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Drivers of greenhouse gas emissions in the Baltic states: decomposition analysis related to the implementation of Europe 2020 strategy

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ABSTRACT

The prevention of climate change by reducing and stabilizing carbon dioxide emissions is the most important concern for policymakers. This study enriches the methodology of decomposition analysis by encompassing the EU 2020 strategy components. Thus, the aim of study is to reveal how the implementation of Europe 2020 strategy contributes to changes in GHG emissions in the Baltic States. The results showed that in all Baltic States, from 1990 to 2012, GHG emissions decreased by 55%. The factor, which contributed to the reduction of GHG emissions the most, was the increase of the share of renewable energy in final energy consumption. The reduction of energy consumption and decarbonisation index influenced the decrease of GHG as well as the increase of intensity of renewable resources and energy efficiency. Considering that during the period of economic growth the slight decrease of share of renewable resources and the growth of final energy consumption was observed, all Baltic States should achieve the increase of energy efficiency and that the energy consumption from renewable resources would increase seeking for the reduction of GHG emissions.

Contents

1. Introduction

The Baltic States (BS) – Lithuania, Latvia and Estonia after the collapse of the Soviet Union began their transition from the 'Soviet-type' towards 'Western-type' states [1]. Having suffered from radical neoliberal transformation, the BS have sharply diversified their trade patterns away from the region of former Soviet Union towards the

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European Union (EU) [2]. In 2004, the BS together with other five countries became new member states of EU. That determined the fast growth of BS economy in last decade due to the Structural and Cohesion funds and economic integration within the European Single Market until economic crisis [3–7]. Moreover, the BS successfully survived the economic crisis as well [8].

It is known, that fast economic growth, particularly in developing countries, raises the level of greenhouse gas (GHG) emissions [9–11]. Hence, Saikku [12], Brizga [13] and Fernández González [14] observed the increase of GHG emissions in the BS in the period of economic growth as well. Additionally, López-Menéndez et al. [15] estimated the increasing pattern of Ecological Kuznets Curve in almost all new EU members including Estonia, Latvia, Lithuania during the period of economic growth. Thus, the prevention of climate change by reducing and stabilizing carbon dioxide emissions is the most important concerns for policymakers.

In the studies on the BS GHG emissions [see 16,17], there was evaluated, that from 1990 to 2010, Lithuania, Latvia and Estonia successfully implemented Kyoto protocol commitments in the period from 2008 to 2012. Moreover, targets of the Europe 2020 strategy, in which countries committed to reduce the greenhouse gas emissions of 1990 by 20% until 2020 (to be extended to 30% if other developed countries assume a similar objective) [18], could also be achievable for Lithuania, Latvia and Estonia. Roos et al. [19] forecasted that the reduction of GHG emissions in 2020 in the BS will be much higher than EU average target. However, a long-term aim to reduce CO_2 equivalent pollution by 80% until 2050 in comparison to 1990 is more challenging for the BS [20]. Thus, the BS countries must make additional efforts to reduce GHG emissions in order to achieve the long-term targets.

A number of studies have applied the decomposition analysis in order to explain factors affecting the GHG emissions [21–24]. The main causal factors determining GHG emissions can be grouped into three methodological categories: the Kaya identity, IPAT identity, and structural decomposition analysis (SDA) [25]. The Kaya identity combines four inputs to estimate the total impact of GHG emissions: population, GDP per capita, energy intensity, and carbon emission per unit of energy consumption [26]. The IPAT framework uses three factors to explain GHG emissions: population, affluence and technology [27]. SDA is based on input-output analysis [28–30].

Moreover, there are two main methods used for time-series decomposition: mentioned SDA and index decomposition analysis (IDA). The advantage of IDA method over SDA is that it can be used to study any available data at any level of aggregation [31–34]. The IDA method is divided into the Laspeyres IDA and the Divisia IDA. The Laspeyres IDA is grounded on the basic Laspeyres and Paasche indices [35]. The Divisia IDA is based on arithmetic mean Divisia index (AMDI) and logarithmic mean Divisia index (LMDI) [36].

In order to evaluate main causal factors determining GHG emission in the BS, Padila and Duro [37] used Kaya identity. Brizga et al. [8] applied a structural decomposition analysis. Additionally, Saikku et al. [12] and Brizga et al. [13] analyzing BS determinants of GHG emissions applied IPAT identity. Brizga et al. [13] applied Divisia IDA method and expanded components of the IPAT to the following six factors: population, affluence, industrialization, energy intensity, energy mix, and carbon intensity. Fernández González et al. [15,38], in the studies on driving forces behind changes in GHG emission levels, applied an LMDI approach analysing the following factors: GDP, energy intensity, fuel mix, and energy carbon intensity.

This study enriches the methodology of decomposition analysis and our determinants encompass the Europe 2020 strategy components: the final energy consumption, energy efficiency, and renewable energy resources. To our knowledge, this is the first time when these factors are used in the decomposition analysis. Only O'Mahony [39] for the first time in decomposition analysis included renewable energy penetration. Thus, the aim of our study was by applying decomposition analysis to reveal how the Europe 2020 strategy implementation contributes to changes in GHG emissions in the BS. Moreover, we reviewed the existing Energy and Climate Change Policy in Estonia, Latvia and Lithuania. Finally, according to these findings, the additional implications for policy were proposed.

The rest of the paper proceeds as follows: Section 2 presents the methods of paper, Section 3 – the results. In Section 4, we discuss the results and review the current policy. Finally, Section 5 closes the paper with the main conclusions.

2. Methods and data

According to the targets of Europe 2020 strategy, we applied a new decomposition analysis and developed the following five factor equations:

$$co2_{ti} = tec_{ti} \cdot \frac{gdp_{ti}}{tec_{ti}} \cdot \frac{rec_{ti}}{gdp_{ti}} \cdot \frac{tec_{ti}}{rec_{ti}} \cdot \frac{co2_{ti}}{tec_{ti}} = tec_{ti} \cdot ee_{ti} \cdot int_{ti} \cdot inv_{ti} \cdot dec_{ti} \tag{1}$$

where

$co2_{ti}$ – total amount of CO_2 emissions (1000 t) during year t in a country i,

tec_{ti} – final energy consumption (million tonnes of oil equivalent (MTOE) during year t in a country i,

gdp_{ti} – stands for national gross domestic product (in 2005 prices, PPP) in year t in a country i,

rec_{ti} – total amount of final energy consumption from renewable resources (million tonnes of oil equivalent (TOE) during year t in a country i),

ee_{ti} – energy efficiency (calculated as national gross domestic product gdp_{ti} and final energy consumption tec_{ti} ratio) in year t in a country i. Represents total value added in a country per unit of energy used,

int_{ti} – intensity or renewable resources (calculated as final energy consumption from renewable resources rec_{ti} and national gross domestic product gdp_{ti} ratio) in year t in a country i. Represents the renewable energy consumed for producing one unit of total value added,

inv_{ti} – inverse coefficient of share of renewable resources (calculated as ratio between total energy consumption tec_{ti} and energy consumption from renewable resources rec_{ti}) in year t in a country i. Represents the intensity of fossil fuel usage compared to renewable energy consumption,

dec_{ti} – decarbonisation index (calculated as $co2_{ti}$ and tec_{ti} ratio) in year t in a country i. Represents the total CO_2 emissions per unit of final energy consumed.

In this study, we used the Divisia IDA method. Ang et al. [36] confirmed that the Divisia IDA method is robust and convenient to apply. Thus both multiplicative and additive decomposition techniques were used to calculate the change in CO_2 emission (ΔCO_2) between a base year t and a target year $t+n$.

The multiplicative decomposition analysis was based on the relative change of aggregate CO_2 emissions between period t and $t+n$ and factors were decomposed by the ratio of each factor, as shown in Eq. (2):

$$\Delta co2_i = \frac{co2_{t+n,i}}{co2_{ti}} = tec_{(eff)i} \cdot ee_{(eff)i} \cdot int_{(eff)i} \cdot inv_{(eff)i} \cdot dec_{(eff)i} \tag{2}$$

The multiplicative form shows the relative aspect for each factor in influencing the emission changes, and the relative changes of each variable should equal the total relative change of the aggregate. Higher coefficient corresponds to greater impact of a factor on changes in GHG emissions. If we have the same coefficient, for example, on total energy consumption (tec) and energy efficiency