2 emissions from transport (Tapio, 2005), decoupling of carbon dioxide emissions per capita from income per capita in developed countries (Marzio, 2003), etc.

There are two basic forms of decoupling: absolute and relative decoupling (e.g. Ballingall, Steel and Briggs, 2003, UNEP, 2011). Relative decoupling of resources or impacts means that the growth rate of the environmentally relevant parameter (resources used or some measure of environmental impact) is lower than the growth rate of a relevant economic indicator (for example GDP). The association is still positive, but the elasticity of this relation is below 1 (Mudgal et al., 2010). Such relative decoupling seems to be fairly common. With absolute decoupling, in contrast, resource use declines, irrespective of the growth rate of the economic driver. This latter relation is shown by the Environmental Kuznets Curve that claims that if prosperity rises beyond a certain point, the environmental impact of production and consumption decreases. Absolute reductions in resource use are rare (De Bruyn, 2002; Steger and Bleischwitz, 2009); they can occur only when the growth rate of resource productivity exceeds the growth rate of the economy. Graphically is this distinction illustrated at fig. 1.

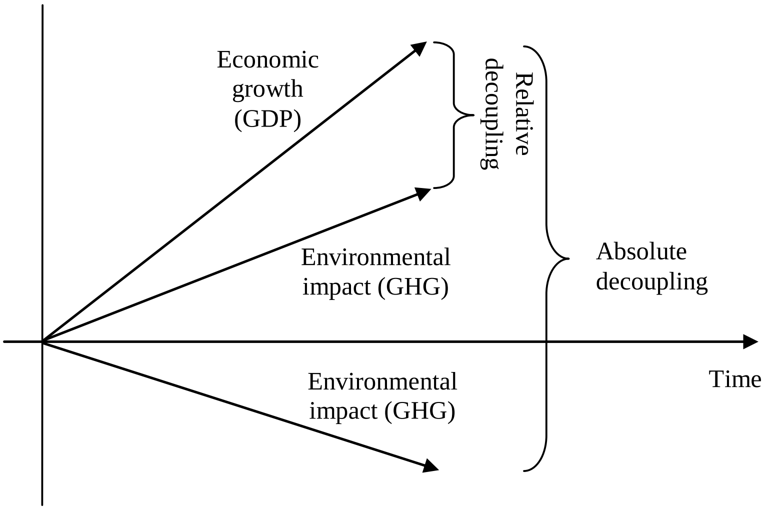

Fig. 1. Relative and absolute decoupling (modified from UNEP, 2011)

The aim of this paper is to quantitatively assess the relationship between economic growth and the production of greenhouse gas emissions in the V4 countries using decoupling method. The data that we used was obtained from the databases of the World Bank (GDP in mil. USD in current prices) and the Eurostat (greenhouse gas emissions in thousand metric tons of CO_2 equivalent).

To compare countries and time periods it is necessary to set the levels, respectively subcategories of decoupling. A similar method used in his research (Tapio, 2005) and (Finel, N. & Tapio, P., 2012), which distinguishes eight subcategories of decoupling, asitillustratesFig.2.

The ration of changes in GHG production (ΔGHG) and GDP (ΔGDP) can be represented according to Finel &Tapio, 2012 as strong decoupling, weak decoupling, coupling, or expansive negative decoupling.

Decoupling of GHG production and economic growth can be calculated as the ratio of percentage units of changes of GHG production and percentage units of changes in GDP in the analyzed period of time. The result will be decoupling elasticity e:

$$e = \%\Delta GHG / \%\Delta HDP \qquad (1)$$

In order to better interpretation of the results, the elasticity value was divided into eight subcategories as recorded in the decoupling model illustrated at Fig. 2.

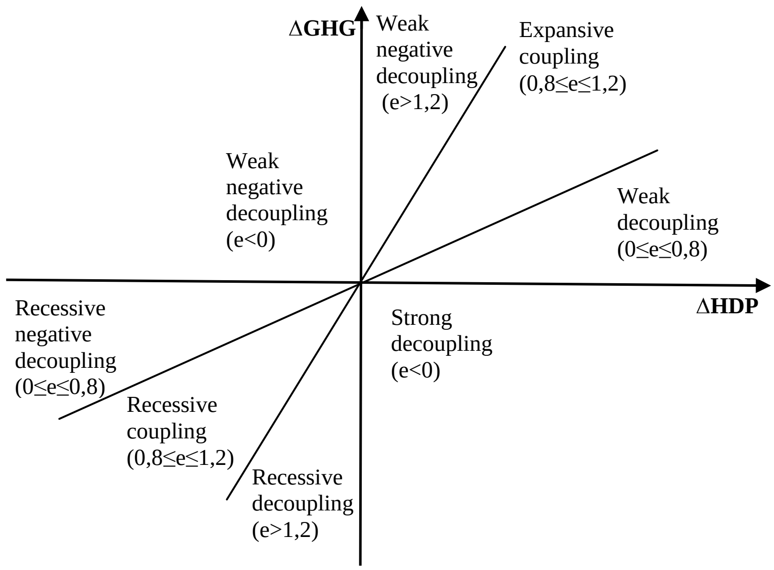

Fig. 2 Decoupling model (modified from Finel &Tapio, 2012)

Identification of differences in the decoupling elasticity between the V4 countries represents a separate part of the survey. For this purpose ANOVA was used. Basic assumptions of using one-way analysis of variance was tested by Shapiro-Wilk test, respectively by Levene test for equality of variances. In case of rejection of assumptions, the differences between countries are assessed by K-W test.

Differences between countries are tested on annual data from the period 1992-2012.The analyses are processed in MSOffice, Statistica and Statgraphics.

3. Results and discussion

In this study, we will analyze the relationship between GDP and Greenhouse gas emissions in V4 countries (Czech Republic, Hungary, Poland and Slovakia) in the period of 1991 – 2012. The analyzed period is divided into seven sections S1 - S7 (see tab.1). Values %ΔGHG and %ΔGDP were calculated using data from available databases of the World Bank and Eurostat. Subsequently the value of decoupling elasticity was calculated using the equation (1).

Tab. 1 Decoupling elasticity of the V4 countries in the period 1991 - 2012

		S1 (1991-1994)	S2 (1994-1997)	S3 (1997-2000)	S4 (2000-2003)	S5 (2003-2006)	S6 (2006-2009)	S7 (2009 – 2012)
Czech Republic (CZ)	%ΔGHG	-21,92	1,57	-3,75	-0,34	0,81	-9,54	-2,09
	%ΔHDP	37,60	23,14	-0,24	38,09	36,02	24,55	0,49
	e	-0,58	0,07	15,67	-0,01	0,02	-0,39	-4,23
Hungary (HU)	%ΔGHG	-13,29	0,07	-3,61	3,89	-2,73	-15,69	-8,06
	%ΔHDP	19,49	8,81	0,09	44,40	25,82	11,69	-2,00
	e	-0,68	0,01	-42,32	0,09	-0,11	-1,34	4,03
Poland (PL)	%ΔGHG	-4,06	1,66	-12,55	-0,69	5,01	-6,82	2,90
	%ΔHDP	22,84	31,02	8,34	20,98	36,63	21,36	12,04
	e	-0,18	0,05	-1,50	-0,03	0,14	-0,32	0,24
Slovakia (SK)	%ΔGHG	-21,83	1,41	-7,45	3,31	-0,61	-12,67	-3,93
	%ΔHDP	29,22	27,40	4,99	37,81	33,55	20,52	4,43
	e	-0,75	0,05	-1,49	0,09	-0,02	-0,62	-0,89

Based on the results of the analysis, we have created a model of decoupling (Fig.3) in which countries are divided within each period in the following sub-categories:

Weak decoupling: in this sub-category, GDP and greenhouse gas emissions both increase, but the GDP grows faster than the emissions. Decoupling occurs to some extent, because emissions grow more slowly than the GDP, but it is weak, since the absolute amount of emissions nevertheless continues to grow. This sub-category includes Czech Republic in the period of years 1994-1997 and 2003-2006, Hungary in the period 1994-1997 and 2000-2003, Poland in the period of 1994-1997, 2003-2006 and 2009-2012 and Slovakia in the period of 1994-1997 and 2000-2003.

Strong decoupling: in this sub-category the GDP increases and greenhouse gas emissions decrease. Thus the GDP elasticity of greenhouse gas emissions is below 0. This is the case of absolute decoupling and the best case for both the economy and the environment. This sub-category is in our survey the most frequent – more than 60% of analyzed cases belong to this group, which can be considered as a positive fact.

Recessive decoupling: in this sub-category both GDP and greenhouse gas emissions decrease, but the emissions decrease more rapidly than the GDP. The GDP elasticity of greenhouse gas emissions is over 1.2. In this sub-category only two cases occurred – Czech Republic in the period of 1997-2000 and Hungary in the period of 2009-2012.

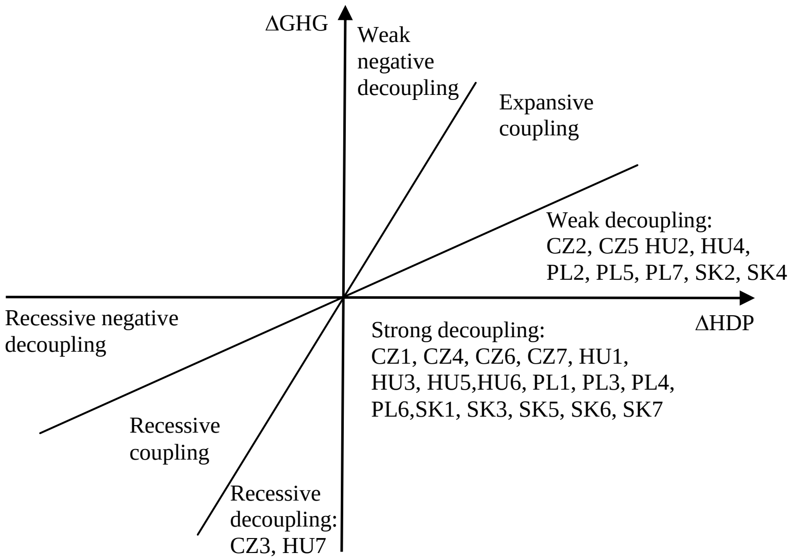

Fig. 3 The distribution of the V4 countries into sub-categories of decoupling

In the European context, the V4 countries are among "the richer out of poor" EU countries and GDP ranges between 66% (Hungary) to 82% (Czech Republic) of the EU-28 average. Greenhouse gas emissions have fallen since 1990, mainly due to the collapse of inefficient industries (Dubravska et al. 2015), increasing energy efficiency and the launch of new carbon-free energy sources; though GHG emissions per unit of GDP remains significantly above the EU average. Here comes up a question, how could the V4 countries support new political and technological solutions towards new carbon economy. It has to be mentioned that “decarbonization” in the long term is considered to be economically beneficial but in the short and medium term is expensive. Therefore part of the investments for decarbonisation should go to research and development, in order to launch a wave of progressive innovation.

Throughout more than 20 year examined period, countries spread out into different forms of decoupling. The largest group of examined periods falls under the subcategory of strong decoupling, which can be seen as a very positive. But as with all studies, this study has limitations. First, the decoupling elasticity does not reveal the environment's capacity to sustain, absorb or resist pressures of various kinds. Elasticity values cannot convey the message of whether the economic growth is sufficiently decoupled from negative environmental impacts. Constant environmental impacts or decreased environmental impacts over time do not guarantee that human economic activity is within the physical limits of biosphere. Even if strong decoupling could be achieved, this would not necessarily ameliorate the environmental impacts of economic growth. For environmental pollutants like GHG emissions, even an absolute decoupling will not be sufficient. Due to the already high emission level and long residence time of greenhouse gases in the atmosphere, a continuation of present emission levels or a slight reduction of those will aggravate global warming.

Though using this method can bring a lot of advantages. The quantification of the extent of decoupling makes it possible to assess if decoupling strategies are sufficient to reach the goal of environmental sustainability. We can track the trends; compare the extent of decoupling among countries and set future decoupling targets. Results of decoupling analysis can facilitate environmental policy making processes.

Despite the confirmation of our assumption by Levene test, Shapiro-Wilk test does not confirm the normality of the distribution of the dependent variable. For this reason, further analysis was proceeded using K-W test.

Tab. 2 Decoupling elasticity of the V4 countries – moment characteristics (1991 – 2012)

	Average	Median	Min	Max	Q_1	Q_3
Czech Republic (CZ)	0,149	0,008	-1,194	3,281	-0,180	0,223
Hungary (HU)	0,441	-0,072	-1,372	5,685	-0,187	0,450
Poland (PL)	-0,316	0,011	-6,227	0,840	-0,120	0,254
Slovakia (SK)	0,313	0,030	-1,152	3,640	-0,220	0,788

K-W test does not confirm the difference between the elasticity of decoupling at the country level (KW: 0.109, p-value 0.99).

4. Conclusion

The issue of reduction of greenhouse gas emissions directly affects all European Union member states, whose vision is to reduce these emissions by 2050 to a level that is about 80-95% lower than the levels that existed in 1990. In this study, we focused on the V4 countries which have several common features - historical, political, economic or geographic. Using the method of decoupling, we determined the rate of decoupling elasticity, thus disengaging economic growth and emissions of greenhouse gases in the individual V4 countries within the monitored periods. On the basis of the analysis can be concluded prevailing strong decoupling, which means that the economies of these countries grow, while production of greenhouse gas emissions is declining.

Both macroeconomic trends and policy initiatives have contributed to these emission reductions. Economic restructuring in Eastern Europe during the 1990s played a role, particularly via changing agricultural practices and the closure of heavily polluting plants in the energy and industrial sectors. More recently, the financial crisis and subsequent economic problems in Europe certainly contributed to a sharp decline in emissions. These achievements notwithstanding, the EU remains far from planned reduction of GHG emission. Data indicate that, in order to meet its 2050 ambitious objectives, the EU countries will need to accelerate its implementation of new policies, while restructuring the ways that Europe meets its demand for energy, food, transport and housing.

Using selected mathematical-statistical methods, the distinction between the elasticity of decoupling of the individual V4 countries has not been confirmed. This result will be tested by other more detailed analysis.

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