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MASTER THESIS

Globalizacijos įtaka anglies dvideginio išmetimui Lietuvoje: aplinkos Kuzneto kreivės hipotezės tikrinimas	**The influence of globalization on carbon dioxide emissions in Lithuania: Testing Environmental Kuznets Curve Hypothesis**

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INTRODUCTION

Relevance of the topic

Over the last several decades, environmental pollution has become one of the greatest global issues caused by ever-increasing greenhouse gases (GHGs) in the atmosphere, the main components of which are carbon dioxide emissions (CO2). The danger of CO2 emissions lies in the fact that they result in global warming and climate change, the evidence of which is already noticeable in increasing of the temperature of air and water, melting of snow and ice, raising the sea level, and depletion of flora and fauna. In the meantime, globalization which has influenced political, economic, and social areas of our life, by all accounts, has both positive and negative impacts on the environment through different channels. The increased volume of international trade in connection with globalization has resulted in an increase in economic growth and hence a change in CO2 emissions (Ahmed et. al., 2016a; Ahmed et. al., 2016b), raising concerns over environmental sustainability. Therefore, considering the attention that has been paid to CO2 emissions and globalization in recent years, the establishment of its impact on CO2 emission, as an indicator of environmental pollution, is significant for Lithuania. Furthermore, given that economic growth has resulted in a rise in CO2 emissions, it is also important to test the Environmental Kuznets Curve (EKC) hypothesis, which states that firstly economic growth impacts the environment negatively, and later when a certain level of income per capita is reached it has a positive impact on environmental quality, to check whether economic growth is a problem or the solution for environmental degeneration in the case of Lithuania. (Kalaycı and Hayaloğlu, 2019).

The level of exploration of the topic and research gap

Many scholars have devoted themselves to the studies of the nexus of globalization with CO2 emissions under the framework of the EKC hypothesis in the recent few years (You and Lv, 2018; Kalaycı and Hayaloğlu, 2019; Zafar et al., 2019; Liu et al., 2020; Vlahinić Lenz and Fajdetić, 2021; Wen et al., 2021). While some of these studies focused on the environmental impact of different variables that can be regarded as globalization indicators, others concentrated on the influence of globalization indices itself on the environment (Destek, 2020).

However, there is a literature gap in studying this subject. Firstly, there is no unanimous answer on the influence of globalization on CO2 emissions in single-country and multiple-country studies. For example, Destek and Ozsoy (2015) and Shahbaz et al. (2017c) discovered that globalization decreases CO2 emissions in Turkey and China, which differs from the results of Khan et al. (2022), who found that globalization increases CO2 emissions in Pakistan. According to the multiple-country studies of Zaidi et al. (2019), and Zafar et al. (2019) globalization lowers CO_2 emissions. On the other hand, Shahbaz et al. (2015b), Shahbaz et al. (2017a), Shahbaz et al. (2017d), Solarin et al. (2017), Saint Akadiri et al. (2019), Kalaycı and Hayaloğlu (2019), Destek (2020), and Wen et al. (2021) concluded in their multiple-country studies that globalization increases CO_2 emissions. With respect to such globalization indicator as trade openness, the positive relationship between trade openness and CO_2 emissions was confirmed by Kasman and Duman (2015), Bento and Moutinho (2016), Kalaycı and Hayaloğlu (2019). However, Shahbaz et al. (2012), Sun et al. (2019), Sinha et al. (2017), and Q. Zhang et al. (2017), Al-Mulali et al. (2015a) found that trade openness decreases CO_2 emissions. However, according to Ohlan (2015), the statistically significant influence of trade openness on CO_2 emissions was not found in the case of India.

Secondly, there is also no consentaneous answer on the validity of the EKC hypothesis in single-country studies. On the one hand, the validity of the EKC hypothesis for the nexus of CO_2 emissions and economic growth has been proven in the time-series single country studies of Esteve and Tamarit (2012) for Spain, Saboori et al. (2012) for Malaysia, Shahbaz et al. (2012) for Pakistan, Ozturk and Acaravci (2013) for Turkey, Kanjilal and Ghosh (2013) and Tiwari et al. (2013) for India, Baek and Kim (2013) for Korea, Destek and Ozsoy (2015) for Turkey, Shahbaz et al. (2015a) for Portugal, Shahbaz et al. (2015b) for India, Balsalobre-Lorente and Shahbaz (2016) for Spain, Bento and Moutinho (2016) for Italy, Shahbaz et al. (2017c) for China, Sinha and Shahbaz (2018) for India, and Rahman et al. (2020) for Lithuania. On the other hand, the existence of the EKC hypothesis between CO_2 emissions and economic growth was not found in the studies of Akbostancı et al. (2009) and Ozturk and Acaravci (2010) for Turkey, Fodha and Zaghdoud (2010) for Tunisia, Al-Mulali et al. (2015b) for Vietnam, Ozturk and Al-Mulali (2015) for Combodia as well as Dogan and Turkekul (2016) for the USA.

Thirdly, although the study of Kalaycı and Hayaloğlu (2019) investigated the influence of globalization and trade openness on CO_2 emissions, testing the validity of the EKC hypothesis for the NAFTA countries, previous research works fail to do such an analysis for Lithuania.

Novelty of the master thesis

This thesis makes a couple of contributions to the existing literature. Firstly, this study employs the overall KOF globalization index proposed by Dreher (2006) to investigate the overall effect of three different aspects of globalization, namely economic, social, and political globalization, on the environment under the framework of the EKC in Lithuania. Although Rahman et al. (2020) tested the validity of the EKC hypothesis for Lithuania before, the authors did not include the KOF globalization index as a determinant of CO_2 emissions in their study. Secondly, while Kalaycı and Hayaloğlu (2019) did similar research for the case of NAFTA countries, they did not implement autoregressive distributed lag (ARDL) cointegration analysis as the methodology in their study. Therefore, the lack of investigation of the impact of globalization on pollution under the EKC hypothesis in the case of Lithuania and the aforementioned explanations of the biased existing empirical results are the reason for examining empirically the nexus of globalization with CO_2 emissions under the framework of the EKC hypothesis model in Lithuania over the period 1995-2019.

Research question or problem of the master thesis

Environmental pollution has become one of the greatest global issues resulting in global warming and climate change caused by ever-increasing CO_2 emissions. However, such a worldwide phenomenon as globalization has influenced our environment both positively and negatively through different channels. The increased volume of international trade in connection with economic globalization has resulted in an increase in economic growth and hence a change in CO_2 emissions (Ahmed et al., 2016a; Ahmed et al., 2016b), raising concerns over environmental sustainability. In order to examine what is the effect of globalization on pollution, the problem statement is formulated as follows.

What is the influence of globalization on carbon dioxide emissions under the framework of the EKC hypothesis in Lithuania?

The aim of the master thesis

This research aims to evaluate the impact of globalization on CO_2 emissions while testing the EKC hypothesis in Lithuania over the period 1995-2019.

The objectives of the master thesis

The following objectives are defined to accomplish the stated aim:

1. To systemize and analyze previous studies on the subject of the nexus of globalization and economic growth with CO_2 emissions;
2. To design a theoretical study model from the literature analysis;
3. To construct the methodology of how the study will be issued;
4. To apply statistical data analysis methods (descriptive statistics and autoregressive distributed lag cointegration analysis) to find how globalization influences CO_2 emissions and examine the validity of the EKC hypothesis in Lithuania;
5. To develop conclusions and suggestions.

Object of research

The research object for this study is the impact of globalization, trade openness, and economic growth on CO_2 emissions in Lithuania.

The methods deployed by the master thesis

The Autoregressive Distributed Lag Approach (ARDL) to cointegration, which was proposed by Pesaran and Shin (1995) and Pesaran et al. (1996), is used to examine the framework of the Environmental Kuznets Curve (EKC) hypothesis for Lithuania to test the existence of long-run relationships between variables. To be sure that the order of integration of the variables is I(0) or I(1) before proceeding to the estimation stage, the weighted symmetric ADF test (ADF-WS) of Park and Fuller (1995) is used as a unit root test. The ARDL bounds testing technique comprises two steps to estimate the long-run relationship. The first step lies in the determination of cointegration through the bound test to confirm the existence of a long-run relationship among all variables in the equation. The second step lies in the estimation of the long-run and short-run models. The bounds testing is based on the joint F-statistic or Wald statistic (Narayan, 2005), while the former tests the significance of association, and the letter tests the significance of all the variables in the cointegration test. If the calculated F-statistics lies above the upper level of the band, after comparing of the value of the F-statistic with critical values of upper and lower bound, cointegration exists.

Structure of the master thesis

The thesis consists of three major segments, the first one, composed of three sub-segments, reviews the literature on theoretical questions and other relevant previous research endeavors in examining the influence of globalization, trade openness, and economic growth on CO_2 emissions. The second segment is divided into two sub-segments methodology of data collection and methodology of data processing, while the first sub-segment consists of the description of research variables, research questions, study model, and data gathering. The third part of this research provides a detailed analysis of the empirical research results as well as conclusions and recommendations.

1. LITERATURE REVIEW

1.1 Globalization and CO2 emissions

There are plenty of studies on the role of globalization in environmental pollution, and their results differ depending on the countries or regions analyzed. The reason for such a difference lies in the fact that these countries have predominantly various levels of development, technological advances, and environmental policies. Globalization, being a multidimensional process, impacts the economic, political, and cultural aspects of our lives (Robertson and White, 2007). Economic globalization, for example, is a long-term process that, starting in the 1980s with technological advances, has improved international transactions, both in trade and finance (The International Monetary Fund, 2008). Suci et al. (2016) determined globalization as the increasing integration of countries and societies across the world. With regard to political globalization, it defines the extent of the state's involvement in international policy (Goryakin et al., 2015). And the role of political globalization lies in the elimination of the inequalities caused by economic globalization as a result of encouraging governments to adopt global institutions (Guzel et al., 2021). Social globalization means the cultural integration of people worldwide that changes their lifestyles as well as consumption and communication habits (Guzel et al., 2021). With respect to cultural globalization, Gygli et al. (2019) stated that it is the diffusion of Western culture through music, series, films, programs, and other pieces of art.

There are various indexes that were created to measure globalization. These indexes, while including the main aspects of globalization, have different methodological approaches. The KOF Globalization Index, introduced by Dreher (2006), is a measurement of the economic, political, and social dimensions of globalization. This index was revised by Gygli et al. (2019) and two new measures such as de jure and de facto globalization were added. According to Martens et al. (2015) facto and de jure globalization, give more accurate results. Then the Maastricht Globalization Index was introduced, including cultural and environmental dimensions. This index was improved by Figge and Martens (2014), including five major aspects: political, economic, sociocultural, technological, and environmental. In addition, The New Globalization Index (NGI) was developed by Vujakovic (2010), covering the economic, social, and political fields.

However, the majority of studies used the KOF Globalization index, taken from the KOF Globalization Index database of Dreher (2006), to determine the influence of globalization on the environment. For example, Destek (2020) and Guzel et al. (2021), Muhammad and Khan (2021) conducted research using the overall KOF globalization index as well as economic, social, and political KOF globalization indexes. The scientific works of Leitão (2014), Shahbaz et al. (2017d), Zafar et al. (2019), Saint Akadiri et al. (2019), Salahuddin et al. (2019), Khan et al. (2021), Vlahinić Lenz and Fajdetić (2021), Wen et al. (2021) also utilized overall KOF globalization index in the analysis of the effects of globalization on carbon dioxide emissions. You and LV (2018) and Kalayci and Hayaloglu (2019) examined globalization through the economic KOF globalization index that is calculated from trade and financial globalization.

By focusing on carbon dioxide emissions, they remain the most influential factor in declining environmental sustainability resulting in global warming and climate change (Solomon et al., 2009). The concentration of CO_2 emissions has considerably increased by around 45% in the last 130 years (Carbon Footprint, 2018). Moreover, according to the Statistical Review of World Energy, CO_2 emissions increased from 29,714.2 million tons in 2009 to 33,444.0 million tons in 2017 (British Petroleum, 2018). Global CO_2 emissions have increased by 1.6%, while European emissions increased by 2.5 % between 2006 and 2017 (British Petroleum, 2018). Therefore, the reduction of CO_2 emissions, which constitute around 80% of greenhouse gas emissions (Eurostat, 2020), has consistently become a vital goal of developed countries. In pursuing this goal, The Paris Agreement, which entered into force in 2020, was adopted worldwide to fight climate change by limiting global average temperatures to 2 °C above pre-industrial levels (United Nations, 2015).

In general, most of the authors focused on studying economic globalization and found that it can influence the environment in a positive and negative way, depending on the level of development of the country. Hence, according to Copeland and Taylor (2004), the relocation of highly polluting industries to developing countries with poor environmental regulation results in environmental degeneration. Dinda (2004) stated that economically globalized countries may have the tendency to pay less attention on their CO_2 emissions, putting their economic goals on the first place. Kalayci and Hayaloglu (2019), studying the influence of globalization and trade openness on CO_2 emissions in NAFTA countries between 1990 and 2015, stated that globalization increases global trade and capital movements all around the world. It leads to the development of new technologies as a result of cooperation and competition among countries, which, in the meantime, increases their income. Companies in such high-income countries tend to have environmental-friendly methods of production, which is beneficial for the environment. On the other hand, Kalayci and Hayaloglu (2019) also stated that globalization causes problems in the environment. Hence, in such countries that use energy-intensive technologies, globalization can result in environmental degradation. Furthermore, environmental protection policies in advanced countries motivate corporations to move their manufacturing to developing countries where environmental standards are not strict. The authors confirmed that economic globalization and trade openness impact CO_2 emissions negatively. Dinda (2006) examined the influence of globalization on the pollution level, pollution intensity, and relative change of pollution for the developed (OECD) and developing (Non-OECD) countries and the whole world between 1965 and 1990. The author stated that the role of globalization in environmental quality considerably depends on certain features of a country. The empirical results of the analysis also demonstrated that globalization lowers carbon dioxide emissions in advanced countries and it increases carbon dioxide emissions in developing countries. However, according to the study of Rennen and Martens (2003), economic globalization can improve environmental conditions. The studies of Gallagher (2009) explain it through the spreading of green technologies in developing countries. Moreover, the influence of real GDP, energy intensity, and globalization on CO2 emissions in 19 African countries was investigated in the studies of Shahbaz et al. (2016) using ARDL bound test and the results showed that in such countries as Angola, Cameroon, Congo Republic, Kenya, Libya, Tunisia, and Zambia globalization reduces CO2 emissions while it increases them in Ghana, Morocco, South Africa, Sudan, and Tanzania. Shahbaz, Mahalik, Shahzad, and Hammoudeh (2019) found that CO2 emissions are reduced because of globalization in middle and high-income countries, but are increased in low-income countries. Shahbaz et al. (2017c) conducted similar research for China and came to the conclusion that globalization increases per capita income leading to technological advancement that improves environmental quality in the country. Similarly, using a spatial regression model, You and Lv (2018) also revealed that economic globalization diminishes CO2 emissions in high-income countries.

However, a positive relationship between globalization and CO2 emissions was found in the studies of Shahbaz et al. (2017a) for 25 developed countries in Asia, North America, Western Europe, and Oceania and Shahbaz et al. (2017d) for Japan, using the threshold ARDL approach, which is opposite to the findings of the abovementioned authors for developed countries. The authors recommended the government to concentrate on decreasing CO2 emissions while revising energy policy to undertake sustainable development. Similarly, Solarin et al. (2017) stated that globalization increases CO2 emissions after investigating their nexus for Malaysia using the ARDL and FMOLS techniques. But after investigating the nexus between CO2 emissions, real income, renewable energy consumption, and globalization in Portugal with the VECM Granger causality method, Leitão (2014) found that CO2 emissions are not influenced by globalization. According to Salahuddin et al. (2019), globalization does not significantly affect CO2 emissions in Sub-Saharan African (SSA) countries. Therefore, even though a couple of studies did not find any effects of globalization on the environment, most of the longitudinal research found that globalization increases carbon dioxide emissions.

On the other hand, it was shown in many studies that globalization can be beneficial to the environment. For instance, Shahbaz et al. (2013b), while analyzing the impact of real income, energy consumption, and overall globalization index on CO2 emissions in Turkey through the ARDL bound test, discovered that globalization decreases CO2 emissions. The nexus between real GDP, energy consumption, urbanization, economic globalization, and CO2 emissions in Turkey was studied by Destek and Ozsoy (2015) with ARDL bound test and asymmetric causality approach and it was also found that economic globalization reduces CO2 emissions. Shahbaz et al. (2017c) concluded that globalization is beneficial for environmental quality in the case of China. Zaidi et al. (2019) also stated that globalization decreases CO2 emissions for the Asia Pacific Economic Cooperation countries. Zafar et al. (2019) examined the effects of globalization on the environment in OECD countries between 1990 and 2014 and the authors found that globalization lowers carbon dioxide emissions in these countries. Furthermore, Saint Akadiri et al. (2019), testing the impact of globalization in Italy between 1970 and 2914, also found that it leads to the enhancement of the environmental state and a decrease in carbon dioxide emissions in the long run. Sabir and Gorus (2019) tested the effects of economic globalization and technological advancement on the environment in South Asian countries between 1975 and 2017. It was found that globalization influenced the environment positively. Therefore, lots of longitudinal research found that globalization reduces carbon emissions in developed and developing countries.

Although lots of effort was made to assess economic globalization, several studies analyzed globalization as a broader concept while examining its influence on environmental quality. For example, Destek (2020) tested the influence of various dimensions of globalization on the environment using the overall globalization index, economic globalization index, social globalization index, and political globalization index in 12 countries in Central and Eastern Europe. The analysis showed that economic globalization influences the environment negatively because the rise in trade openness and foreign direct investments results in growing emission levels. While it was confirmed that social globalization does not influence carbon dioxide emissions, political globalization lowers them. The reason for this is that the countries in question have enforced environmental policies. It was also found that overall globalization increases carbon dioxide emissions. Similarly, Leal and Marques (2019) studied the influence of economic, social, and, political globalization, including de jure and de facto measures, on the environment in 25 countries of the EU between 1990 in 2016. The results showed that overall globalization increases carbon dioxide emissions. In addition, it was found that the de jure measure has a bigger impact on high-globalized countries, while the de facto measure has a bigger impact on low-globalized countries. Muhammad and Khan (2021) also investigated the influence of different aspects of globalization on carbon emissions in 31 developed and 155 developing countries between 1991 and 2018. The empirical results showed that social globalization contributes to the reduction in carbon dioxide emissions in developed as well as developing countries. Furthermore, while economic globalization increases carbon dioxide emissions in advanced countries, it decreases them in developing countries. However, political globalization affects pollution negatively. Vlahinić Lenz and Fajdetić (2021) investigated the role of globalization in carbon dioxide emissions for 26 countries of the EU between 2000 and 2018. It was confirmed that economic globalization increases greenhouse gas emissions. However, social and political globalization improves environmental quality. The impact of overall globalization and economic, social and political globalization indices, energy consumption, and real income on $CO2$ emissions in India was studied by Shahbaz et al. (2015b) with ARDL bound test and the results showed that economic globalization decreases $CO2$ emissions while overall, social and political globalization increase them. Khan et al. (2019) reported that economic, social, and political globalization have a positive impact on $CO2$ emissions in Pakistan. While investigating China with ARDL bound test, Shahbaz et al. (2017c) concluded that all types of globalization indices decrease $CO2$ emissions. The nexus between overall, economic, social, and political globalization indices on $CO2$ emissions was examined by Xu et al. (2018) for Saudi Arabia with the ARDL approach and the results showed that economic globalization increases $CO2$ emissions but overall, social and political globalization doesn’t have an impact on $CO2$ emissions.

In contrast to the abovementioned studies that used globalization indices for the assessment, there are also scientific works that analyzed the effects of different variables, that can be viewed as indicators of globalization, on the environmental quality. Thus, one of the most important globalization indicators is trade openness, which is also considered a relevant variable affecting environmental contamination. Numerous studies examined the relationship between trade liberalization and $CO2$ emissions (Acaravci and Ozturk, 2010; Shahbaz et al., 2013a; Kasman and Duman, 2015; Dogan and Turkekul, 2016; Bento and Moutinho, 2016). While it was revealed that trade liberalization increases economic growth and then at a certain income level environmental quality improves (World Bank, 1992), Gallagher (2009) stated that trade openness can worsen the state of our environment as a result of the movement of pollution-intensive firms to countries with weak environmental policies. Therefore, trade openness can influence environmental contamination both positively and negatively.

The positive relationship between trade openness and $CO2$ emissions was confirmed by Kasman and Duman (2015) for European Union countries and Bento and Moutinho (2016) for Italy. According to Ahmed et al. (2016a) and Ahmed et al. (2016b), trade liberalization increases economic growth, contributing to environmental pollution. S. Zhang et al. (2017), after investigating the nexus among trade openness, $CO2$ emissions, real GDP and energy consumption in 17 industrialized countries, concluded that trade openness negatively affects carbon dioxide emissions. According to the study of Tiwari et al. (2013), trade openness increases environmental pollutants in India. Kalaycı and Hayaloğlu (2019) also revealed that trade openness results in higher carbon dioxide emissions. However, Le et al. (2016) revealed that the effects of trade openness on carbon dioxide emissions depend on the level of income in the country, hence, trade openness has a positive influence on the environment in high-income countries, which is the opposite in middle and low-income countries. Similarly, Muhammad and Khan (2020) confirmed that trade openness decreases carbon dioxide emissions in advanced countries and increases them in developing countries as these countries use polluting equipment, which is the opposite in advanced countries using new equipment. Although Khan et al. (2019), while examining the impact of globalization and trade openness on carbon dioxide emissions in Pakistan through the ARDL model, found that trade openness influences CO2 emissions positively in the long run, it affects them negatively in the short run.

On the other hand, according to other researchers, trade openness can be beneficial to the environment. For instance, Shahbaz et al. (2012) argued that CO2 emissions can be decreased by trade openness. Sun et al. (2019) found through FMOLS methodology and the vector error correction model (VECM) that trade openness decreases CO2 emissions in Southeast Asia and Europe. Sinha et al. (2017) confirmed a negative correlation between trade openness and CO2 emissions too, using a GMM estimator. Q. Zhang et al. (2017) also showed a negative correlation between trade and CO2 emissions too. Akın (2014) studied influence of energy consumption, economic growth and trade openness on CO2 emissions in 85 countries, using panel co-integration analysis. Although the results demonstrated that there is a positive relationship between CO2 emissions and energy consumption, income per capita and trade openness, the author revealed that trade openness reduces CO2 emissions in the long run. But according to Ohlan (2015), the statistically significant influence of trade openness on CO2 emissions was not found in the case of India.

However, Gallagher (2009) argued that trade can impact the environment directly or indirectly. The author claims that increased transportation can be a direct effect of trade openness. Grossman and Krueger (1991) stated that trade openness can influence environmental conditions either positively or negatively through indirect effects such as the scale, technical and composition effects. These effects can be clarified by the pollution haven hypothesis (Guo et al., 2010), in accordance with which people in developing countries are more concerned with income than with environmental pollution as compared to people in developed countries (Tang, 2015). Scale effect was described in the studies of Antweiler et al. (2001) and Farhani et al. (2014), which stated that trade openness results in higher rates of CO2 emissions because of increased production and energy consumption, but as the development progresses trade openness leads to environmental improvements. Liddle (2001) stated that technological effect can improve environmental damage, as developing countries will receive technology through the foreign direct investment that may decrease pollution. According to the composition effect, the production of countries depends on their comparative advantage, meaning that when there is an increase in demand of traded goods produced with the intense contamination of the environment, then countries are willing to produce these goods.

From this subsection, it can be concluded that, as previous studies showed, the impact of globalization on the environment has been assessed either through globalization indicators such as trade openness, or through overall, economic, social, and political globalization indices all around the world. However, there was no consensus reached on the direction of the relationship between globalization and environmental pollution as some studies underlined that globalization results in increases in carbon dioxide emissions and others revealed that globalization leads to decreases in carbon dioxide emissions.

1.2 Economic growth and CO2 emissions under the EKC

Over the last few decades, economic growth, which was induced by globalization, has come at the expense of higher CO2 emissions, which boosted the world's attention to environmental issues, resulting in contrary viewpoints on environmental protection and economic growth. For example, in EU countries, economic growth induced by globalization is regarded as one of the most influential factors for increasing CO2 emissions (Acaravci and Ozturk, 2010; Ozturk, 2015). Therefore, environmental regulation is crucial for EU countries to achieve economic growth without increasing CO2 emissions. While the nexus between economic growth and CO2 emissions was described in the recent studies of Fávero et al. (2022) and Khan et al. (2022), the negative impact of economic growth on CO2 emissions was confirmed in the study of Magazzino (2015). Although Kasperowicz (2015) found a negative relationship between GDP and CO2 emissions in the long run, in the short run, this relationship was positive.

The relationship between economic growth and the environment can be shown through the Environmental Kuznets Curve (EKC) hypothesis, which was found while analyzing the ecological impact of the North American Free Trade Agreement (NAFTA) and it explains that environmental conditions degenerate firstly and then become better after reaching a threshold level while economic growth increases (Grossman and Krueger, 1991). Therefore, in the long run, economic growth is beneficial to the environment in accordance with the EKC hypothesis. This hypothesis has been tested in a single country as well as cross-country studies for the purpose of finding the option for sustainable economic growth (Dinda, 2004). However, contradictory empirical evidence has been found in both types of these studies.

On the one hand, the validity of the EKC hypothesis for the nexus of carbon dioxide emissions and economic growth has been proven in the time-series single-country studies of Acaravci and Ozturk (2010) for Denmark and Italy, Xuemei et al. (2011) for China, Kanjilal and Ghosh (2013) for India, Baek and Kim (2013) for Korea, Ozturk and Acaravci (2013) as well as Destek and Ozsoy (2015) for Turkey, and Bento and Moutinho (2016) for Italy. Rahman et al. 2020 tested the Environmental Kuznets Curve (EKC) relationship for economic growth in Lithuania using time series data of 1989-2018 and the autoregressive distributed lag (ARDL) model. The U-shaped relation between CO2 emissions and economic growth was confirmed, validating the EKC hypothesis in the long and short run. Moreover, the results showed that Lithuania can slow down climate change and fulfill its environmental goals endorsed by the Parliament of the Republic of Lithuania without mitigating its economic growth. On the other hand, the existence of the EKC hypothesis between carbon dioxide emissions and economic growth was not found in the studies of Ghosh (2010) for India, Fodha and Zaghdoud (2010) for Tunisia, Ozturk and Al-Mulali (2015) for Cambodia, Shahbaz et al. (2015a) for Portugal. Dogan and Turkekul (2015) for the USA. Al-Mulali et al. (2015) also confirmed that the EKC hypothesis is not valid for the case of Vietnam as the nexus between economic growth and environmental pollution is positive in both the short and long run. Therefore, with respect to time-series single-country studies, contradictory results have been achieved as some abovementioned studies supported the EKC, while others rejected it.

Considering cross-sectional and panel data analyses in cross-country studies, the EKC hypothesis was proven for 14 Asian countries (Apergis and Ozturk, 2015), the EU (Dogan and Seker, 2016), the 25 OECD countries (Jebli et al., 2016), 17 industrialized countries (S. Zhang, 2017), the 83 countries (You and Lv, 2018), 12 CEECs countries (Destek, 2020), the G7 countries (Liu et al., 2020), 5 South Asian countries (Wen et al., 2021). Musolesi (2010) also tested the EKC hypothesis for 109 countries between 1959 and 2001 and it was supported in wealthier countries. In the meantime, Alam et al. (2016) investigated the effects of income on carbon dioxide emissions for India, Indonesia, China, and Brazil and found that Indonesia and Brazil support the EKC hypothesis in both the long run and short run, the hypothesis is valid in China only in the long run and India does not support this hypothesis at all. However, this hypothesis was rejected in the studies of Arouri et al. (2012) for 12 Middle East and North African countries, Jebli et al. (2016) for 25 OECD countries, and Musolesi et al. (2010) for 106 developed and developing countries. Hence, even though the majority of panel data cross-country studies validated the EKC hypothesis, some of them rejected it.

Grossman and Krueger (1991) proposed the inverted U-shaped EKC hypothesis that economic growth initially reduces environmental quality and then improves it, once the economy has achieved a threshold level of income. There is a nonlinear inverted U-shaped relationship between CO2 emissions and economic growth under the EKC model according to the studies of Ang (2007), Baek and Kim (2013), Kasman and Duman (2015), Apergis and Ozturk (2015), Shun Zhang et al. (2017), Shahbaz et al. (2019), Destek (2019). But Arouri et al., (2012), Esteve and Tamarit (2012), and Fodha and Zaghdoud (2010) uncovered a linear relationship between CO2 emissions and economic growth. However, the studies of Grossman and Krueger (1995), Musolesi et al. (2010), and Ozturk and Acaravci (2010) found that the relationship between CO2 emissions and economic growth is N-shaped, meaning that, firstly, economic growth increases environmental degradation, then after reaching a threshold level environmental degradation improves before worsening again. Moreover, Akbostancı et al. (2009) tested the nexus between income and environmental pollution in Turkey, and an N-shape relationship was found also between these variables. Balsalobre-Lorente et al. (2018) tested the relationship between economic growth and carbon dioxide emissions in Germany, France, Italy, Spain, and the United Kingdom and also confirmed the N-shaped relationship between these variables in all the countries. Fávero and Souza (2022), examining the relationship between economic growth and carbon dioxide emissions in 187 countries between 1800 and 2016, validated the N-shaped EKC hypothesis too. Hence, when it is more common for the countries or regions analyzed to have U-shaped EKC, some countries have N-shaped EKC which means that the environmental degradation eventually does not improve with the increase of economic growth there.

Some literature clarifies the reasons for the conflicting empirical results of the relationship between environmental protection and economic growth. Firstly, the contrasting climate conditions and pattern of carbon emissions of the country can be one of the reasons (Toman and Jemelkova, 2003). Secondly, the diverse financial system of countries can be also the reason (Ewing et al., 2007). Thirdly, there is different ranges of data in various periods of time (Smyth, 2013). The argument of methodological flaws and omitted variable prejudice was outlined as a contradiction reason by Ozturk (2010). Moreover, due to the problems such as the adoption of clean production technology, change of output composition, and environmental awareness and policies, it can be difficult to identify associations between particular types of pollution proxy and economic growth as they influence the relationship between environmental protection and economic growth, which is the main constraint of applying aggregated data (Panayotou, 1997). Finally, in the early studies of Grossman and Krueger (1991), Grossman and Krueger (1995), Holtz-Eakin and Selden (1995), and Heil and Selden (2001) economic growth and environmental degradation nexus under the EKC model was tested without any explanatory variables but according to Saboori et al. (2012), the amount of carbon dioxide emissions is dependent not only on economic growth so additional economic explanatory variables should be considered as potential reasons for CO_2 emissions. Thus, there are various reasons for the different directions of the relationship between the quality of the environment and economic growth.

1.3 Summary of the literature review

Overall, the review of the previous studies indicated that the impact of globalization and trade openness on CO_2 emissions in the framework of the EKC hypothesis is not clear. It can be summarized that the influence of globalization on the environment has been assessed either through globalization indicators such as trade openness, or through overall, economic, social, and political globalization indices in different countries and regions. Hence, most of the scholars used the KOF Globalization index to measure the impact of different types of globalization on pollution. With respect to trade openness as an indicator of globalization, previous scientific works revealed that it can be either detrimental or beneficial to our environment, impacting it directly or indirectly through scale, technical, or composition effects. However, there was no consensus reached on the direction of the relationship between globalization and environmental pollution. While some studies confirmed the negative influence of globalization on carbon dioxide emissions, others highlighted its positive influence on them.

Induced by globalization economic growth, being one of the key contributors to emissions, was also analyzed in the literature review section. In the majority of studies, the relationship between economic growth and the environment was demonstrated through the Environmental Kuznets Curve (EKC) hypothesis, according to which economic growth is beneficial to the environment in the long run. However, while most of the scientific works supported this hypothesis, some of them rejected it, indicating that economic growth can be detrimental to the environment in the long run, which depends on the level of development of the country.

Although Rahman et al. (2020) in their study investigated the long-run relationship between economic growth, financial development, trade, energy consumption, foreign direct investment, and CO_2 emissions under the framework of the EKC hypothesis for the case of Lithuania, there has apparently been no empirical study for Lithuania that examines the nexus of globalization, trade openness, and economic growth with CO_2 emissions using the EKC framework. Therefore, the present study will fill this research gap, contributing to the existing literature.

2. RESEARCH METHODOLOGY

Carbon dioxide emissions (CO2) in this thesis are going to be studied from the perspective of globalization and certain globalization-induced factors such as trade openness and economic growth in Lithuania because there are no significant studies made that can provide information about how much globalization in a combination of the abovementioned factors is related to CO2 emissions. Collected results are going to help highlight and evaluate the significance between CO2 emissions and the above globalization-induced factors.

In this chapter of the thesis, all research methods that will be used for the collection and processing of data are discussed as well as a detailed description of dependent and independent research variables and instructions for the data analysis steps are included.

In order to achieve an accurate outcome of the study the following empirical study objectives will be followed step by step:

- To conduct the descriptive analysis of the four variables to measure the standard deviation, the mean, minimum, and maximum values as well as medians of the variables;
- To apply the Autoregressive Distributed Lag Approach (ARDL) of cointegration to examine the framework of the Environmental Kuznets Curve (EKC) hypothesis for Lithuania and to test the existence of long-run relationships between variables;
- To present a conclusion by drawing attention to the necessity of taking measures for decreasing CO2 emissions.

2.1 Methodology of data collection

2.1.1 Description of research variables

Independent variables (causes): globalization (the KOF globalization index), trade openness, economic growth (GDP).

1) *Globalization* – is the key independent variable of interest, measured as the overall KOF Globalization Index, which was created by Dreher (2006), it will be used to evaluate the degree of globalization. The globalization variables are between 0–100, and 100 refers to the highest globalization level. Consisting of economic, social, and political aspects of globalization, this index is used to observe changes in the degree of globalization of countries over a long period of time (KOF Swiss Economic Institute, n.d.a). Hence, economic globalization, being one of the components of overall globalization, is a compound measure incorporating the variables as follows: trade, stocks, portfolio investment, income payments to foreign nationals (in percent of GDP) as well as foreign direct investment, hidden import barriers, mean tariff rate, taxes on international trade, and capital account restrictions (Goryakin et al., 2015). Social

globalization, being the second component of overall globalization, consists of such variables as telephone traffic transfers, international tourism, foreign population, number of McDonald's restaurants, number of Ikea, and trade in books (Goryakin et al., 2015). And political globalization, being the third component in overall globalization, is measured based on the number of overseas embassies, membership in international organizations, and involvement in the United Nations. (Goryakin et al., 2015). The decision to choose the overall KOF globalization index is consistent with the recent studies of Zafar et al. (2019), Saint Akadiri et al. (2019), Khan et al. (2021), and Wen et al. (2021).

2) *Trade openness* - measures the extent to which a country participates in the global trading system. The degree of openness is measured by the size of registered imports and exports of the country. (Mazumdar et al., 2019). The selection of this independent variable, which is utilized in percent, corresponds to the scientific works of Tiwari et al. (2013), Kasman and Duman (2015), Bento and Moutinho (2016), Ahmed et al. (2016a), Ahmed et al. (2016b), Kalaycı and Hayaloğlu (2019), which found positive associations between trade openness and carbon dioxide emissions.
3) *Economic growth* – will be measured by gross domestic product (GDP) per capita, that is the sum of gross value added by all resident producers in the economy plus any product taxes not included in the valuation of output, divided by midyear population. GDP per capita defines a country's economic output per each person living there. (The World Bank, n.d.). Since different researchers confirmed that GDP per capita affects environmental emissions (Destek, 2020; Liu et al., 2020; Wen et al., 2021; Fávero et al., 2022; and Khan et al., 2022), this variable was included in the thesis.

Dependent variables (effect): carbon dioxide emissions (CO2) emissions.

CO2 emissions are emissions deriving from the burning of fossil fuels and the manufacture of cement; they include CO2 produced during the consumption of solid, liquid, as well as gas fuels and flaring. Carbon dioxide emissions are the main cause of global climate change, making up the vast majority of greenhouse gas emissions (Eurostat, n.d.).

The study analyzes anthropogenic CO2 emissions in metric tons per capita to examine environmental pollution deriving from global warming.

2.1.2 Research questions & research model

Based on the literature review and the information that was possible to collect through it, in order to conduct the research, the following research questions were developed:

RQ1: Is the EKC hypothesis valid in the case of Lithuania?

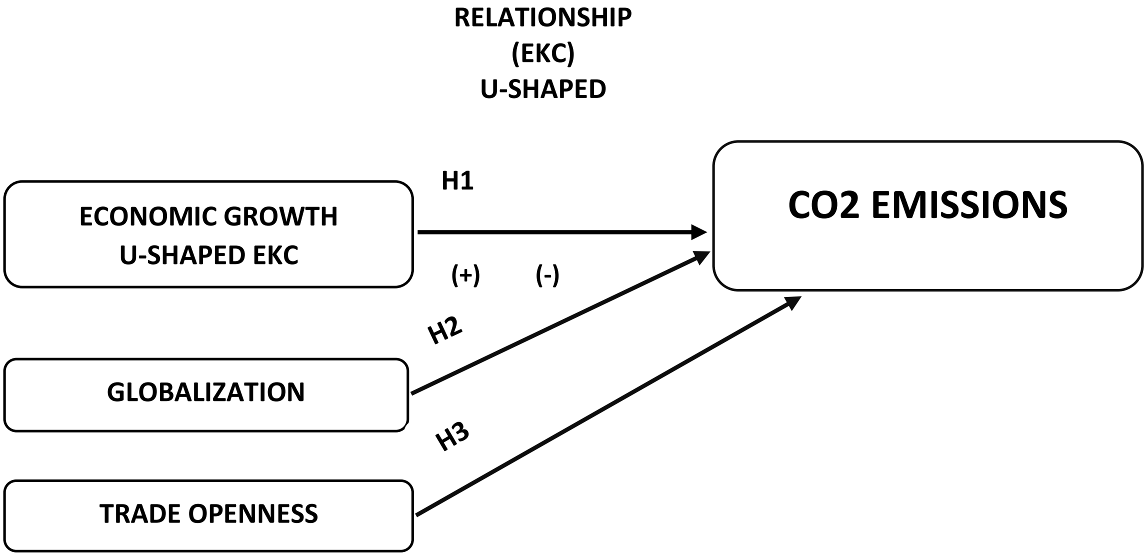
RQ2: Is there an impact caused by globalization on CO2 emissions in Lithuania?

RQ3: Is there an impact caused by trade openness on CO2 emissions in Lithuania?

Based on the research questions and the information gathered while analyzing and systematizing previous studies on this topic, the following research model was designed (see *Figure* 1):

Figure 1

Research Model



Source: author

The arrows of this model show the relationships between the independent variables and the dependent variable which will be tested. The U-shaped relationship between economic growth and CO_2 emissions will also be tested to find out whether the environmental conditions degenerate firstly and then improve after reaching a threshold level while economic growth increases. This will show whether economic growth is beneficial to the environment in Lithuania in accordance with the EKC hypothesis.

The research hypotheses are explained as follows:

H1: GDP per capita has an inverted U-shape relationship with CO_2 emissions (EKC hypothesis).

H2: Globalization increases CO_2 emissions.

H03: Trade openness does not influence CO_2 emissions.

H3: Trade openness increases CO_2 emissions.

The abovementioned hypotheses were made based on the analyzed literature on the effects of globalization on carbon dioxide emissions and the Environmental Kuznets Curve (EKC). Thus, Rahman et al. (2020) tested the Environmental Kuznets Curve (EKC) relationship for economic growth in Lithuania and revealed the U-shaped relation between CO_2 emissions and economic growth, validating the EKC hypothesis in the long and short run. Therefore, it was assumed in H1 that economic growth is advantageous to pollution in Lithuania. Moreover, H2, which states that globalization increases CO2 emissions, was assumed on the basis of the scientific works of Shahbaz et al. (2017a) for 25 developed countries in Asia, North America, Western Europe, and Oceania, Shahbaz et al. (2017d) for Japan, Solarin et al. (2017) for Malaysia, and Destek (2020) for 12 countries in Central and Eastern Europe, which, using the ARDL model, confirmed that globalization increases emissions. Lastly, it was assumed in H3 that trade openness increases carbon dioxide emissions in accordance with the time-series single-country studies of Bento and Moutinho (2016) for Italy and Tiwari et al. (2013) for India. However, H03 was also included stating that trade openness does not influence CO2 emissions since according to Ohlan (2015), the statistically significant influence of trade openness on CO2 emissions was not found for India.

2.1.3 Data gathering

Considering the aim of the thesis the official channels of secondary data will be the most appropriate to collect data for the present research. Secondary data is data that has been collected for purposes other than the problem at hand. Boslaugh (2007) defined this type of data as "the analysis of data gathered by someone else". Usually, government institutions provide highly reliable and comprehensive data that allows scholars to increase the validity of their research by receiving more precise outcomes.

In order to conduct the research, the data on CO2 emissions in metric tons per capita, GDP in EUR per capita, overall KOF globalization index, and trade openness (percentage of the trade in GDP) will be obtained. To collect the annual time series data on the abovementioned dependent and independent variables, which consists of twenty-five annual observations from 1995 to 2019 for Lithuania, four sources of secondary data were used, namely the Lithuanian Official Statistics Portal, the World Bank, KOF Swiss Economic Institute, and Our World in Data. The limited availability of such an independent variable as GDP in EUR per capita restricts the research to this time frame for Lithuania.

The Lithuanian Official Statistics Portal is the official database of Lithuania where statistics regarding the topics of economy, society, and environment can be found. The majority of databases are yearly renewable and provided in English (Lithuanian Official Statistics Portal, n.d.). At the World Bank, the Development Data Group coordinates statistical and data work and maintains multiple macro, financial, and sector databases in accordance with professional data collection standards so that all data users can get accurate data (World Bank Open Data, 2022). The KOF Swiss Economic Institute has gathered a unique amount of Swiss and international data, especially KOF data (KOF Swiss Economic Institute, n.d.b). Our World in Data (OWID) is a scientific internet platform that, concentrating on important world issues, uses different diagrams and maps to show study results. The research team is located in the University of Oxford. (Our World in Data, n.d.a).

2.2. Methodology of data processing

The following approaches will be applied to analyze the gathered data using EViews statistical software:

1. *Descriptive statistical data analysis:*

This method will be used to describe secondary data taken from the official databases. The information on the standard deviation, the mean, minimum, and maximum values as well as medians of all the variables will be provided.

2. *Autoregressive distributed lag (ARDL) cointegration analysis*

The Autoregressive Distributed Lag Approach (ARDL) to cointegration will be used to examine the impact of globalization on the CO2 emissions and the framework of the Environmental Kuznets Curve (EKC) hypothesis for Lithuania to know whether the underlying variables in the model are cointegrated or not. This technique was proposed by Pesaran and Shin (1995) and Pesaran et al. (1996). The ARDL technique has different benefits compared to the cointegration methods of Engle and Granger (1987), Johansen (1988), and Johansen and Juselius (1990): a) all the variables in the system don't need to be of equal order of integration except I (2), (b) even if samples are small and there is endogeneity because ARDL technique doesn't have residual correlation it is still efficient estimator, (c) variables may have different optimal lags, (d) this approach helps in identifying the cointegrating vectors meaning that it has a single reduced form equation relationship between the dependent variable and the exogenous variables (Pesaran et al. 2001). However, it may be necessary to carry out the unit root test to be sure that the order of integration of the variables is I(0) or I(1) before proceeding to the estimation stage. This test will be useful since the critical bounds provided by Pesaran et al. (2001) and Narayan (2005) won't be valid if the order of integration of the variables is bigger than one, for example an I(2) variable. The weighted symmetric ADF test (ADF-WS) of Park and Fuller (1995) will be used as a unit root test.

The ARDL bounds testing technique comprises two steps to estimate the long-run relationship. The first step lies in the determination of cointegration through the bound test to confirm the existence of a long-run relationship among all variables in the equation. The second step lies in the estimation of the long-run and short-run models. The bounds testing is based on the joint F-statistic or Wald statistic (Narayan, 2005), while the former tests the significance of association, and the letter tests the significance of all the variables in the cointegration test. If the calculated F-statistics lies above the upper level of the band, after comparing of the value of the F-statistic with critical values of upper and lower bound, cointegration exists.

The reason behind choosing that methodology for data processing was that the ARDL model is the most commonly used in similar single-country studies such as the research of Ozturk and Acaravci (2013) for Turkey and Rahman et al. (2020) for Lithuania where the validity of EKC hypothesis and the causality between CO_2 emissions and other independent variables are tested.

3. EMPIRICAL RESULTS ANALYSIS

This chapter of the thesis represents what has been studied in the course of research and reports the findings of the empirical study. The third part consists of several subsections following the order of statistical methods presented in sub-segment 2.2. The results are outlined in the following order:

- Firstly, the descriptive analysis of the four variables will be conducted, calculating the standard deviation, the mean, minimum, and maximum values as well as medians of the variables;
- Secondly, the results of autoregressive distributed lag (ARDL) cointegration analysis, which tests whether there is a long-run relationship among the variables, will be presented;

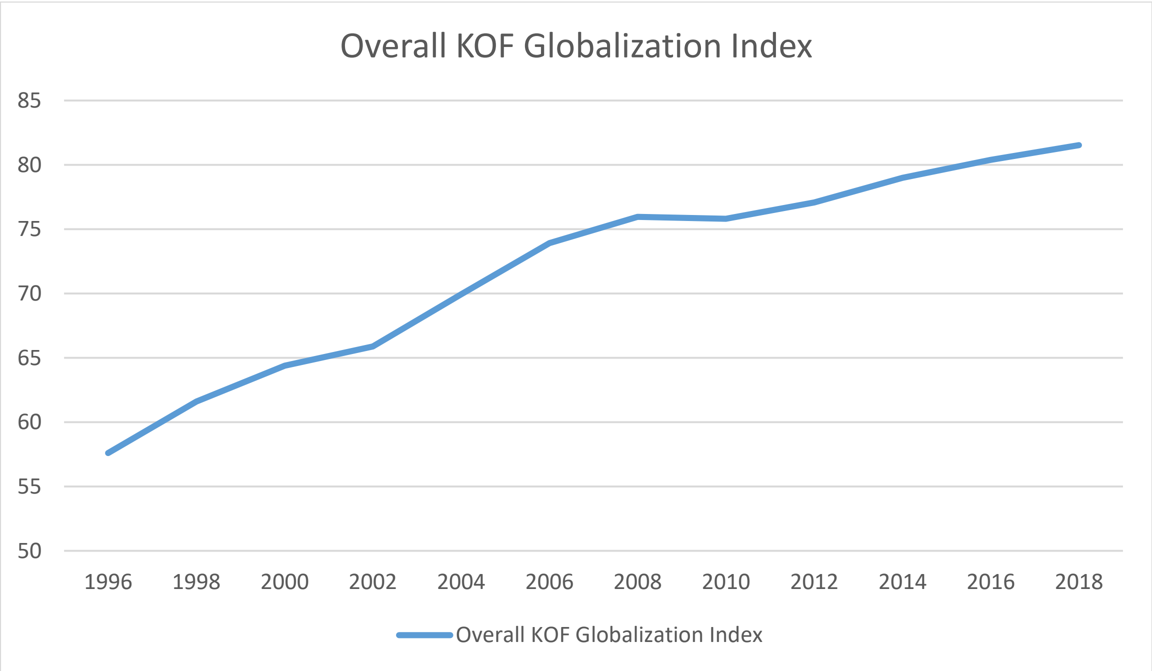
3.1 Descriptive analysis results

The annual trends of the 4 variables analyzed in the research for the period of 1995-2019 for Lithuania are presented in *Annex 1*.

Figure 2 shows the trend of globalization in Lithuania over the period 1995-2019.

Figure 2

The Overall KOF Globalization Index in Lithuania over the period 1995-2019



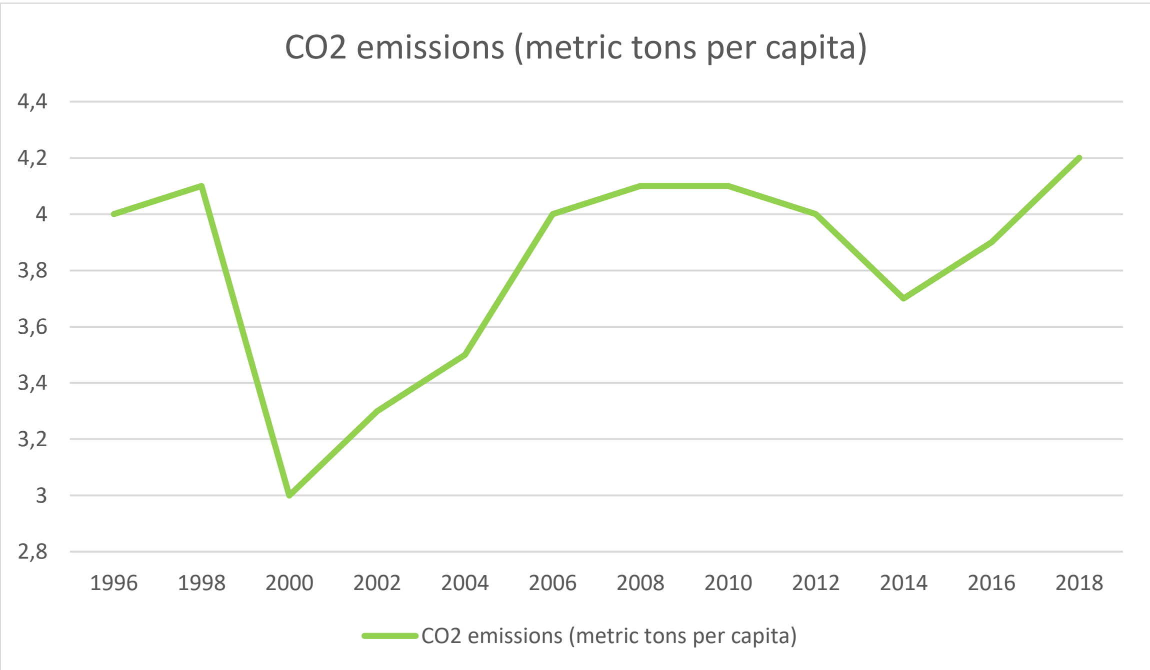
Source: KOF Swiss Economic Institute

It can be seen from *Figure* 2 that the overall KOF globalization index kept increasing in the long run, which means that Lithuania actively participated in the economic, social, and political dimensions of the globalization process. From an economic perspective this can be explained by the fact that after Lithuania became an independent state, it started shifting from centrally planned and excluded from the global market economies to private markets (Stark and Bruszt, 1998). Such a transition was accompanied by the increasing development of export activities that connected the economy of Lithuania to the world's economy (Bandelj and Mahutga, 2010). However, the globalization level remained stable between 2008 and 2010 which can be explained by the crisis of 2008-2009, which caused huge disruptions in global trade and financial flows.

With respect to environmental pollution, it can be seen from *Figure* 3 that carbon dioxide emissions per capita fluctuated during the period of 25 years in Lithuania. There was a sharp drop in CO2 emissions from 4.1 to 3 metric tons between 1998 and 2000, which coincides with the time when Lithuania signed the Kyoto Protocol (1998), undertaking to reduce its greenhouse gas emissions (Ministry of Environment of the Republic of Lithuania, 2006). Then the emission figures rose back to 4.1 metric tons per capita in 8 years, remaining stable between 2008 and 2010 due to the 2008-2009 crises. Lastly, there was one more drop in emissions between 2010 and 2014 which marks the first commitment period under the Kyoto Protocol when the country was obliged to lower its emissions by 8% (Ministry of Environment of the Republic of Lithuania, 2006).

Figure 3

CO2 emissions in metric tons per capita in Lithuania over the period 1995-2019

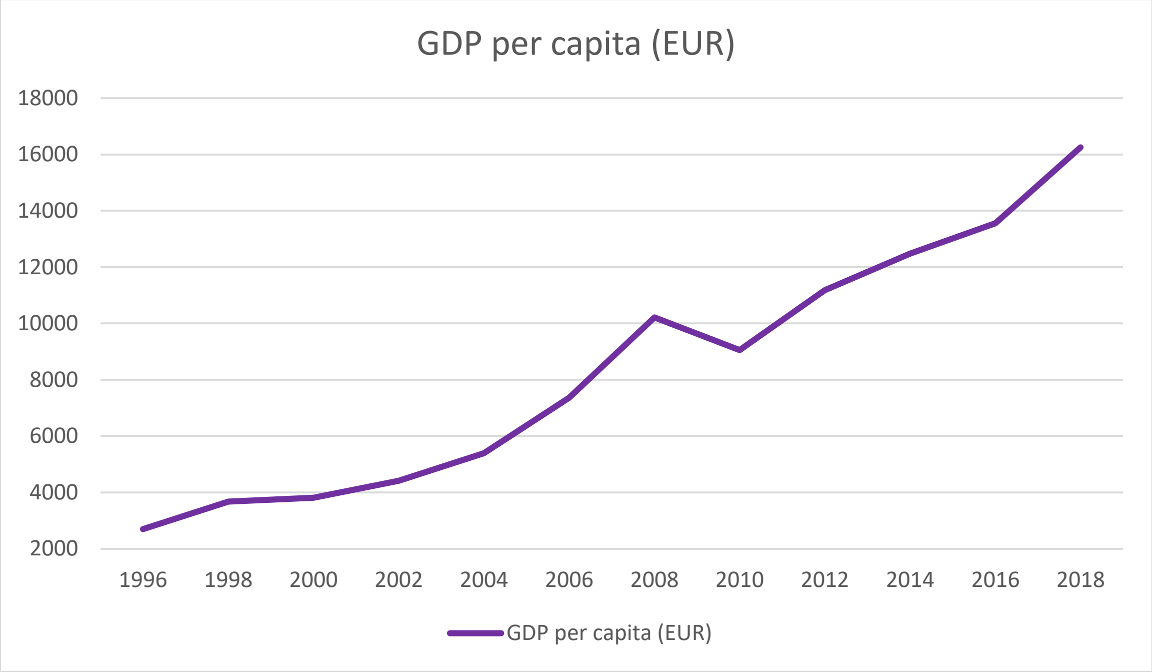


Source: World Bank Open Data

Figure 4 represents economic growth, measured in GDP per capita, in Lithuania between 1995 and 2019. Similarly, GDP per capita kept gradually rising as the KOF globalization index in the long run. Furthermore, a more rapid rise in GDP per capita is noticeable starting from 2004, the year when Lithuania joined the EU. Hence, the country received 10 billion euros as financial aid which enhanced economic growth. However, there was a slight decrease in GDP per capita from 10000 to 9000 euros between 2008 and 2010 caused by the 2008-2009 crisis, when a decline in domestic production occurred (Ministry of Foreign Affairs of the Republic of Lithuania, 2016).

Figure 4

GDP per capita (EUR) in Lithuania over the period 1995-2019

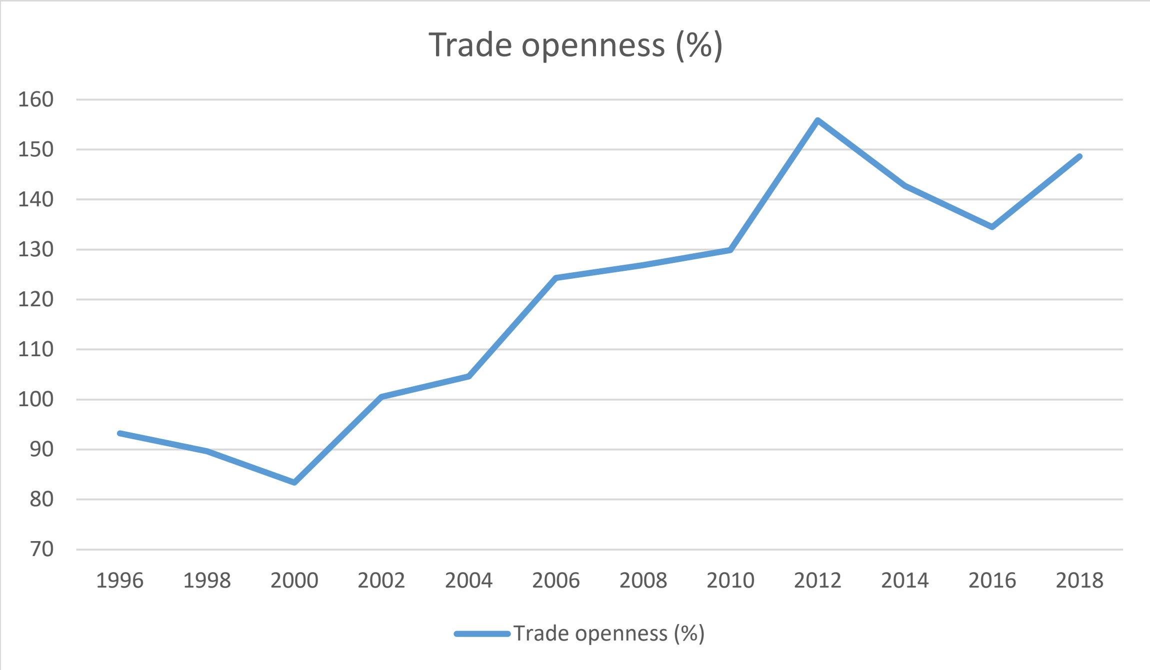


Source: Lithuanian Official Statistical Portal

Figure 5 displays the trend of trade openness in Lithuania over the period 1995-2019. The percentage of trade openness kept climbing in a fluctuant way from 90% to 150 %. However, reaching the highest figure of around 155% in 2013, trade openness noticeably dropped over the next 3 years. Such a sudden decrease can be justified by the decline in trade ties of Lithuania with russia when the terrorist state started military aggression against Ukraine in 2014.

Figure 5

Trade openness (%) in Lithuania over the period 1995-2019



Source: Our world in data

Table 1 provides the general descriptive statistics for one dependent variable and six independent variables employed in the analysis of the Lithuanian economy.

Table 1

Descriptive statistics for all four variables in Lithuania over the period 1995-2019

	CO2	GDP	KOF	TO
Mean	3.800000	8373.712	71.68000	118.4972
Median	3.900000	8503.900	74.64000	117.4800
Maximum	4.200000	17503.90	81.83000	155.8900
Minimum	3.000000	2138.500	53.76000	74.82000
Std. Dev.	0.327872	4580.776	8.259040	25.45043
Skewness	-0.919381	0.364930	-0.576434	-0.024120
Kurtosis	2.895709	1.951471	2.144325	1.646718
Jarque-Bera	3.533251	1.700113	2.147172	1.910102
Probability	0.170909	0.427391	0.341781	0.384792
Sum	95.00000	209342.8	1792.000	2962.430
Sum Sq. Dev.	2.580000	5.04E+08	1637.082	15545.39
Observations	25	25	25	25

Source: author.

The figures in *Table* 1 show that the average CO2 emissions in Lithuania have been 3.8 metric tons per capita, the average GDP per capita has been 8373.7, the average overall KOF globalization index was 71.7, and the average trade openness was 118.5% for the period of 1995-2019. The lowest GDP per capita, representing economic growth, was 2138.5 EUR, whereas the highest GDP per capita was 17503.9 EUR during this period. With respect to pollution, the lowest level of CO2 emissions per capita accounted for 3 metric tons, while the highest level was 4.2 metric tons per capita. Regarding globalization, its smallest index was 53.8, while the largest index accounted for 81.8. Lastly, the lowest trade openness was 74.8%, while the highest was 155.9%. Evidently, all the variables considered show little difference in their means and medians. The standard deviation shows us how data is spread and how much it varies from the average. Looking at probability in Jarque-Bera test, it can be concluded that every variable is normally distributed as their probability is above the significance level of 0.05.

3.2 Autoregressive distributed lag (ARDL) cointegration analysis

To analyze the impact of globalization on environmental pollution and the existence of the EKC hypothesis, the variables of globalization, trade openness, economic growth, and pollution were incorporated in the study. In this framework, following the empirical literature, the basic model in functional form is presented in *Equation 1* as follows.

$$CO2 = f\ (GDP, GDP2, KOF, TO) \quad (1)$$

Equation 1 includes CO2 emissions (CO2), gross domestic product (GDP), the square of gross domestic product (GDP2), KOF Globalisation Index (KOF), and trade openness (TO). The variables in question are converted into natural logarithms for consistent and reliable results, which can be seen in the EKC model given in *Equation 2.* Such an approach is frequently used in scientific works investigating the causes of anthropogenic emissions (Rosa et al., 2004; Rosa and Dietz, 2012).

Model 1.

EKC model

$$lnCO2t = \gamma 0 + \gamma 1 ln\text{GDPt} + \gamma 2 ln\text{GDPt2} + \gamma 3 ln\text{KOFt} + \gamma 4 ln\text{TOt} + \epsilon t \quad (2)$$

Where, ln CO2t = log of carbon emission per capita; ln GDPt = log of GDP per capita; ln GDP2t = long GDP per capita square; ln KOFt = log of KOF Globalization Index; ln TOt = log of trade openness; $\gamma 1$, $\gamma 2$, $\gamma 3$, $\gamma 4$ are coefficient estimates on the relevant variables; t = time; and ϵt = error term.

It is required by the EKC theory $\gamma1$ to be positive and significant and $\gamma2$ to be negative and significant. The EKC hypothesis claims that the first stage of economic growth results in adverse consequences to the environment, but the adverse consequences decrease when the growth rate surpasses a specific turning point.

In order to run the ARDL model it is important to check the stationarity of all the time series variables by the Unit Root Test. If variables have different orders of integration that is some variables are stationary at the level and some are stationary at the first difference, then the ARDL test is performed. But it is important to assure that all the variables are stationary for the construction of the ARDL model. Hence, the weighted symmetric ADF test (ADF-WS) of Park and Fuller (1995) was utilized as a unit root test. The unit root test was performed in level and first differences for all the variables. An intercept was chosen to include in test equation. The lag length was automatically selected through Schwarz info criterion in the case of each variable.

Table 2 displays the results of the unit root test performed for all the variables and it is visible that all the analyzed variables are stationary in first differences, but not stationary in levels (*Annex* 2). Such a conclusion was made on the basis of probability results. Every analyzed variable, except for Ln(KOF), has a probability higher than 0.05, which means that these variables have unit roots in levels. Therefore, all variables are used in the first differences in the ARDL model, when the probability results are lower than 0.05.

Table 2

Unit root test results

Variable	**Levels**		**The first differences**	
	t-stat	**Prob**	**t-stat**	**Prob**
Ln(CO2)	-1.7055	0.4159	-4.6119	0.0014
Ln(KOF)	-4.4754	0.0019	-3.9844	0.0062
Ln(GDP)	-1.8009	0.3710	-3.8931	0.0073
Ln(TO)	-1.2364	0.6412	-4.7886	0.0009
Ln(GDP^2)	-1.8009	0.3710	-3.8931	0.0073

Source: author

After checking the variables for stationarity, the next step was to specify the ARDL model and select the best number of lags. Akaike's information criterion was chosen for model selection. Overall, 192 models were evaluated, while ARDL (1, 3, 2, 0) model was selected. *Table* 3 displays the result of the ARDL model with 3 lags for independent variable and repressors in first differences.

Table 3

ARDL model results on the relationship between variables

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(LCO2_EMISSIONS__METRIC_TONS...	0.379748	0.264161	1.437562	0.1811
D(LGDP_PER_CAPITA__EUR_)	0.172989	0.333052	0.519406	0.6148
D(LGDP_PER_CAPITA__EUR_(-1))	-0.698381	0.319920	-2.182986	0.0540
D(LGDP_PER_CAPITA__EUR_(-2))	0.668450	0.276708	2.415726	0.0363
D(LGDP_PER_CAPITA__EUR_(-3))	-0.467332	0.168709	-2.770051	0.0198
D(LOVERALL_KOF_GLOBALISATION_...	-1.484387	1.370626	-1.082999	0.3042
D(LOVERALL_KOF_GLOBALISATION_...	4.101880	1.681594	2.439281	0.0349
D(LOVERALL_KOF_GLOBALISATION_...	-2.705359	1.433626	-1.887075	0.0885
D(LTRADE_OPENNESS___)	0.278080	0.203745	1.364844	0.2022
C	0.026650	0.031406	0.848538	0.4160

R-squared	0.727797	Mean dependent var	0.001205
Adjusted R-squared	0.482814	S.D. dependent var	0.073367
S.E. of regression	0.052762	Akaike info criterion	-2.739193
Sum squared resid	0.027838	Schwarz criterion	-2.241327
Log likelihood	37.39193	Hannan-Quinn criter.	-2.642004
F-statistic	2.970809	Durbin-Watson stat	1.579991
Prob(F-statistic)	0.052480		

*Note: p-values and any subsequent tests do not account for model selection.

Source: author

It is noticeable from the results of this ARDL model that the R-squared is 72%, which means that the model is a good fit. The probability (F-statistic) is 0.05, which means that the overall model is significant. Ln(GDP) (-2) is statistically significant as the probability is 0.0363, <0.05, and the t-Statistic is 2.4, which is > 2. Hence, the rise in GDP by 1% results in a rise of CO2 emissions by 0.7% in the short-run. Ln(KOF) (-2) is statistically significant as the probability is 0.0349, and the t-Statistics is 2.4, which is >2. Thus, the rise in the overall KOF globalization index by 1% results in the rise of CO2 emissions by 4% in the short run. With respect to Ln(TO), the result is insignificant as the probability is higher than 0.05, and the t-Stat is lower than 2.

The next step in the present analysis is presented in *Table* 4, where the long-run relationship between the variables is tested. The result of the bound test is inconclusive as the value of the F-statistic (3.35) is between the values of upper bound l(1), which is 3.67, and the lower bound l(0), which is 2.79 at the 5% significance level. All the dependent variables are insignificant, which means that there is no long-run relationship between globalization, economic growth, and trade openness with CO2 emissions.

Table 4

ARDL Long Run Form and Bounds Test

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP_PER_CAPIT...	-0.522809	0.988021	-0.529148	0.6082
D(LOVERALL_KOF_G...	-0.141662	3.465182	-0.040882	0.9682
D(LTRADE_OPENNE...	0.448333	0.428499	1.046289	0.3201
C	0.042966	0.057594	0.746010	0.4728

EC = D(LCO2_EMISSIONS__METRIC_TONS_PER_CAPITA_) - (-0.5228 *D(LGDP_PER_CAPITA__EUR_) -0.1417*D(LOVERALL_KOF_GLOBALISATION_INDEX) + 0.4483*D(LTRADE_OPENNESS___) + 0.0430)

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	3.355722	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
Actual Sample Size	20		Finite Sample: n=30	
		10%	2.676	3.586
		5%	3.272	4.306
		1%	4.614	5.966

Source: author

Lastly, the EKC hypothesis was tested through the ARDL model and *Table* 5 reveals the results with 3 lags for independent variable and repressors. Akaike's information criterion was chosen for model selection. Overall, 48 models were evaluated, while ARDL (1, 1, 1) model was selected.

Table 5

ARDL model results on the EKC hypothesis

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CO2_EMISSIONS__METRIC_TONS_P...	0.607141	0.142637	4.256557	0.0005
GDP_PER_CAPITA__EUR_	0.000965	0.000347	2.780072	0.0124
GDP_PER_CAPITA__EUR_(-1)	-0.001005	0.000373	-2.694658	0.0148
GDPS	-4.11E-08	1.79E-08	-2.289988	0.0343
GDPS(-1)	4.73E-08	2.10E-08	2.258244	0.0366
C	1.212338	0.531216	2.282196	0.0349

R-squared	0.733962	Mean dependent var	3.800000
Adjusted R-squared	0.660063	S.D. dependent var	0.334924
S.E. of regression	0.195274	Akaike info criterion	-0.216505
Sum squared resid	0.686377	Schwarz criterion	0.078009
Log likelihood	8.598058	Hannan-Quinn criter.	-0.138370
F-statistic	9.931920	Durbin-Watson stat	2.125183
Prob(F-statistic)	0.000109		

*Note: p-values and any subsequent tests do not account for model selection.

Source: author

It can be concluded from the results of this ARDL model that the R-squared is 73%, which means that the model is a good fit. The probability (F-statistic) is 0.0001, which means that the overall model is significant. GDP is statistically significant as the probability is 0.01, <0.05, and the t-Statistic is 2.8, which is > 2. GDPS (GDP^2) (-1) is statistically significant as the probability is 0.04, and the t-Statistics is 2.2, which is >2. However, both variables GDP and GDPS have positive signs next to their coefficients, which means that the main condition for the validation of the EKC hypothesis is not supported. In accordance with this hypothesis, it can only be confirmed when the coefficient of the GDP is positive and significant and the coefficient of the GDPS is negative and significant.

3.3 Discussion

Overall, after conducting the ARDL analysis, the relationship between the independent the dependent variables in Lithuania over the period 1995-2019 was established by testing the hypotheses mentioned in the research methodology. Hence, the empirical results suggest that the Environmental Kuznets Curve (EKC) hypothesis is not valid for Lithuania as H1, assuming that GDP per capita has an inverted U-shape relationship with CO2 emissions, is rejected by the results of the analysis. The analysis failed to confirm that the first phase of economic growth results in adverse consequences to the environment, but the adverse consequences decrease when the growth rate reaches a certain turning point. However, it was revealed that the increase in economic growth resulted in greater CO2 emissions in the short run. Similarly, to the findings of the thesis, the existence of the EKC hypothesis was not found in the studies of Akbostancı et al. (2009) and Ozturk and Acaravci (2010) for Turkey as well as Dogan and Turkekul (2016) for the USA. On the other hand, the failure to validate the EKC hypothesis contradicts the findings of Rahman et al. (2020) as the researchers confirmed the U-shaped relation between CO2 emissions and economic growth, implementing the same methodology, in the case of Lithuania. The reason for the opposite results may lie in the fact that the authors had 30 observations for Lithuania, which helped them to run the ARDL model more sufficiently, compared to the present thesis which included only 25 observations due to the limitation of the availability of secondary data.

It was also found that globalization results in higher pollution levels in Lithuania. As the rise in the overall KOF globalization index by 1% increases CO2 emissions by 4% in the short run. Therefore, H2, assuming that globalization increases CO2 emissions, was supported, as empirical results showed that globalization increases pollution. This finding is consistent with the results of Shahbaz et al. (2017a) for 25 developed, Shahbaz et al. (2017d) for Japan, and Solarin et al. (2017) for Malaysia, as the authors stated that globalization increases CO2 emissions after investigating the nexus of these variables using the ARDL model. However, Destek and Ozsoy

(2015) and Shahbaz et al. (2017c) received the opposite results, having discovered that globalization decreases CO_2 emissions in Turkey and China.

Lastly, H3, assuming that trade openness increases CO_2 emissions, was not validated in the case of Lithuania as the result was not significant. But, H03 was supported as the value of trade openness was insignificant, meaning that it hardly affects CO_2 emissions. Although the empirical result was opposite to the results of other similar time-series single-country studies of Bento and Moutinho (2016) for Italy and Tiwari et al. (2013) for India, it does not contradict the findings of Ohlan (2015) for India as the author didn't find the statistically significant influence of trade openness on CO_2 emissions too. Therefore, although trade openness is an important aspect of globalization, in contrast with the effects of overall globalization on CO_2 emissions, it has an insignificant influence on pollution. That implies trade openness is not a cause of globalization-induced pollution in Lithuania.

CONCLUSIONS AND SUGGESTIONS

1. The purpose of the thesis was to evaluate the impact of globalization on CO_2 emissions while testing the EKC hypothesis in Lithuania over the period 1995-2019. In order to accomplish this aim, different previous studies were systemized and analyzed. Overall, the literature analysis indicated that the impact of globalization and trade openness on CO_2 emissions in the framework of the EKC hypothesis is ambiguous. While some scientific works assessed the influence of globalization on the environment through globalization indicators such as trade openness, others tested this relationship using overall, economic, social, and political globalization indices. The analysis showed that the KOF Globalization index is used the most frequently to measure the impact of different types of globalization on pollution. However, there was no consensus reached on the effects of globalization on CO_2 emissions. While some studies confirmed the negative influence of globalization on CO_2 emissions, others highlighted its positive impact on them.
2. Economic growth was also analyzed in the literature review part as this factor, being induced by globalization, is one of the main contributors to CO_2 emissions. Hence, it was discovered that many scientific works explain the relationship between economic growth and pollution through the Environmental Kuznets Curve (EKC) hypothesis, according to which economic growth is detrimental to the environment in the short run, but is beneficial to it in the long run. However, while most of the scientific works supported this hypothesis, some of them rejected it, stating that economic growth negatively affects the environment in the long run too. Therefore, having analyzed the previous works on this subject, it became necessary to study CO_2 emissions from the perspective of globalization and economic growth in Lithuania.
3. The main findings of the thesis showed that the Environmental Kuznets Curve (EKC) hypothesis is not valid for Lithuania, meaning that the ARDL model failed to confirm that environmental pollution firstly increases and later after reaching a certain level decreases while economic growth increases. Although, it was proven that in the short run economic growth increases CO_2 emissions. Moreover, the empirical results showed that globalization results in higher pollution levels in Lithuania, namely the rise in the overall KOF globalization index by 1% increases CO_2 emissions by 4% in the short run. Finally, the analysis revealed that trade openness does not influence CO_2 emissions as the value of trade openness was insignificant.
4. Considering the main findings of this research, Lithuania should study the following suggestions to achieve a better environmental state by reducing CO_2 emissions. Firstly, since the EKC hypothesis was rejected, it can be concluded that economic growth is a problem for

the environmental quality in Lithuania. Therefore, the present study recommends investing in environmental-friendly technologies and low-carbon manufacturing to not only diminish the negative impact of economic growth on pollution but also make it beneficial for the environment. Secondly, since the findings revealed that overall globalization increases CO_2 emissions in Lithuania, it is suggested that the Lithuanian government take measures to reduce the detrimental impact of globalization on the environment by implementing environmental policies.

5. Given the fact that one of the main limitations of the thesis was the limited number of observations for the analyzed variables as such secondary data was mostly available yearly starting from the second half of the 1990x, it would be interesting to do similar research for Lithuania through the ARDL model using a bigger number of observations or frequencies and see whether the result will be the same or not. Furthermore, additional independent globalization-induced variables such as foreign direct investment or energy consumption can be implemented in the EKC framework to run a more specific analysis of the influence of globalization on the environment. Future research could also test different aspects of globalization separately, to see how the specific aspect of globalization influences pollution levels in Lithuania.

SUMMARY

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THE INFLUENCE OF GLOBALIZATION ON CARBON DIOXIDE EMISSIONS IN LITHUANIA: TESTING ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS

Final Master Thesis

Academic supervisor Prof. Dr. Vincentas Giedraitis

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Faculty of Economics and Business Administration, Vilnius University

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The study was conducted with the aim to evaluate the impact of globalization on CO2 emissions while testing the EKC hypothesis in Lithuania.

The thesis consists of four main parts of literature analysis, a detailed research methodology, an analysis of the empirical results, and conclusions with recommendations. Literature analysis reveals the theoretical basis of the chosen topic and explains the relationships of globalization and trade openness with CO2 emissions as well as the framework of the EKC hypothesis. Moreover, the analyzed literature is fundamental for the design of the research model of the thesis. In accordance with the structure of the model, the specific methodology of data collection and data processing, namely descriptive analysis and autoregressive distributed lag (ARDL) cointegration analysis, were chosen to accomplish the aim of the study.

The analysis showed that the Environmental Kuznets Curve (EKC) hypothesis is not valid for Lithuania, meaning that the ARDL model failed to confirm that environmental pollution firstly increases and later, after reaching a certain level, decreases while economic growth increases. Although, it was proven that in the short run economic growth increases CO2 emissions. Moreover, the empirical results showed that globalization results in higher pollution levels in Lithuania, namely the rise in the overall KOF globalization index by 1% increases CO2 emissions by 4% in the short run. Finally, the analysis revealed that trade openness does not influence CO2 emissions as the value of trade openness was insignificant.

Considering the findings and literature review suggestions on lowering CO2 emissions and enhancement of environmental quality were given to the Lithuanian government.

SANTRAUKA

Sofija Osadčuk

GLOBALIZACIJOS ĮTAKA ANGLIES DVIDEGINIO IŠMETIMUI LIETUVOJE: APLINKOS KUZNETO KREIVĖS HIPOTEZĖS TIKRINIMAS

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Tyrimas atliktas siekiant įvertinti globalizacijos įtaką CO2 emisijai, tikrinant EKC hipotezę Lietuvoje.

Darbą sudaro keturios pagrindinės literatūros analizės dalys, išsami tyrimo metodika, empirinių rezultatų analizė, išvados su rekomendacijomis. Literatūros analizė atskleidžia teorinius pasirinktos temos pagrindus, paaiškina globalizacijos ir prekybos atvirumo sąsajas su CO2 emisija bei EKC hipotezės pagrindą. Be to, analizuojama literatūra yra esminė kuriant baigiamojo darbo tyrimo modelį. Atsižvelgiant į modelio struktūrą, tyrimo tikslui pasiekti buvo pasirinkta specifinė duomenų rinkimo ir duomenų apdorojimo metodika – aprašomoji analizė ir autoregresinė paskirstytosios vėlavimo (ARDL) kointegracijos analizė.

Analizė parodė, kad Aplinkos Kuzneco kreivės (EKC) hipotezė Lietuvai negalioja, o tai reiškia, kad ARDL modelis nepatvirtino, kad aplinkos tarša pirmiausia didėja, o vėliau, pasiekusi tam tikrą lygį, mažėja, o ekonomikos augimas didėja. Nors buvo įrodyta, kad trumpuoju laikotarpiu ekonomikos augimas padidina CO2 emisiją. Be to, empiriniai rezultatai parodė, kad globalizacija lemia aukštesnius Lietuvos taršos lygius, o bendras KOF globalizacijos indekso padidėjimas 1% trumpuoju laikotarpiu padidina CO2 emisiją 4%. Galiausiai, analizė atskleidė, kad prekybos atvirumas neturi įtakos CO2 emisijai, nes prekybos atvirumo vertė buvo nereikšminga.

Atsižvelgus į išvadas ir literatūros apžvalgą, Lietuvos vyriausybei buvo pateikti siūlymai dėl CO2 emisijų mažinimo ir aplinkos kokybės gerinimo.

REFERENCES

1. Acaravci, A., & Ozturk, I. (2010). On the relationship between energy consumption, CO2 emissions and economic growth in Europe. Energy, 35(12), 5412-5420. *ScienceDirect*. https://www.sciencedirect.com/science/article/pii/S0360544210003737?casa_token=cm_4VtM8udUAAAAA:_1g-oxfARjF1vBjRjknd3flF6EeZMfvzJOlW4ANBqbk0FCJ6q5XNy-2oF3v9bb6TLNb3YuphJ5s
2. Ahmed, K., Mahalik, M.K., & Shahbaz, M. (2016a). Dynamics between economic growth, labor, capital and natural resource abundance in Iran: an application of the combined cointegration approach. Policy 49, 213-221. *ScienceDirect*. https://www.sciencedirect.com/science/article/abs/pii/S0301420716301477
3. Ahmed, K., Shahbaz, M., & Kyophilavong, P. (2016b). Revisiting the emissions-energy-trade nexus: evidence from the newly industrializing countries. Environ Sci Pollut Res 23, 7676–7691. *Springer*. https://link.springer.com/article/10.1007/s11356-015-6018-x Akbostancı, E., Türüt-Aşık, S., & Tunç, G. İ. (2009). The relationship between income and environment in Turkey: is there an environmental Kuznets curve? Energy policy, 37(3), 861-867. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421508005624?casa_token=RzqCquOnxh0AAAAA:GTdOi41ZPfonGPecr5YyLS876UjSwg2E7yDOEbuUoMBq4gwVqJIJCOJfRu_A8IJi5Z15ibCGGgY
4. Akın, C.S. (2014), The impact of foreign trade, energy consumption and income on CO 2 emissions. International Journal of Energy Economics and Policy, 4(3), 465-475. *DergiPark.* https://dergipark.org.tr/en/pub/ijeeep/issue/31910/350827?publisher=http-www-cag-edu-tr-ilhan-ozturk
5. Alam, M. M., Murad, M. W., Noman, A. H. M., & Ozturk, I. (2016). Relationships among carbon emissions, economic growth, energy consumption and population growth: Testing Environmental Kuznets Curve hypothesis for Brazil, China, India and Indonesia. Ecological Indicators, 70, 466-479. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1470160X16303685
6. Al-Mulali, U., Ozturk, I., & Lean, H. H. (2015a). The influence of economic growth, urbanization, trade openness, financial development, and renewable energy on pollution in Europe. Natural Hazards, 79(1), 621-644. *Springer*. https://link.springer.com/article/10.1007/s11069-015-1865-9

7. Al-Mulali, U., Saboori, B., & Ozturk, I. (2015b). Investigating the environmental Kuznets curve hypothesis in Vietnam. Energy policy, 76, 123-131. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421514006272?casa_token=i-feaQ8unLAAAAAA:bMIVragox8Yfd3EjpSb2fBwGQ8h-s-CaDeAB6uzKl5Dj3O6tylazfEnFAUMXdlmNsMnRq-4MTxs
8. Ang, J. B. (2007). CO2 emissions, energy consumption, and output in France. Energy policy, 35(10), 4772-4778. *ScienceDirect*. https://www.sciencedirect.com/science/article/pii/S0301421507001498
9. Antweiler, W., Copeland, B. R., & Taylor, M. S. (2001). Is free trade good for the environment? *American economic review*, *91*(4), 877-908. *American Economic Association.* https://www.aeaweb.org/articles?id=10.1257/aer.91.4.877
10. Apergis, N., & Payne, J. E. (2009). CO2 emissions, energy usage, and output in Central America. Energy Policy, 37(8), 3282-3286. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421509002213?casa_token=i8Knaqp1Th4AAAAA:lDKTqFn5J6UoqAJg8TzvgBs62R2o6mMfkv_v3eZxQVYXkIdzOEg83ssiFgyQFpD52vN19piBZ-M
11. Apergis, N., & Ozturk, I. (2015). Testing environmental Kuznets curve hypothesis in Asian countries. Ecological indicators, 52, 16-22. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1470160X14005615?casa_token=T9bbxl2FV8gAAAAA:UgFHaA59FYmJxNNn-rDDB7NCHx08jWJbAA9aPdbyrPLUzVU0IXXW92kmBa_1twx4jWKormjjTrM
12. Arouri, M. E. H., Youssef, A. B., M'henni, H., & Rault, C. (2012). Energy consumption, economic growth and CO2 emissions in Middle East and North African countries. Energy policy, 45, 342-349. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421512001590?casa_token=UH4YvwHiWegAAAAA:S02LtPR85WYfRpG_jeKYr8XW4nzxOQKm77V5RUFojKOQreaivomj6aKEIXfTfd4NMjDGtzw1POM
13. Baek, J., & Kim, H. S. (2013). Is economic growth good or bad for the environment? Empirical evidence from Korea. Energy Economics, 36, 744-749. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0140988312003180?casa_token=B_7qfuiBjFEAAAAA:iIM9RAv8j58TVTTkD34YxqYpZV7r1f1FRvxU06ZqSEaT1_W7MJpIsRQSgZkwNi60ZoN7pMU90hI
14. Balsalobre-Lorente, D., & Shahbaz, M. (2016). Energy consumption and trade openness in the correction of GHG levels in Spain. Bulletin of Energy Economics, 4(4), 310-322. *Research gate.*

https://www.researchgate.net/publication/316155031_Energy_Consumption_and_Trade_Openness_in_the_Correction_of_GHG_Levels_in_Spain

15. Balsalobre-Lorente, D., Shahbaz, M., Roubaud, D., & Farhani, S. (2018). How economic growth, renewable electricity and natural resources contribute to CO2 emissions? Energy policy, 113, 356-367. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421517307255
16. Bandelj, N., & Mahutga, M. C. (2010). How socio-economic change shapes income inequality in post-socialist Europe. Social Forces, 88(5), 2133-2161. *Oxford Academic.* https://academic.oup.com/sf/article-abstract/88/5/2133/1891919
17. Bento, J. P. C., & Moutinho, V. (2016). CO2 emissions, non-renewable and renewable electricity production, economic growth, and international trade in Italy. Renewable and sustainable energy reviews, 55, 142-155. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S1364032115012307
18. Boslaugh, S. An Introduction to Secondary Data Analysis. (2007). *Academia.* https://d1wqtxts1xzle7.cloudfront.net/16662702/boslaugh__2007-libre.pdf?1390865011=&response-content-disposition=inline%3B+filename%3DAn_introduction_to_secondary_data_analys.pdf&Expires=1674734509&Signature=b1EtdZmDtv7J3rYnWVG7n9Hpw1k--KWINhkOn5hxu38USYENk2HKkkADjLj0lCOKQygdYJGhOGtE96QkV2xarJEnByemAgosfsikGcQ8-fSiNh2dHh4Z-JZ~8bUgQpuS7~kMAFwdv-SU6QFzj2WjOQxFB0f3rwcR3gJ~vKwQbx08WJebbeAAQ9tX9Fe5753rl5E-GE0mfCrvk7n26FlO3xRJhD1ZeA5MLFsSrFLHe~~esunD8GtrtpFtX3n0v3p10a-8c9taxfz3pPZPBuN2IDPyoK6UEdIRPzhP5oFCaH-OADuYZp~hHgOSCJ-tnMdEy-Apb2sLFLseZwgc9OgU1g__&Key-Pair-Id=APKAJLOHF5GGSLRBV4ZA
19. British Petroleum (BP). (2018). BP statistical review of world energy. https://www.bp.com/en/global/corporate/energy-economics/statistical-review-of-world-energy/downloads.html
20. Copeland, B.R., & Taylor, M.S. (2004). Trade, growth, and the environment. J. Econ. Lit. 42, 7–71. *American Economic Assosiation.* https://doi.org/10.1257/002205104773558047.
21. Destek, M. A. (2020). Investigation on the role of economic, social, and political globalization on environment: evidence from CEECs. Environmental Science and Pollution Research, 27(27), 33601-33614. *Springer*. https://link.springer.com/article/10.1007/s11356-019-04698-x

22. Destek, M., & Ozsoy, F., (2015) Relationships between economic growth, energy consumption, globalization, urbanization and environmental degradation in Turkey. *World Scientific*. https://www.worldscientific.com/doi/abs/10.1142/S2335680415500179
23. Destek, M. A., & Sinha, A. (2020). Renewable, non-renewable energy consumption, economic growth, trade openness and ecological footprint: evidence from organisation for economic Co-operation and development countries. Journal of Cleaner Production, 242, 118537. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0959652619334079
24. Dinda, S. (2004). Environmental Kuznets curve hypothesis: a survey. Ecological economics, 49(4), 431-455. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0921800904001570
25. Dinda, S. (2006). Globalization and environment: can pollution haven hypothesis alone explain the impact of globalization on environment?. *MPRA.* https://mpra.ub.uni-muenchen.de/id/eprint/50590
26. Dogan, E., & Seker, F. (2016). Determinants of CO2 emissions in the European Union: the role of renewable and non-renewable energy. Renewable Energy, 94, 429-439. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0960148116302622
27. Dogan, E., & Turkekul, B. (2016). CO2 emissions, real output, energy consumption, trade, urbanization and financial development: testing the EKC hypothesis for the USA, 1203–1213. *Springer*. https://link.springer.com/article/10.1007/s11356-015-5323-8
28. Dreher, A. (2006). Does globalization affect growth? Evidence from a new index of globalization. *Applied economics*, *38*(10), 1091-1110. *Taylor & Francis Online.* https://www.tandfonline.com/doi/abs/10.1080/00036840500392078
29. Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: journal of the Econometric Society, 251-276. *Jstor*. https://www.jstor.org/stable/1913236
30. Esteve, V., & Tamarit, C. (2012). Is there an environmental Kuznets curve for Spain? Fresh evidence from old data. Economic Modelling, 29(6), 2696-2703. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S026499931200257X?casa_token=WvxnjU7TqhcAAAAA:vPlVlJ79HXyMpfg7cSJPbrvsXbTm7zHjL4ce8GtlfCOJKUfFMeQkmcPPx0J6Rprn_cWVeD_7Fvs
31. Eurostat. (n.d.). Glossary: Carbon dioxide emissions. https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Carbon_dioxide_emissions
32. Eurostat. (2020). https://ec.europa.eu/eurostat/documents/2995521/10820684/8-06052020-BP-EN.pdf/e1dd6cf1-09b5-d7ee-b769-ffe63e94561e

33. Ewing, B. T., Sari, R., & Soytas, U. (2007). Disaggregate energy consumption and industrial output in the United States. Energy policy, 35(2), 1274-1281. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421506001248?casa_token=EgX6026enO8AAAAA:BCgxkjKGjlkCIqv6Jfc26lMLEAuKJd-ktMG-ZVQKt02adTY8J4sGVI0QKKJQQkFI9mbZaFc7c_k
34. Farhani, S., Chaibi, A., & Rault, C. (2014). CO2 emissions, output, energy consumption, and trade in Tunisia. Economic Modelling, 38, 426-434. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0264999314000285
35. Farhani, S., & Shahbaz, M. (2014). What role of renewable and non-renewable electricity consumption and output is needed to initially mitigate CO2 emissions in MENA region?. Renewable and Sustainable Energy Reviews, 40, 80-90. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1364032114006224
36. Fávero, L. P., De Freitas Souza, R., Belfiore, P., Roberto Luppe, M., & Severo, M. (2022). Global Relationship between Economic Growth and CO2 Emissions across Time: a Multilevel Approach. Int. J. Glob. Warming 26 (1), 38. *InderScience Online.* https://doi.org/10.1504/IJGW.2022.120067
37. Figge, L., & Martens, P. (2014). Globalisation continues: the Maastricht globalisation index revisited and updated. Globalizations 11, 875–893. *Taylor & Francis Online.* https://doi.org/10.1080/14747731.2014.887389.
38. Fodha, M., & Zaghdoud, O. (2010). Economic growth and pollutant emissions in Tunisia: an empirical analysis of the environmental Kuznets curve. Energy policy, 38(2), 1150-1156. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421509008301
39. Gallagher, K.P. (2009). Economic globalization and the environment. Annu. Rev. Environ. Resour. 34, 279–304. *Annual Reviews*. https://doi.org/10.1146/annurev.environ.33.021407.092325.
40. Ghosh, S. (2010). Examining carbon emissions economic growth nexus for India: a multivariate cointegration approach. Energy policy, 38(6), 3008-3014. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421510000686?casa_token=3G6esfLedb0AAAAA:hw5TSa87WONWCudDpGlXvOmfhMblljcoIPMUMXq6T-9-vvfAL6lmtAwjuE-apHedjcFGeICiRjM
41. Goryakin, Y., Lobstein, T., James, W. P. T., & Suhrcke, M. (2015). The impact of economic, political and social globalization on overweight and obesity in the 56 low and middle income countries. Social Science & Medicine, 133, 67-76. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0277953615001744

42. Granger, C. W. (1988). Some recent development in a concept of causality. Journal of econometrics, 39(1-2), 199-211. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/0304407688900450
43. Grossman, G., & Krueger, A. (1991). Environmental Impacts of the North American FreeTrade Agreement. *NBER.* https://www.nber.org/papers/w3914
44. Grossman, G., & Krueger, A. (1995). Economic Growth and the Environment. The Quarterly Journal of Economics, 110(2), 353–377. *Oxford Academic.* https://academic.oup.com/qje/article-abstract/110/2/353/1826336?redirectedFrom=fulltext
45. Guo, J., Zou, L. L., & Wei, Y. M. (2010). Impact of inter-sectoral trade on national and global CO2 emissions: An empirical analysis of China and US. Energy Policy, 38(3), 1389-1397. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421509008507
46. Guzel, A. E., Arslan, U., & Acaravci, A. (2021). The impact of economic, social, and political globalization and democracy on life expectancy in low-income countries: are sustainable development goals contradictory? Environment, Development and Sustainability, 1-18. *SpringerLink* https://link.springer.com/article/10.1007/s10668-021-01225-2
47. Gygli, S., Haelg, F., Potrafke, N., & Sturm, J. E. (2019). The KOF globalisation index–revisited. The Review of International Organizations, 14(3), 543-574. *Springer.* https://link.springer.com/article/10.1007/s11558-019-09344-2
48. Heil, M. T., & Selden, T. M. (2001). Carbon emissions and economic development: future trajectories based on historical experience. Environment and Development Economics, 6(1), 63-83. *Cambridge core.* https://www.cambridge.org/core/journals/environment-and-development-economics/article/carbon-emissions-and-economic-development-future-trajectories-based-on-historical-experience/F97857670F4B6CC896DB1ECBB24597CD
49. Holtz-Eakin, D., & Selden, T. M. (1995). Stoking the fires? CO2 emissions and economic growth. Journal of public economics, 57(1), 85-101. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/004727279401449X
50. International Energy Agency. 2013. https://iea.blob.core.windows.net/assets/a22dedb8-c2c3-448c-b104-051236618b38/WEO2013.pdf
51. International Monetary Fund. (2008). https://www.imf.org/external/np/exr/ib/2008/053008.htm
52. Jebli, M. B., Youssef, S. B., & Ozturk, I. (2016). Testing environmental Kuznets curve hypothesis: The role of renewable and non-renewable energy consumption and trade in OECD countries. Ecological Indicators, 60, 824-831. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1470160X15004525?casa_token=MyO2CPpBv2cAAAAA:9gB3Rc-

pfH3FwDt54Vc6mdMN0DNK1vFTuZwHagyMXhu6xc8PXT1nm5F3aRA1qjBokyVpmW4nK8o

53. Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. Oxford Bulletin of Economics and statistics, 52(2), 169-210. *Wiley Online Library*. https://onlinelibrary.wiley.com/doi/10.1111/j.1468-0084.1990.mp52002003.x
54. Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of economic dynamics and control, 12(2-3), 231-254. *ScienceDirect*. https://www.sciencedirect.com/science/article/pii/0165188988900413
55. Kalaycı, C., & Hayaloğlu, P. (2019). The impact of economic globalization on CO2 emissions. *ZBW*. https://www.zbw.eu/econis-archiv/bitstream/11159/2741/1/104687263X.pdf
56. Kanjilal, K., & Ghosh, S. (2013). Environmental Kuznet's curve for India: Evidence from tests for cointegration with unknown structuralbreaks. Energy Policy, 56, 509-515. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421513000220?casa_token=bW1xTrtx3WIAAAAA:fpnlIyvtsOjpMU7WiwLGk9-l9h6AlrFcvvg1ck3E5Bw4DWH6X-tew50n7ZBu2_bJXpiWPrqNe68
57. Kasman, A., & Duman, Y. S. (2015). CO2 emissions, economic growth, energy consumption, trade and urbanization in new EU member and candidate countries: a panel data analysis. Economic modelling, 44, 97-103. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0264999314003770?casa_token=X1Flp_hHOVoAAAAA:izPKVersbVUL0BrDomAEVKmnrsKgdXEFVK6g8AbcRRlLg0exW9Vrtw-ErJfbGCqeCkaM2X0k1X8
58. Kasperowicz, R. Economic growth and CO2 emissions: The ECM analysis. J. Int. Stud. 2015, 8, 91–98. *JOIS*. https://www.jois.eu/files/07_Kasperowicz.pdf
59. Khan, M. K., Teng, J. Z., Khan, M. I., & Khan, M. O. (2019). Impact of globalization, economic factors and energy consumption on CO2 emissions in Pakistan. Science of the total environment, 688, 424-436. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0048969719326336?casa_token=pteXqA4D63sAAAAA:F2i2RwwQOSo83znc060iUHHllKHRcL0T_b_ETh9YGnY8hdFDP0tzEwAe5B804bD4gAAKJGWR3e0
60. Khan, M. B., Saleem, H., Shabbir, M. S., & Huobao, X. (2022). The Effects of Globalization, Energy Consumption and Economic Growth on Carbon Dioxide Emissions in South Asian Countries. Energy. Environ. 33 (1), 107–134. *Sage journals.* https://journals.sagepub.com/doi/abs/10.1177/0958305X20986896

61. KOF Swiss Economic Institute. (n.d.a). Methodology. https://kof.ethz.ch/en/news-and-events/media/press-releases/2018/12/kof-globalisation-index-globalisation-lull-continues.html
62. KOF Swiss Economic Institute. (n.d.b). Data. https://kof.ethz.ch/en/data.html
63. Le, T. H., Chang, Y., & Park, D. (2016). Trade openness and environmental quality: International evidence. Energy policy, 92, 45-55. *ScienceDirect*. https://www.sciencedirect.com/science/article/pii/S0301421516300301
64. Lean, H., & Smyth, R. (2010). CO2 emissions, electricity consumption and output in ASEAN, 87(6), 2010, 1858-1864. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0306261910000346
65. Leitão, N.C. (2014) Economic growth, carbon dioxide emissions, renewable energy and globalization. Int J Energy Econ Policy 4(3), 391–399. *DergiPark*. https://dergipark.org.tr/en/pub/ijeeep/issue/31910/350817?publisher=http-www-cag-edu-tr-ilhan-ozturkeconomic
66. Liddle, B. (2001). Free trade and the environment-development system. Ecological Economics, 39(1), 21–36. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0921800901002154
67. Lithuanian Official Statistics Portal. (n.d.). https://www.stat.gov.lt/en
68. Liu, M., Ren, X., Cheng, C., & Wang, Z. (2020). The role of globalization in CO2 emissions: a semi-parametric panel data analysis for G7. Science of the Total Environment, 718, 137379. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0048969720308895
69. Magazzino, C. (2015). Economic Growth, CO2 Emissions and Energy Use in Israel. Int. J. Sustain. Dev. World Ecol. 22 (1), 89–97. *CCSE*. https://www.ccsenet.org/journal/index.php/jsd/article/view/51577
70. Martens, P., Caselli, M., De Lombaerde, P., Figge, L., & Scholte, J.A. (2015). New directions in globalization indices. Globalizations 12, 217–228. *Taylor & Francis Online*. https://www.tandfonline.com/doi/abs/10.1080/14747731.2014.944336
71. Mazumdar, D., Bhattacharjee, M., & Chowdhury, J. R. (2019). Trade and environment nexus: a theoretical appraisal. In Handbook of Research on Economic and Political Implications of Green Trading and Energy Use (pp. 1-17). IGI Global. *IGI Global*. https://www.igi-global.com/chapter/trade-and-environment-nexus/230581
72. Ministry of Environment of the Republic of Lithuania. (2006). Lithuania’s Initial Report under the Kyoto Protocol. https://unfccc.int/files/national_reports/initial_reports_under_the_kyoto_protocol/application/pdf/initial_report_lithuania.pdf

73. Ministry of Foreign Affairs of the Republic of Lithuania. (2016). Membership. https://www.urm.lt/default/en/foreign-policy/lithuania-in-the-region-and-the-world/lithuania-member-of-the-european-union/membership
74. Muhammad, B., & Khan, S. (2021, May). Understanding the relationship between natural resources, renewable energy consumption, economic factors, globalization and CO2 emissions in developed and developing countries. In Natural resources forum (Vol. 45, No. 2, pp. 138-156). Oxford, UK: Blackwell Publishing Ltd. *Wiley Online Library.* https://onlinelibrary.wiley.com/doi/full/10.1111/1477-8947.12220
75. Musolesi, A., Mazzanti, M., & Zoboli, R. (2010). A panel data heterogeneous Bayesian estimation of environmental Kuznets curves for CO2 emissions. Applied Economics, 42(18), 2275-2287. *Taylor & Francis Online.* https://www.tandfonline.com/doi/abs/10.1080/00036840701858034
76. Mutascu, M., & Sokic, A. (2020). Trade openness-CO2 emissions nexus: a wavelet evidence from EU. Environmental Modeling & Assessment, 25(3), 411-428. *Springer.* https://link.springer.com/article/10.1007/s10666-020-09689-8
77. Narayan, P. K. (2005). The saving and investment nexus for China: evidence from cointegration tests. Applied economics, 37(17), 1979-1990. *Taylor & Francis Online.* https://www.tandfonline.com/doi/abs/10.1080/00036840500278103
78. Ohlan, R. (2015). The impact of population density, energy consumption, economic growth and trade openness on CO2 emissions in India. Natural Hazards, 79(2), 1409-1428. *Springer.* https://link.springer.com/article/10.1007/s11069-015-1898-0
79. Our World in Data. (n.d.a). https://ourworldindata.org/about
80. Our World in Data. (n.d.b). https://ourworldindata.org/grapher/trade-openness?tab=chart&region=Europe&country=~LTU
81. Ozturk, I., & Acaravci, A. (2010). CO2 emissions, energy consumption and economic growth in Turkey. Renewable and Sustainable Energy Reviews, 14(9), 3220-3225. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1364032110001851?casa_token=mpBy9N8vNSIAAAAA:cWUVdL3vKwDxPynmDF0HzCEhgOm7Tcq3RgrPLXD6uhh37jimSEJUNzBVnm9d5ovvdye-yAfMvZM
82. Ozturk, I. (2010). A literature survey on energy–growth nexus. Energy policy, 38(1), 340-349. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421509007071
83. Ozturk, I., & Acaravci, A. (2013). The long-run and causal analysis of energy, growth, openness and financial development on carbon emissions in Turkey. Energy Economics, 36, 262-267. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0140988312001958

84. Ozturk, I., & Al-Mulali, U. (2015). Investigating the validity of the environmental Kuznets curve hypothesis in Cambodia. Ecological Indicators, 57, 324-330. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1470160X1500240X?casa_token=xcIdoHaURQIAAAAA:h7y8ZGNV5t8aI1FSsmQRg6tuZnWRXME83er4n67QAhCeyOGrjTlBTJjlmI0k2JtimDphsqIfwSc
85. Panayotou, T. (1997). Demystifying the environmental Kuznets curve: turning a black box into a policy tool. Environment and development economics, 2(4), 465-484. *Cambridge Core*. https://www.cambridge.org/core/journals/environment-and-development-economics/article/demystifying-the-environmental-kuznets-curve-turning-a-black-box-into-a-policy-tool/3410AAB71BDA7A3D6C819B8E1F3ACE14
86. Park, H. J., & Fuller, W. A. (1995). Alternative estimators and unit root tests for the autoregressive process. Journal of Time Series Analysis, 16(4), 415-429. *Wiley Online Library*. https://onlinelibrary.wiley.com/doi/abs/10.1111/j.1467-9892.1995.tb00243.x
87. Pesaran, M. H., & Shin, Y. (1995). An autoregressive distributed lag modelling approach to cointegration analysis. *ResearchGate.* https://www.researchgate.net/publication/4800254_An_Autoregressive_Distributed_Lag_Modeling_Approach_to_Co-integration_Analysis
88. Pesaran, M. H., Shin, Y., & Smith, R. J. (1996). Testing for the 'Existence of a Long-run Relationship' (No. 9622). Faculty of Economics, University of Cambridge. *Ideas.* https://ideas.repec.org/p/cam/camdae/9622.html
89. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. Journal of applied econometrics, 16(3), 289-326. *Wiley Online Library.* https://onlinelibrary.wiley.com/doi/abs/10.1002/jae.616?casa_token=zsIYHJ2-7zEAAAAA:NoSM5STBhF2nmQixnwbJ8hDKxCLXCtwMMkafP64WQUEx-7wXDU7lGLQGEaJRHB31I9FFzDproLDVbKc
90. Rahman, H. U., Ghazali, A., Bhatti, G. A., & Khan, S. U. (2020). Role of economic growth, financial development, trade, energy and FDI in environmental Kuznets curve for Lithuania: evidence from ARDL bounds testing approach. Engineering Economics, 31(1), 39-49. *Kaunas University of Technology*. https://www.inzeko.ktu.lt/index.php/EE/article/view/22087
91. Rennen, W., & Martens, P. (2003). The globalisation timeline. Integr. Assess. 4, 137–144. *Taylor & Francis Online*. https://doi.org/10.1076/iaij.4.3.137.23768.
92. Robertson, R., & White, K. E. (2007). What is globalization. The Blackwell companion to globalization, 54-66. *Google books.* https://books.google.com/books?hl=en&lr=&id=XKnmvRATtfAC&oi=fnd&pg=PA54&dq=

Robertson,+R.%3B+White,+K.E.+What+is+globalization.+The+Blackwell+Companion+to+Globalization%3B+&ots=_-OMXi7HyV&sig=EoWkHnAy7aH2npwdpWThBz42XIE

93. Rosa, E. A., & Dietz, T. (2012). Human drivers of national greenhouse-gas emissions. Nature Climate Change, 2(8), 581-586. *Nature Climate Change.* https://www.nature.com/articles/nclimate1506

94. Rosa, E. A., York, R., & Dietz, T. (2004). Tracking the anthropogenic drivers of ecological impacts. AMBIO: A Journal of the Human Environment, 33(8), 509-512. *BioOne Digital Library.* https://bioone.org/journals/ambio-a-journal-of-the-human-environment/volume-33/issue-8/0044-7447-33.8.509/Tracking-the-Anthropogenic-Drivers-of-Ecological-Impacts/10.1579/0044-7447-33.8.509.short

95. Sabir, S., & Gorus, M. S. (2019). The impact of globalization on ecological footprint: empirical evidence from the South Asian countries. Environmental Science and Pollution Research, 26, 33387-33398. *SpringerLink.* https://link.springer.com/article/10.1007/s11356-019-06458-3

96. Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic growth and CO2 emissions in Malaysia: a cointegration analysis of the environmental Kuznets curve. Energy policy, 51, 184-191. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421512007471?casa_token=80Oqq3fiDvQAAAAA:jEBUgfj0XJvicBu0TBvj1xwHmpep-GOL3MvwhHUgzBd60wqxnInKtsMn2BfcNkB4D-C8LHkxm5s

97. Saint Akadiri, S., Lasisi, T. T., Uzuner, G., & Akadiri, A. C. (2019). Examining the impact of globalization in the environmental Kuznets curve hypothesis: The case of tourist destination states. Environmental Science and Pollution Research, 26(12), 12605–12615. *Springer.* https://link.springer.com/article/10.1007/s11356-019-04722-0

98. Salahuddin M., Ali M.I., Vink N., & Gow J. (2019) The effects of urbanization and globalization on CO2 emissions: evidence from the sub-Saharan Africa (SSA) countries. Environ Sci Pollut Res, 26, 2699–2709. *Springer*. https://link.springer.com/article/10.1007/s11356-018-3790-4

99. Sinha, A., & Shahbaz, M. (2018). Estimation of environmental Kuznets curve for CO2 emission: role of renewable energy generation in India. Renewable energy, 119, 703-711. ScienceDirect. https://www.sciencedirect.com/science/article/abs/pii/S0960148117312624

100. Sinha, A., Shahbaz, M., & Balsalobre, D. (2017). Exploring the relationship between energy usage segregation and environmental degradation in N-11 countries. Journal of cleaner production, 168, 1217-1229. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0959652617320607

101. Smyth, R. (2013). Are fluctuations in energy variables permanent or transitory? A survey of the literature on the integration properties of energy consumption and production. Applied Energy, 104, 371-378. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S030626191200801X?casa_token=xMwzwtBhxxkAAAAA:9vwL9RNw4htxpkyvP3Hmkv0dHfG84QAz1Xfe4M5evh6Y8t8TACGrrPQPhhVMv8xscp6-OoxcUIk

102. Shahbaz, M., Lean, H. H., & Shabbir, M. S. (2012). Environmental Kuznets curve hypothesis in Pakistan: cointegration and Granger causality. Renewable and Sustainable Energy Reviews, 16(5), 2947-2953. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1364032112001086?casa_token=dl9kkn6zkI8AAAAA:hVqPITYvAlvLP9s34kusxAek885UMVPSHIUW6qt5CfWr2XS_as_fibot8B7_sW8l6DWlKCTseLg

103. Shahbaz, M., Ozturk, I., Afza, T., & Ali, A. (2013a). Revisiting the environmental Kuznets curve in a global economy. Renewable and sustainable energy reviews, 25, 494-502. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1364032113003249

104. Shahbaz, M., Hye, Q. M. A., Tiwari, A. K., & Leitão, N. C. (2013b). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia. Renewable and Sustainable Energy Reviews, 25, 109-121. *ScienceDirect*. https://www.sciencedirect.com/science/article/pii/S1364032113002608?casa_token=yjGU0yC-3r8AAAAA:3sIfKi-KDxB4Jf5R6XuEv_dSBhFpyefr-6iAsfv6REpnTVF3kAgvUk1wAyqC4cubY1cRl4Q8FBQ

105. Shahbaz, M., Dube, S., Ozturk, I., & Jalil, A. (2015a). Testing the environmental Kuznets curve hypothesis in Portugal. International Journal of Energy Economics and Policy, 5(2), 475-481. *DergiPark.* https://dergipark.org.tr/en/pub/ijeeep/issue/31913/350901?publisher=http-www-cag-edu-tr

106. Shahbaz, M., Mallick, H., Mahalik, M. K., & Loganathan, N. (2015b). Does globalization impede environmental quality in India? Ecological Indicators, 52, 379–393. *ScientificDirect*. https://www.sciencedirect.com/science/article/pii/S1470160X14006013

107. Shahbaz, M., Solarin, S. A., & Ozturk, I. (2016). Environmental Kuznets curve hypothesis and the role of globalization in selected African countries. Ecological Indicators, 67, 623-636. *ScientificDirect.* https://www.sciencedirect.com/science/article/pii/S1470160X16301285

108. Shahbaz M., Shahzad S.J.H., Mahalik M.K., & Hammoudeh S. (2017a). Does globalisation worsen environmental quality in developed economies? Environ Model Assess 23(2):141–156. *Springer*. https://link.springer.com/articl2018e/10.1007/s10666-017-9574-2

109. Shahbaz, M., Nasreen, S., Ahmed, K., & Hammoudeh, S. (2017b). Trade openness–carbon emissions nexus: the importance of turning points of trade openness for country panels. Energy Economics, 61, 221-232. *ScientificDirect.* https://www.sciencedirect.com/science/article/pii/S0140988316303292?casa_token=n6Dy5PvEa7AAAAAA:c6a30B5JOgHUg4C2W7oxbE32w9Xe1bAsvsiYzIaV2DJRGcanpKmMQ5TToMzsCHjU3ISQbEOyF-g

110. Shahbaz, M., Khan, S., Ali, A., & Bhattacharya, M. (2017c). The impact of globalization on CO2 emissions in China. The Singapore Economic Review, 62(04), 929-957. *World Scientific*. https://www.worldscientific.com/doi/abs/10.1142/S0217590817400331

111. Shahbaz M., Shahzad S.J.H., & Mahalik M.K. (2017d). Is globalization detrimental to CO 2 emissions in Japan? New threshold analysis. Environ Model Assess 23(5):557–568. *Springer*. https://link.springer.com/article/10.1007/s10666-017-9584-0

112. Shahbaz, M., Mahalik, M. K., Shahzad, S. J. H., & Hammoudeh, S. (2019). Testing the globalization-driven carbon emissions hypothesis: international evidence. International Economics, 158, 25-38. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S2110701718301902

113. Sharif, A., Raza, S. A., Ozturk, I., & Afshan, S. (2019). The dynamic relationship of renewable and nonrenewable energy consumption with carbon emission: A global study with the application of heterogeneous panel estimations. Renewable Energy, 133, 685–691. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0960148118312369

114. Sun, H., Attuquaye Clottey, S., Geng, Y., Fang, K., & Clifford Kofi Amissah, J. (2019). Trade openness and carbon emissions: evidence from belt and road countries. Sustainability, 11(9), 2682. *MDPI*. https://www.mdpi.com/2071-1050/11/9/2682

115. Solarin, S. A., Al-Mulali, U., Musah, I., & Ozturk, I. (2017). Investigating the pollution haven hypothesis in Ghana: an empirical investigation. Energy, 124, 706-719. *ScienceDirect*. https://www.sciencedirect.com/science/article/abs/pii/S0360544217302724

116. Solomon, S., Plattner, G. K., Knutti, R., & Friedlingstein, P. (2009). Irreversible climate change due to carbon dioxide emissions. Proceedings of the national academy of sciences, 106(6), 1704-1709. *PNAS*. https://www.pnas.org/doi/abs/10.1073/pnas.0812721106

117. Stark, D., & Bruszt, L. (1998). Postsocialist pathways: Transforming politics and property in East Central Europe. *Cambridge University Press.* https://books.google.com/books?hl=en&lr=&id=0LALcIC6lvsC&oi=fnd&pg=PP11&dq=Stark,+David,+and+Laszlo+Bruszt.+1998.+Postsocialist+Pathways:+Transforming+Politics+and+Property+in+East+Central+Europe.+Cambridge:+Cambridge+University+Press.&ots=N5WdRtiNWp&sig=7BOuvfk1L2vHDIxjtgvn_YczIUw

118. Stern, D. (2004). The Rise and Fall of the Environmental Kuznets Curve. World Development, 32 (8), 1419-1439. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0305750X04000798

119. Suci, S. C., Asmara, A., & Mulatsih, S. (2016). The impact of globalization on economic growth in ASEAN. BISNIS & BIROKRASI: Jurnal Ilmu Administrasi dan Organisasi, 22(2), 79-87. *Bisnis & Birikrasi*. https://scholarhub.ui.ac.id/jbb/vol22/iss2/1/

120. Tang, J. P. (2015). Pollution havens and the trade in toxic chemicals: Evidence from US trade flows. Ecological Economics, 112, 150-160. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0921800915000695

121. The World Bank. (n.d.). Metadata Glossary. https://databank.worldbank.org/metadataglossary/statistical-capacity-indicators/series/5.51.01.10.gdp#:~:text=Long%20definition-,GDP%20per%20capita%20is%20the%20sum%20of%20gross%20value%20added,GDP%20data%20in%20local%20currency

122. Tiwari, A. K., Shahbaz, M., & Hye, Q. M. A. (2013). The environmental Kuznets curve and the role of coal consumption in India: Co-integration and causality analysis in an open economy. Renewable and Sustainable Energy Reviews, 18, 519–527. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1364032112005734

123. Toman, M. T., & Jemelkova, B. (2003). Energy and economic development: an assessment of the state of knowledge. The Energy Journal, 24(4). *IAEE.* https://www.iaee.org/energyjournal/article/1421

124. United Nations. (2015). Paris Agreement. https://unfccc.int/sites/default/files/english_paris_agreement.pdf

125. Vlahinić Lenz, N., & Fajdetić, B. (2021). Globalization and GHG emissions in the EU: do we need a new development paradigm?. Sustainability, 13(17), 9936. *MDPI.* https://www.mdpi.com/2071-1050/13/17/9936

126. Vujakovic, P. (2010). How to measure globalization? A new globalization index (NGI). Atl. Econ. J. 38 237–237. *Springer*. https://doi.org/10.1007/s11293-010-9217-3.

127. Wen, J., Mughal, N., Zhao, J., Shabbir, M., Niedbała, G., Jain, V., & Anwar, A. (2021). Does globalization matter for environmental degradation? Nexus among energy consumption, economic growth, and carbon dioxide emission. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0301421521000999

128. World Bank Open Data. (n.d.). https://data.worldbank.org/

129. World Bank. (1992). World Development Report. https://openknowledge.worldbank.org/handle/10986/5975

130. Xu Z., Baloch M.A., & Danish. (2018). Nexus between financial development and CO2 emissions in Saudi Arabia: analyzing the role of globalization. Environ Sci Pollut Res. *Springer*. https://doi.org/10.1007/s11356-018-2876-3

131. Xuemei, H. A. N., Mingliang, Z. H. A. N. G., & Su, L. I. U. (2011). Research on the relationship of economic growth and environmental pollution in Shandong province based on environmental Kuznets curve. Energy Procedia, 5, 508-512. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S1876610211010241

132. You, W., & Lv, Z. (2018). Spillover effects of economic globalization on CO2 emissions: a spatial panel approach. Energy economics, 73, 248-257. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S014098831830183X?casa_token=fuy49aVLaMgAAAAA:WCH74_3FMaWldd60W56eBCj6nINBQwltJUDjpxt3QSxyjvvBxXyENssGufLMVmGmHvxhH5EVHgw

133. Zafar, M. W., Saud, S., & Hou, F. (2019). The impact of globalization and financial development on environmental quality: evidence from selected countries in the Organization for Economic Co-operation and Development (OECD). Environmental science and pollution research, 26(13), 13246-13262. *Springer.* https://link.springer.com/article/10.1007/s11356-019-04761-7

134. Zaidi, S. A. H., Zafar, M. W., Shahbaz, M., & Hou, F. (2019). Dynamic linkages between globalization, financial development and carbon emissions: evidence from Asia Pacific Economic Cooperation countries. Journal of Cleaner Production, 228, 533-543. *ScienceDirect.* https://www.sciencedirect.com/science/article/pii/S0959652619312971?casa_token=8VJWQuw280UAAAAA:Omz-o2_k_bIf1Q-uL2qx95fHgv8SuLMSTYQZicAYZbjQ3TRjDasMd6O_Jx8X_uieXXp2Axg9e9k

135. Zhang, S., Liu, X., & Bae, J. (2017), Does trade openness affect CO2 emissions: Evidence from ten newly industrialized countries? Environmental Science and Pollution Research, 21(24), 17616-17625. *Springer*. https://link.springer.com/article/10.1007/s11356-017-9392-8

136. Zhang, Q., Yang, J., Sun, Z., & Wu, F. (2017). Analyzing the impact factors of energy-related CO2 emissions in China: What can spatial panel regressions tell us? Journal of Cleaner Production, 161, 1085–1093. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0959652617310028

137. Zhang, N., Yu, K., & Chen, Z. (2017). How does urbanization affect carbon dioxide emissions? A cross-country panel data analysis. Energy Policy, 107, 678-687. *ScienceDirect.* https://www.sciencedirect.com/science/article/abs/pii/S0301421517301933

ANNEXES

Annex 1. The trends of selected variables in Lithuania in 1995-2019

Years	Overall KOF Globalisation Index	Trade openness (%)	GDP per capita (EUR)	CO2 emissions metric tons per capita
1995	53.76	84.96	2,138.5	3.8
1996	57.59	93.20	2,696.3	4
1997	60.27	100.03	3,278.9	3.9
1998	61.6	89.66	3,668.6	4.1
1999	61.85	74.82	3,606.6	3.5
2000	64.39	83.38	3,815.2	3
2001	65.65	93.67	4,084.6	3.2
2002	65.89	100.49	4,409.6	3.3
2003	67.72	98.23	4,875.2	3.3
2004	69.93	104.60	5,395.1	3.5
2005	71.57	117.48	6,314.4	3.9
2006	73.92	124.34	7,356.0	4
2007	75.93	116.39	8,978.2	4.1
2008	75.95	126.85	10,211.9	4.1
2009	74.64	105.34	8,503.9	3.7
2010	75.8	129.89	9,051.1	4.1
2011	76.63	148.45	10,342.1	3.9
2012	77.08	155.84	11,182.3	4
2013	78.18	155.89	11,846.9	3.8
2014	79	142.72	12,475.0	3.7
2015	79.77	138.55	12,856.1	3.8
2016	80.38	134.45	13,558.8	3.9
2017	81.14	144.87	14,947.1	4
2018	81.53	148.64	16,246.5	4.2
2019	81,83	149.69	17,503.9	4.2

Source: KOF Swiss Economic Institute, n.d.b; Our World in Data, n.d.b; Lithuanian Official Statistics Portal, n.d.; World Bank Open Data, n.d.

Annex 2. The output of the Augmented Dickey-Fuller Unit Root Test on 1 dependent and 3 independent variables

Annex 2.1 Ln(CO2) in level

Null Hypothesis: LCO2_EMISSIONS__METRIC_TONS_PER_CAPITA_ has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.705482	0.4159
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCO2_EMISSIONS__METRIC_TONS_PER_CAPITA_)
Method: Least Squares
Date: 05/28/23 Time: 10:30
Sample (adjusted): 1996 2019
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCO2_EMISSIONS__METRIC_TONS_...	-0.260737	0.152882	-1.705482	0.1022
C	0.350135	0.203298	1.722275	0.0991

R-squared	0.116773	Mean dependent var	0.004170
Adjusted R-squared	0.076627	S.D. dependent var	0.068415
S.E. of regression	0.065742	Akaike info criterion	-2.526502
Sum squared resid	0.095084	Schwarz criterion	-2.428331
Log likelihood	32.31803	Hannan-Quinn criter.	-2.500457
F-statistic	2.908670	Durbin-Watson stat	1.719395
Prob(F-statistic)	0.102186		

Source: author

Annex 2.2 Ln(CO2) in first difference

Null Hypothesis: D(LCO2_EMISSIONS__METRIC_TONS_PER_CAPITA_) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.611881	0.0014
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LCO2_EMISSIONS__METRIC_TONS_PER_CAPITA_,2)
Method: Least Squares
Date: 05/28/23 Time: 10:44
Sample (adjusted): 1997 2019
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCO2_EMISSIONS__METRIC_TONS...	-0.995579	0.215873	-4.611881	0.0002
C	0.002102	0.014798	0.142055	0.8884

R-squared	0.503187	Mean dependent var	-0.002230
Adjusted R-squared	0.479530	S.D. dependent var	0.098171
S.E. of regression	0.070824	Akaike info criterion	-2.374301
Sum squared resid	0.105336	Schwarz criterion	-2.275563
Log likelihood	29.30447	Hannan-Quinn criter.	-2.349469
F-statistic	21.26945	Durbin-Watson stat	1.966598
Prob(F-statistic)	0.000151		

Source: author

Annex 2.3 Ln(KOF) in level

Null Hypothesis: LOVERALL_KOF_GLOBALISATION_INDEX has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.475440	0.0019
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOVERALL_KOF_GLOBALISATION_INDEX)
Method: Least Squares
Date: 05/28/23 Time: 10:54
Sample (adjusted): 1996 2018
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOVERALL_KOF_GLOBALISATION_IN...	-0.106443	0.023784	-4.475440	0.0002
C	0.470864	0.101202	4.652702	0.0001

R-squared	0.488174	Mean dependent var	0.018106
Adjusted R-squared	0.463801	S.D. dependent var	0.017985
S.E. of regression	0.013169	Akaike info criterion	-5.738911
Sum squared resid	0.003642	Schwarz criterion	-5.640172
Log likelihood	67.99748	Hannan-Quinn criter.	-5.714078
F-statistic	20.02956	Durbin-Watson stat	1.489173
Prob(F-statistic)	0.000208		

Source: author

Annex 2.4 Ln(KOF) in first difference

Null Hypothesis: D(LOVERALL_KOF_GLOBALISATION_INDEX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.984406	0.0062
Test critical values:	1% level	-3.769597	
	5% level	-3.004861	
	10% level	-2.642242	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOVERALL_KOF_GLOBALISATION_INDEX,2)
Method: Least Squares
Date: 05/28/23 Time: 10:55
Sample (adjusted): 1997 2018
Included observations: 22 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOVERALL_KOF_GLOBALISATION_...	-0.632184	0.158665	-3.984406	0.0007
C	0.008919	0.004092	2.179556	0.0414

R-squared	0.442516	Mean dependent var	-0.002910
Adjusted R-squared	0.414642	S.D. dependent var	0.017264
S.E. of regression	0.013209	Akaike info criterion	-5.729355
Sum squared resid	0.003489	Schwarz criterion	-5.630169
Log likelihood	65.02291	Hannan-Quinn criter.	-5.705990
F-statistic	15.87549	Durbin-Watson stat	2.088749
Prob(F-statistic)	0.000730		

Source: author

Annex 2.5 Ln(GDP) in level

Null Hypothesis: LGDP_PER_CAPITA__EUR_ has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.800960	0.3710
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP_PER_CAPITA__EUR_)
Method: Least Squares
Date: 05/28/23 Time: 10:57
Sample (adjusted): 1996 2019
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LGDP_PER_CAPITA__EUR_(...	-0.048823	0.027109	-1.800960	0.0854
C	0.518678	0.239886	2.162186	0.0417

R-squared	0.128487	Mean dependent var	0.087597
Adjusted R-squared	0.088873	S.D. dependent var	0.081330
S.E. of regression	0.077632	Akaike info criterion	-2.194023
Sum squared resid	0.132587	Schwarz criterion	-2.095852
Log likelihood	28.32828	Hannan-Quinn criter.	-2.167978
F-statistic	3.243458	Durbin-Watson stat	1.499311
Prob(F-statistic)	0.085434		

Source: author

Annex 2.6 Ln(GDP) in first difference

Null Hypothesis: D(LGDP_PER_CAPITA__EUR_) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.893155	0.0073
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LGDP_PER_CAPITA__EUR_,2)
Method: Least Squares
Date: 05/28/23 Time: 10:58
Sample (adjusted): 1997 2019
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LGDP_PER_CAPITA__EUR_(-1))	-0.760332	0.195300	-3.893155	0.0008
C	0.060198	0.023419	2.570421	0.0178

R-squared	0.419194	Mean dependent var	-0.006836
Adjusted R-squared	0.391537	S.D. dependent var	0.097599
S.E. of regression	0.076131	Akaike info criterion	-2.229779
Sum squared resid	0.121715	Schwarz criterion	-2.131040
Log likelihood	27.64246	Hannan-Quinn criter.	-2.204946
F-statistic	15.15665	Durbin-Watson stat	1.968136
Prob(F-statistic)	0.000839		

Source: author

Annex 2.7 Ln(TO) in level

Null Hypothesis: LTRADE_OPENNESS___ has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.236423	0.6412
Test critical values:	1% level	-3.737853	
	5% level	-2.991878	
	10% level	-2.635542	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LTRADE_OPENNESS___)
Method: Least Squares
Date: 05/28/23 Time: 11:00
Sample (adjusted): 1996 2019
Included observations: 24 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LTRADE_OPENNESS___(-1)	-0.113981	0.092186	-1.236423	0.2293
C	0.563994	0.437513	1.289090	0.2108

R-squared	0.064973	Mean dependent var	0.023599
Adjusted R-squared	0.022472	S.D. dependent var	0.098366
S.E. of regression	0.097255	Akaike info criterion	-1.743313
Sum squared resid	0.208086	Schwarz criterion	-1.645142
Log likelihood	22.91975	Hannan-Quinn criter.	-1.717268
F-statistic	1.528743	Durbin-Watson stat	1.947285
Prob(F-statistic)	0.229339		

Source: author

Annex 2.8 Ln(TO) in first difference

Null Hypothesis: D(LTRADE_OPENNESS___) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=5)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.788567	0.0009
Test critical values:	1% level	-3.752946	
	5% level	-2.998064	
	10% level	-2.638752	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LTRADE_OPENNESS___,2)
Method: Least Squares
Date: 05/28/23 Time: 11:00
Sample (adjusted): 1997 2019
Included observations: 23 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LTRADE_OPENNESS___(-...	-1.033311	0.215787	-4.788567	0.0001
C	0.021411	0.021852	0.979815	0.3383

R-squared	0.521971	Mean dependent var	-0.003719
Adjusted R-squared	0.499207	S.D. dependent var	0.143756
S.E. of regression	0.101732	Akaike info criterion	-1.650016
Sum squared resid	0.217336	Schwarz criterion	-1.551277
Log likelihood	20.97518	Hannan-Quinn criter.	-1.625183
F-statistic	22.93037	Durbin-Watson stat	2.035555
Prob(F-statistic)	0.000099		

Source: author