Araştırma Makalesi / Research Article

The Relationship Between Inflation, Human Development Index and CO2 in Selected Country Groups

Ufuk ALKAN [1] Canan DAĞIDIR ÇAKAN[2] Aykut ŞENGÜL[3] Mehmet Hanifi ATEŞ [4]

Makale Gönderim Tarihi : 25 Şubat 2024
Makale Kabul Tarihi : 03 Eylül 2024

Abstract
UNDP report observes that countries with a high Human Development Index (HDI) are industrialized nations. It is well-known that industrialization leads to high carbon dioxide (CO2) emissions. These countries also experience low inflation rates due to their high production volumes. In light of this information, this study aims to empirically investigate the complex relationship between inflation, HDI, and CO2 across different country groups. The study employs panel data analysis over the period from 1994 to 2021, focusing on specific subdivisions within country groups (OECD, G20, EU, developed, high-income, and low-income countries). The results reveal a linear relationship between HDI and CO2 and an inverse relationship between inflation and CO2, providing policy recommendations based on these findings.

Keywords: *Inflation, Carbon Emissions, Human Development Index, Panel Data Analysis.*

JEL Codes: *H62, Q50, O15, C23*

[1] Sorumlu Yazar, Doç.Dr., Marmara Üniversitesi, Finansal Bilimler Fakültesi, Bankacılık Anabilim Dalı, ualkan@marmara.edu.tr, ORCID ID: 0000-0002-0586-8146
[2] Doç.Dr., Marmara Üniversitesi, Finansal Bilimler Fakültesi, Bankacılık Anabilim Dalı, cdagidir@marmara.edu.tr, ORCID ID: 0000-0001-7230-6373
[3] Araştırmacı, Türkiye Cumhuriyet Merkez Bankası, aykut.sengul@tcmb.gov.tr, ORCID ID: 0000-0002-1916-3403
[4] Araştırmacı, Türkiye Cumhuriyet Merkez Bankası, mehmetates@marun.edu.tr, ORCID ID: 0000-0001-5795-3951

https://doi.org/10.33203/mfy.1442703

Seçili Ülke Gruplarında Enflasyon, İnsani Gelişme Endeksi ve CO2 Arasındaki İlişki

Öz

Birleşmiş Milletler Kalkınma Programı raporunda yüksek İnsani Gelişme Endeksine (İGE) sahip ülkelerin sanayileşmiş ülkeler olduğu gözlemlenmektedir. Sanayileşmenin yüksek karbondioksit (CO2) salınımına neden olduğu bilinmektedir. Bu ülkeler aynı zamanda yüksek üretim hacimleri nedeniyle düşük enflasyona sahiptir. Bu bilgiler ışığında çalışma, farklı ülke gruplarında enflasyon, İGE ve CO2 arasındaki karmaşık ilişkiyi ampirik olarak araştırmayı amaçlamaktadır. Çalışmada, 1994-2021 yılları arasında ülke grupları (OECD, G20, AB, gelişmiş, yüksek ve düşük gelirli) bazında ilgili alt kırılımlar üzerinden panel veri analizi yapılmıştır. Sonuçlar, İGE ile CO2 arasında doğrusal, enflasyon ile CO2 arasında ise ters yönlü bir ilişki olduğunu ortaya koymuş ve politika önerileri sunulmuştur.

***Anahtar Sözcükler**: Enflasyon, Karbon Emisyonları, İnsani Gelişme Endeksi, Panel Veri Analizi.*

***JEL Kodları**: H62, Q50, O15, C23*

1. Introduction

Nowadays, when analyzing the level of development of countries, indicators representing environmental, financial and social living conditions are taken into account. One such important indicator is carbon dioxide (CO2) emissions. However, it is important to clarify that the term "carbon emissions," which is often used in the context of climate change, is somewhat imprecise. What is meant by this term is "carbon footprint" or "greenhouse gas emissions". Greenhouse gases cause a greenhouse effect by absorbing and then emitting infrared radiation from the sun in the Earth's atmosphere. While these gases occur naturally in the atmosphere, the warming of the Earth that results from increased levels of greenhouse gases is caused by human activities. This intensifies the greenhouse effect and ultimately causes climate change. The "carbon footprint", on the other hand, is the quantification of greenhouse gas emissions resulting from human-induced (anthropogenic) activities, expressed in CO2 equivalents. The use of the terms "carbon emissions" or "CO2 emissions" stems from the fact that these calculations are often made in terms of carbon dioxide. It is important to note that carbon dioxide is the primary greenhouse gas. In the atmosphere, CO2 acts as a heat trap for solar infrared radiation. This effect is one of the important details that make the Earth habitable. In this regard, climate change has emerged as a foremost factor significantly impacting both human development and the development of nations. As climate change and the associated increase in carbon emissions reach unprecedented levels, catastrophic events such as hurricanes and wildfires have led to the extinction of species, causing significant economic, welfare and developmental losses to human societies and all living things. Moreover, as ecological threats increase, so do social vulnerabilities and inequalities (UNDP, 2020, p.3). Thus, it is no longer conceivable to achieve development by ignoring the environment, forests and nature (UNDP, 2020, p.5).

In the economic literature, the relationship between economic growth and environmental pollution is theoretically grounded in the "Environmental Kuznets Curve" (EKC). According to this curve, economic growth leads to pollution until per capita income rises to a certain level, after which economic growth leads to a decrease in pollution due to the development of environmental awareness and the shift of production to cleaner sectors. Therefore, economic growth stimulated by foreign trade is expected to increase environmental pollution, especially in Less Developed Countries (LDCs) and Developing Countries (DCs) that are below the income threshold (Kuznets, 1955). On the other hand, the existence of strict environmental regulations in developed countries leads to the manufacturing of products that cause severe environmental pollution in LDCs and DCs, where environmental regulations are either non-existent or poorly enforced. Many companies in developed countries may even relocate their production to countries where the environment can be polluted rampantly to get around these legal regulations in their own countries. This phenomenon, referred to in the literature as the "Pollution Ports Hypothesis", has recently been taken into account in empirical studies investigating the causes and consequences of foreign direct investment (FDI) (Deger and Pata, 2017, p. 32). Based on this hypothesis, Grossman and Krueger (1991, 1995) argued in the 1990s that environmental pollution would increase in the early years of economic growth, but would decrease as growth progressed. In other words, it is assumed that the rate of negative impact of environmental factors in developing countries will be high when the first steps of development are taken, but this will be compensated as the country progresses in its development.

CO2 emissions and related climate change are among the most important global challenges of our time, as they transcend borders and affect all countries regardless of their level of development. The world has begun to experience the negative aspects of global warming, including the decrease in water resources, desertification and related ecological degradation. In the context of combating climate change, the global transition to a low-carbon economy envisions a radical transformation that will change people's lifestyles and production and manufacturing methods. In the post-1980 period, as awareness of this issue has grown, countries around the world have been exerting efforts and entering into agreements that do not compromise the development goals of the countries, developing bilateral cooperation and actively participating in regional and international activities to prevent negative developments, compensate for the damage done and bequeath a clean environment to future generations.

The rapidly changing production structure since the Industrial Revolution has both fueled economic growth and development while also triggering discussions on its adverse effects on the environment and climate. The perspective that a strong link exists between economic prosperity and human development has positioned economic growth as the primary driver of increased human well-being. However, an increase in a nation's income alone is not enough to enhance welfare (Kangas, 2010). More than just economic growth, it is the quality of economic growth and the attainment of sustainable welfare that matter. Economic development encompasses both the quantitative and qualitative dimensions of growth. Development can be defined as the process of increasing per capita income and improving the living standards of society. Sustainable development, on the other hand, can be described as maximizing the satisfaction of the needs and desires of current generations without compromising the ability to meet the needs and desires of future generations (Van den Berg, 2016). While economic growth has, on one hand, increased prosperity, on the other hand, it has led to local and global social inequality and ecological degradation (Hirvilammi, 2020). While an increase in national income in a country may facilitate access to services like education and healthcare, it is observed that it does not necessarily improve living standards. Therefore, concepts of welfare and human development come to the forefront. Human development, which goes beyond income, involves an individual's state of well-being, leading a healthy, free and happy life. According to Anand and Sen (1994), what matters in human development is not just the goods and income a person possesses but the life they lead. While income levels, commodities and wealth have instrumental significance, they do not directly measure the standard of living. Today, the tools used to increase welfare have become the primary focus. The primary goal of economic growth, which used to be the priority, has often led to neglecting the well-being of future societies and has exacerbated inequalities. This situation necessitates the creation of policies that are sensitive to environmental issues. In this regard, the HDI is an important indicator for comparing countries in terms of development and welfare. Today, the tools used to increase welfare have become the primary focus. The primary goal of economic growth, which used to be the priority, has often led to neglecting the well-being of future societies and has exacerbated inequalities. This situation necessitates the creation of policies that are sensitive to environmental issues. In this regard, the HDI is an important indicator for comparing countries in terms of development and welfare.

Poverty and income inequality are factors that adversely affect an individual's living standards and societal welfare. To elevate the living standards of individuals and meet the growing needs of a rising population, there is a need for increased production of goods and services. This approach, based on an unlimited concept of production and consumption, is made possible through the increase in purchasing power and national income (Van den Berg, 2016, p. 63). Inflation, which leads to a decrease in purchasing power, will have a negative impact on living standards. Inflation disrupts optimal resource allocation, reducing the welfare of all segments and exacerbating inequalities. The decline in welfare caused by inflation is referred to as the welfare cost. The relationship between inflation and welfare has been the subject of many studies. For example, Lucas (2000), in his study estimating the welfare cost of inflation, predicts that a 10% inflation rate would have a slightly less than 1% impact on GDP (Craig and Rocheteau, 2008). Ensuring price stability and reducing inflation will contribute to the increase in individual and societal welfare. Instead of continuous production and consumption, a responsible approach to production and consumption should be adopted and growth should operate within the natural limits. A balance should be struck between sustainable economic growth and ecological sustainability.

In light of all this information, our study was conducted with 191 countries to measure the effects of inflation and the HDI on CO2 emissions per national income after the UNFCCC, which entered into force in 1994. In this study, model results were presented with breakdowns for OECD, G20 and EU member countries, as well as for advanced, high-income and low-income countries.

Concerning our first independent variable, "inflation", generally there is no direct causal relationship between inflation and CO2 emissions in the existing economic literature (Musarat et al., 2021). However, a potential relationship arises from the correlation between increased economic activity and increased energy consumption, which subsequently leads to increased carbon dioxide emissions. In particular, the positive economic effects of foreign direct investment ignore the pollution of the natural environment, which can cause various environmental problems (Yang et al., 2008; Zheng and Sheng, 2017). While inflation refers to a general increase in prices within the economy, CO2 emissions refer to the amount of carbon dioxide gas released into the atmosphere as a result of human activities. However, increased economic activity and energy consumption caused by increased aggregate demand can lead to increased CO2 emissions, which may have some relationship to inflation. For example, higher economic growth and surges in demand may increase industrial production and energy consumption. In this case, factors such as increased use of fossil fuels and vehicle emissions could increase CO2 emissions. However, the correlation between increased economic activity and CO2 emissions is subject to variation across countries and periods (Kasperowicz, 2015). This variation is due to differences in energy sources, industrial structures and environmental policies across countries.

On the other hand, the relationship between our second independent variable, the HDI and CO2 emissions is more straightforward than the relationship between inflation and CO2. However, this relationship is also complex and can be influenced by many factors. The HDI serves as a measure of a country's development, encompassing fundamental indicators such as life expectancy, educational attainment and per capita income. In particular, CO2 emissions are often the primary source of greenhouse gas emissions. The link between HDI and CO2 emissions can be seen in two main contexts. First, countries with a consistently high HDI tend to have higher levels of economic activity and living standards. In this case, there may be an increased demand for industrial production, energy consumption and transportation, potentially leading to increased CO2 emissions (Bedir and Yılmaz, 2016). However, the relationship between HDI and CO2 emissions is not exact and may vary between countries and even within regions of the same country (Adekoya et al., 2021). In the second case, some countries may have a high HDI but low CO2 emissions due to environmentally friendly policies and the use of green energy sources (Akbar et al., 2021). On the other hand, countries with a low HDI may experience reduced economic activity and energy consumption, resulting in lower CO2 emissions. Consequently, as mentioned earlier, there is some relationship between HDI and CO2 emissions in the economic literature, but this relationship is complex and can be determined by many factors. For a sustainable future, environmentally friendly policies and efforts to reduce carbon emissions are crucial, even in countries with high HDI.

When examining the HDI reported annually in the UNDP report, it is observed that countries with high scores have completed their development and industrialization. However, high industrialization inevitably leads to increased CO2 emissions. Moreover, the high production volume in industrialized economies suggests a hypothesis posited in economic literature: when supply is abundant, prices are low (ceteris paribus). As a result, inflation in industrialized countries tends to be lower compared to developing economies. In light of this information, this study aims to empirically investigate the complex relationship between inflation, HDI, and CO2 emissions across different country groups. The study conducts panel data analysis for OECD, G20, EU member states, developed, high-income, and low-income countries between 1994 and 2021. By including a much broader categorization of countries and subgroups than other studies in the literature, this research contributes significantly to the literature.

The difficulties encountered in the study were excluded from the scope of the study because some country data (especially non-advanced) could not be accessed. In addition, when examining different country groups, it was observed that there is a phase in which the overlapping countries of EU members, OECD members, advanced economy countries and G20 countries are observed. In other words, the large number of partner countries reveals the difficulty of revealing the differences between these groups. Additionally, it should be known that the model results are obtained specific to the period and method applied. There may be studies that provide different cointegration tests and long-term relationship coefficients. Finally, we completed the study with the most up-to-date data, but since we cannot yet access 2022 data, there is a limitation in terms of current time data.

2. Literature Review

Although there is a relationship between carbon emissions and the level of human development, this relationship is complex and subject to multifaceted causality in the literature. Studies highlighting the relationship between the level of human development and carbon emissions, as well as the importance of environmental sustainability, also demonstrate the positive effects of renewable energy usage on human development and environmental sustainability. Existing literature indicates that as the level of human development increases, carbon emissions tend to decrease.

Sadiq et al. (2022), investigated the influence of nuclear energy use on human development and its subsequent impact on carbon emissions within the BRICS countries. The long-run results of CS-ARDL, CCEMG and AMG estimation covering 1990-2019 show that nuclear energy have positive effects on human development, while external debt and carbon emissions hinder human development. It is also noted that the use of nuclear energy contributes to economic growth and improved quality of life, as nuclear energy protect the environment due to its low carbon emissions in electricity generation.

Adekoya et al. (2021), provide an assessment of the role of renewable energy consumption and carbon emissions in influencing the HDI across global regions. For this, countries were grouped into eight regions and analyses were conducted using stationary individual effects and stationary time effects models. It is indicated a negative association between renewable energy consumption and carbon emissions and that this relationship strengthens over time. In addition, a positive correlation was found between the human development index (HDI) and renewable energy consumption. It is also found that there are differences in the regional analyses, characterized by different trends between regions. As a result, the study concludes that both renewable energy consumption play a significant role in mitigating carbon emissions, underscoring the importance of accounting for regional variations.

Afolayan (2020), examined the existence of cointegration among variables using the ARDL method with annual time series covering the years 1980-2017. Their study found that a 1% increase in government investment in healthcare increases economic development by 0.008%, while a 1% increase in CO2 levels decreases income per GDP by 0.1%. Results demonstrated that there is no causal relationship between fossil fuel consumption and CO2 emissions. Although fossil fuel consumption has a causal effect on CO2 levels, CO2 has no causal effect on fossil fuel consumption.

Mohmmed et al. (2019), examined the factors affecting CO2 emissions in countries using the panel data method, the impact of various industries on CO2 emissions, the related human development index and economic growth between 1991 and 2014 was examined. The overall results of the study show that population and income have a significant impact on the change in CO2 emissions. Importantly, the study's projections indicate an expected increase in CO2 emissions in all countries over the next 16 years. However, the forecast predicts an increase in CO2 emissions. It highlights the need for policy plans to reduce CO2 emissions for a safer environment. The results of the study emphasize the need for policy plans to reduce CO2 emissions in these countries.

Akbar et al. (2021), examine the relationship between health expenditures, CO2 emissions and the Human Development Index among OECD member countries. The results of the study show a positive relationship between increased health expenditure and increased CO2 emissions. Conversely, a negative relationship is observed between the human development index and CO2 emissions. A higher human development index was found to be associated with lower CO2 emissions. The results show that human development index is an important factor in reducing CO2 emissions. These findings highlight the importance of effectively managing health expenditures and prioritizing human development as critical components of sustainable development.

Asongu and Odhiambo (2019), demonstrated that environmental degradation has a negative impact on the inclusive human development index. Increased CO2 emissions, coupled with issues such as water pollution and deforestation, are associated with lower levels of human development, particularly in areas such as education and health. In addition, research shows a link between environmental degradation and increased income inequality.

Liu and Hao (2018), investigate the associations between CO2 emissions energy consumption and economic development with data from 69 countries for the period between 1970 and 2013. The estimation results using vector error correction model (VECM), modified OLS (FMOLS) and dynamic OLS (DOLS) approaches show that the relationships between energy consumption and economic development vary in different subgroups. Evidence for a long-run reciprocal causality between carbon emissions, energy consumption, industrial value added and GDP per capita was presented for all country groups. The study results suggest that CO2 emissions tend to increase in line with increased energy consumption and economic development. The fact that CO2 emissions tend to decrease as countries reach higher income levels is interpreted as an indication that countries have the potential to achieve their environmental sustainability goals in the process of economic development.

Bedir and Yilmaz (2016), investigated that CO2 emissions had an impact on human development in specific OECD countries. They observed a reciprocal relationship between CO2 emissions and the human development index within these nations. Interestingly, some countries, such as Australia, Austria, Belgium, Canada, Hungary, the Netherlands, Slovenia, Sweden, and the United Kingdom, did not show a causal link between CO2 emissions and the Human Development Index. In contrast, in Iceland, Norway, Portugal, and Switzerland, an increase in CO2 emissions directly influenced the human development index, and conversely, a higher human development index encouraged greater CO2 emissions in these countries.

Wang et al. (2019), examine the association between CO2 emissions, human development index, with empirical evidence based on long-term estimation using data covering the period 1990-2015. The results revealed a negative relationship between financial development and CO2 emissions. However, a positive relationship was found between globalization and CO2 emissions. These results highlight the importance of human and financial development in reducing CO2 emissions, while emphasizing the potential for globalization to increase CO2 emissions.

Goswami et al. (2023), aimed to assess the impact of factors on carbon emissions in India during the period from 1980 to 2021. According to the results of the long-term analysis, energy consumption, urbanization and trade openness exhibited a positive correlation with CO2 emissions, while economic growth and previous lagged CO2 emissions showed a negative correlation. These findings suggest that energy consumption is a primary driver of CO2 emissions in India, as indicated by its positive long-term coefficient.

The relationship between carbon emissions and inflation can be complex and subject to the interaction of numerous factors, varying depending on countries, sectors and other environmental and economic variables. According to studies in the literature, countries with higher levels of human development tend to exhibit greater economic activities and industrialization. Industrial activities and energy production often rely on the use of fossil fuels, leading to increased carbon emissions. Therefore, countries with higher levels of human development typically experience higher carbon emissions, whereas countries with lower levels of human development tend to have lower carbon emissions.

Kalantari et al. (2022), conducted a case study focusing on inflation and carbon emission policies. The primary goal of the study is to ensure the sustainability of the network by minimizing environmental impacts while increasing economic efficiency. The results of the study show that the proposed method is capable of solving large-scale problems.

Rahman et al. (2022), investigated the relationship between industrial production, agriculture and forestry, inflation, financial development and carbon emissions. Industrial and agricultural production were analyzed separately and their effects on the carbon emission function were evaluated together with inflation and financial development. The study investigates the effect of agricultural and industrial production on the carbon emissions function and applies a new FARDL method.

Nabi et al. (2020), analyzed the relationship between population growth and carbon emissions by using cross-sectional regression and transition regression system with cross-sectional data for 2011. Panel data analysis and dynamic panel data methods were used to understand the impact of carbon emissions. The results showed a positive correlation between population growth and carbon emissions. In addition, there was a positive correlation between price levels and carbon emissions. However, the study found that the poverty rate had no significant effect on carbon emissions. These findings underscore that population growth and price levels have an increasing impact on carbon emissions. In addition, the study highlighted the potential for anti-poverty policies to contribute to sustainable development goals. While the study shows that there are differences between countries, population growth and poverty rates are higher in some countries, while price levels are more effective in others. These underscore the variety of factors affecting carbon emissions.

Marín-Rodríguez et al. (2023), examine the time dependence between Brent oil returns, the green bond index and CO2 futures returns. Their study measures reciprocal movements and causality tests over the period 2014-2022. The research analyzes how the changes in oil prices, green bonds and CO2 emissions are related over time and how these relationships vary across wavelengths. The results showed a positive relationship between oil prices and green bonds and between oil prices and CO2 emissions. Wavelet analysis further revealed that the strength of these relationships varied in different periods and changed over time. In particular, these relationships, especially those involving oil prices, green bonds and CO2 emissions, were found to be more pronounced during financial crises and at certain wavelengths.

Moessner (2022), conducted an extensive analysis of 55 countries, focusing on climate policy, carbon emissions and inflation. The fact that the analysis in the study shows that higher inflation is generally observed in countries with higher carbon dioxide emissions. Singh and Kaur (2022), examine the relationship between energy consumption, carbon emissions using data from 1985 to 2019 and including additional variables. Accordingly, there was a unidirectional Granger causality, indicating that economic growth affected energy consumption, carbon emissions and agricultural land.

Islam et al. (2021), investigated the factors influencing economic growth in Saudi Arabia, considering carbon emissions, inflation and unemployment. The study concluded inflation and population growth were identified as obstacles to economic growth, while the unemployment rate was found to not affect economic growth. While the increase in carbon emissions harms economic growth, precipitation, temperature, population growth and low unemployment rate have supportive effects on economic growth.

The relationship between inflation and people's well-being is generally examined in a negative light. When demand increases but production capacity does not, rising inflation can pose a serious threat to the economy (Ayyoub et al., 2011). Furthermore, increasing inflation can harm the balance of payments, negatively affecting resource allocation (Gokal and Hanif, 2004). It can also disrupt income distribution, leading to delayed wage increases and benefiting businesses while causing harm to households (Datta and Mukhopadhyay, 2011). Lastly, an increase in inflation can lead to higher capital costs, shifting capital owners' preference towards interest over investment in production, which can result in a reduction in the country's potential production capacity (Tunalı and Ozkan, 2016).

Appiah et al. (2019), have concluded that between the years 1990 and 2015, human development had a positive and significant impact on economic growth and development in African countries. The results indicated a positive and significant relationship between variables such as labor force and foreign aid with growth. Additionally, due to the heterogeneity of African countries, a negative relationship between capital and growth, as well as a negative relationship between investment and growth, were identified.

Kim and Lin (2023), conducted an analysis covering the period from 1970 to 2019, using a sample that includes both developing and developed countries. Their findings indicate that inflation increases income inequality; however, this adverse effect diminishes with financial development. In other words, financial development has the potential to mitigate the negative impact of inflation on income distribution. These results highlight the moderating role of the financial sector in the economy and increased access to financial services.

Berisha et al. (2020), conducted a study encompassing BRICS economies, examining how income growth, real interest rates and inflation affected income inequality from 2001 to 2015. The study's findings indicate that increases in inflation and real income growth contribute to the escalation of income inequality.

This study aims to contribute to the literature by analyzing the relationship between countries' carbon emissions per GDP, general price levels and the level of human development, focusing on 191 countries categorized by their development levels. While existing literature often examines countries by regional or groupings, this study stands out by grouping countries based on various criteria and including inflation and the Human Development Index as independent variables in the model, adding to its originality.

3. Econometric Analysis

3.1. Methodology

Cointegration is used for identifying and analyzing long-term relationships. The prerequisite for cointegration is a level of nonstationarity. It is used to examine the long-run relationships of series that are stationary only in their first differences. In this study, we used panel cointegration tests developed by Pedroni (2001) to interpret our model results. These tests, proposed by Pedroni, are based on the analysis of error terms. Thus, the first step is to compute the residuals for the cointegration regression, which can be defined as follows (Pedroni, 1999, p. 656).

$$Y_{i,t} = \alpha_i + \delta_i t + \beta_{1i} x_{1i,t} + \beta_{2i} x_{2i,t} + \ldots + \beta_{mi} x_{mi,t} + \varepsilon_{i,t}$$
$$t = 1,\ldots,T \quad i=1,\ldots N \quad m=1,\ldots M \tag{1}$$

Where "t" represents the periods, "N" is the number of units within the panel data and "M" is the number of variables in the regression model. The regression model is formulated by estimating equations (2) and (3) below, followed by a cointegration test.

$$\varepsilon_{it} = \emptyset_{it-1} + \nu_{it} \tag{2}$$

$$H_0 = \emptyset_i = 0 \tag{3}$$

Here, the null hypothesis is the absence of cointegration, while the alternative hypothesis refers to the tests (Panel-ν, Panel-ρ, Panel-PP, Panel-

ADF, Group-ρ, Group-PP, Group-ADF) that vary according to homogeneity and heterogeneity with standard normal distributions. Four of these tests are referred to as within-dimension panel cointegration tests, while the other three involve between-dimension panel cointegration data. The relationship between the seven different tests and their prominent aspects are supported by the data construction process. In general, the panel-ρ statistic is preferred in studies with a small number of data, while the panel-ν statistic is preferred in studies with a large number of data (Pedroni, 2004, p. 614).

Once the cointegration is confirmed by the Pedroni test, the cointegration parameters are estimated. Here we encounter FMOLS and DOLS. DOLS is usually preferred when analyzing highly volatile data. Consequently, our study includes the results of both FMOLS and DOLS estimators. The panel FMOLS (Fully Modified Ordinary Least Squares), introduced by (Pedroni, 2001), serves as the variable identification method.

FMOLS and DOLS methods have begun to replace traditional cointegration tests in obtaining long-term relationships between variables. FMOLS, proposed by Phillips and Hansen (1990) and DOLS, developed by Stock and Watson (1993) are preferred due to the endogeneity problem that occurs in the estimation phase and the inability to interpret the long-term coefficients obtained. FMOLS and DOLS cointegration methods are based on the condition that the series used are stationary at difference, just like the Johansen Cointegration method. However, the possibility of interpreting the obtained coefficients offers an important advantage. Using two methods such as FMOLS and DOLS is important to increase the reliability of the findings. Additionally, FMOLS uses the covariance matrix of error terms to solve problems arising from long-term correlations between stochastic processes and cointegration equations. DOLS develops an asymptotically efficient estimator that terminates feedback effects in the long-run relationship equation. DOLS technique eliminates the problem of serial connection between standard errors arising from the ordinary least squares (OLS) method. FMOLS, on the other hand, relaxes the condition that all variables are integrated to the same degree. In line with Angeris et al. (2021), DOLS outperforms FMOLS estimators in terms of mean biases.

The estimator is calculated as expressed in equation (4).

$$B^{*}_{GFM} = N^{-1} \sum_{i=1}^{N} \beta_{FMi} \tag{4}$$

Dynamic Least Squares (DOLS) was developed by Saikkonen (1992) and Stock and Watson (1993). DOLS is a simple method to obtain an asymptotic estimator that effectively mitigates the problem of feedback within the cointegration system. DOLS requires the first difference variables to eliminate the small sample bias due to the correlation between the error term and the I(1) variables (Caporale and Chui, 1999). The augmented cointegration equation including lags and priors of the independent variable, which is used to ensure that the error term in the cointegration equation is orthogonal to the stochastic regressor updates, is expressed as follows:

$$Y_t = BX_t + \sum_{j=-q}^{r} X_{t+j}\delta + v_d \tag{5}$$

In addition, two other cointegration tests were conducted to increase the robustness of the results, although the methodology of these tests is not detailed here.

3.2. Dataset and Empirical Results

This study was conducted with 191 countries listed on the official website of the World Bank for the period from 1994 to 2021. In other words, the study was completed with N:191, 6112 observations and T:32 with annual data. The annual averages for the selected countries can be found in Appendix 1. In this context, various econometric tests were conducted to determine the most appropriate estimation method and the results were then compared within different groups. In this study, model results were presented with breakdowns for OECD, G20 and EU member countries, as well as for advanced, high-income and low-income countries. In this context, the relationships between inflation, the HDI and GDP per national income were examined to determine their directional trends. The data in question were obtained from the website https://data.worldbank.org/ and underwent various data cleaning procedures to make them suitable for use as an unbalanced panel. Table 1 below provides a summary of the variable abbreviations.

The variable referred to as "CO2 emissions" in our study is explicitly expressed as "CO2 consumption per GDP," measured in kilograms per GDP in current US dollars. The definition of "CO2 emissions" adopted in our research aligns closely with the explanation provided by the World Bank. As per this definition, CO2 emissions primarily result from the combustion of fossil fuels and cement production. These emissions encompass a wide range of energy consumption activities, including the utilization of solid, liquid, and gas fuels, as well as the release of carbon dioxide during gas flaring processes. Consequently, it is crucial to recognize that the generation of national income inherently requires a certain level of energy consumption, which, in turn, leads to CO2 emissions. Given the intricate and multifaceted relationship between economic growth, energy consumption, and CO2 emissions, we made a deliberate choice to employ the variable "CO2 consumption per GDP" within our research model. This specific variable was chosen to facilitate a nuanced assessment of the impact of energy consumption on CO2 emissions, particularly within the broader context of economic growth.

Since the population data of the countries were missing, national income, a proxy variable, was used instead. It is clear that as the population increases, national income will also increase. Since the nature of the modeling is based on carbon consumption per national income rather than carbon consumption, national income, taken as the population proxy variable of the countries, was included in the model as a dependent variable. Since inflation changes positively with economic growth, it was decided to use inflation as a proxy instead of growth. Since there was a positive correlation between economic growth and inflation in the model we used and this could create a multicollinearity problem, growth data was not included in the model. In addition to this, when examining carbon consumption, most studies have primarily focused on the variables we use Adekoya et al. (2021), Afolayan (2020), Bieth (2021), Appiah et al. (2019), Singh and Kaur (2022).

Table 1: Variables and Definitions

	Variable	**Notation**	**Source**
Dependent Variable	CO2 Consumption per National Income	CO2PG	https://data.worldbank.org/
Independent Variable	Inflation rate	CPI	https://data.worldbank.org/
Independent Variable	Human Development Index	HCI	https://data.worldbank.org/

Table 2 presents descriptive statistics for the dataset. According to these results, 191 country data were used for 3 different variables. Inclusiveness, minimum and maximum values, normality and number of observations of the data are presented in Table 2. Note that statistics and tables on breakdowns are not reported separately; only the results of the cointegration tests are presented.

Table 2: Descriptive Statistics

	CO2PG	**CPI**	**HCI**
Mean	0.292738	2,684,771	0.675194
Median	0.209456	3,904,927	0.699000
Maximum	1,381,083	23773.13	0.962000
Minimum	0.000737	-1,611,733	0.216000
Std. Dev.	0.525307	3,921,249	0.164702
Skewness	1,391,410	4,821,910	-0.369121
Jarque-Bera	12339433	1.59E+09	2,210,101
Probability	0.000000	0.000000	0.000000

Sum	1,430,319	131177.9	3,298,996
Sum Sq. Dev.	1,348,004	7.51E+08	1,325,136
Sum	1,430,319	131177.9	3,298,996
Observations	4886	4886	4886

Stationarity tests, which indicate whether the variables contain unit roots, cross-sectional dependence tests, which indicate whether there is dependence between units and homogeneity tests, which allow the estimation methods to be changed, were computed. In addition, panel cointegration tests and FMOLS coefficient estimations were carried out using the Eviews 12 and Stata software programs. As shown in Table 3, the stationarity of all variables was assessed both at the level and the first differences and the results indicated that the first differences of these variables were stationary.

Since there was no cross-sectional dependence in the panel data set, the Im et al. (2003) (IPS) test, a first-generation unit root test, was preferred. According to the panel unit root test results presented in Table 3, the null hypothesis that the series contains I(0) unit roots, at the level, cannot be rejected. In other words, the data were found to be non-stationary at the level values. Accordingly, the results of the unit root tests, considering both the stationary term and the stationary with trend models, indicated that all the data in the study were I(1).

Table 3: Stationarity Test

Variables	Stationary Term	Stationary Term and Trend	Conclusion
CO2PG	6.5	4.1	Non-Stationary
CPI	10.4	5.4.	Non-Stationary
HCI	3.45	2.55	Non-Stationary
DCO2PG	-3.65***	-3.05***	Stationary
DCPI	-2.45***	-2.85***	Stationary
DHCI	-2.6***	-2.9***	Stationary

4. ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively

To perform first or second-generation unit root tests on panel data, we first assess the presence of cross-sectional dependence. In this context, we applied the LM test or Pesaran CD test. The results of these tests are presented in Table 4. The results of these tests indicate the absence of cross-sectional dependence in the model. The cross-sectional dependence means that there is no correlation between the error terms computed for each country within the panel data model.

Table 4: Cross-Sectional Dependence Test

Dependent Variable FDGR		
Test	**Chi-Square / z Value**	**p Value**
Breusch-Pagan LM Test (1980)	2.10	p >0.10
Pesaran CD Test (2004)	1.60	p >0.10

As the next test, although it does not change our variable estimation method, the results of the Pesaran-Yamagata test, which is used to determine whether the panel data is homogeneous or heterogeneous, are shown in Table 5. The results indicate that the slope coefficients exhibit homogeneity. In other words, we can reasonably assume that the country data are homogeneously distributed.

Table 5: Homogeneity Test

Dependent Variable FDGR		
Test	**Delta**	**Probability**
Pesaran Yamagata Test (2008)	0.35	p >0.10

At this point, it becomes imperative to test for the existence of cointegration among the variables. To this end, we used the Pedroni (1999) cointegration test to test the null hypothesis that there is no cointegration among the panel variables. The statistics presented in Table 6 confirm that the variables used in the analysis are cointegrated in the long run.

Table 6: Panel Cointegration Test

Panel Cointegration Test Results		
Within-Dimension Tests	**Stationary Term**	**Stationary Term and Trend**
Panel-ν	-5.96	-12.80
Panel-ρ	-2.25***	5.80
Panel-PP	-12.10***	-11.55***
Panel-ADF	-13.35***	-11.33***
Between-dimensions Tests		
Group-ρ	2.05*	6.70
Group PP	-4.1***	-3.50***
Group ADF	-1.75**	-4.45***
Within-Dimension Tests	**Stationary Term**	**Stationary Term and**
Panel-ν	-5.96	-12.80
Panel-ρ	-2.25***	5.80

5. ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively.

We also use KAO and Fisher tests to strengthen the cointegration result. These test statistics yield results consistent with the Pedroni test and are presented in Table 7 below.

Table 7: Panel Cointegration Estimator Coefficients

Dependent Variable FDGR		
	KAO Cointegration Test	**Fisher Cointegration Test**
ADF Test	-7.14***	-
Fisher Statistics	-	776***

6. ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Having confirmed the existence of cointegration among the variables, we presented the cointegration parameters for FMOLS and DMOLS in Table 8.

Table 8: Panel Cointegration Estimator Coefficients

	FMOLS Estimator Results		**DMOLS Estimator Results**	
Variable	**Coefficient**	**T statistics**	**Coefficient**	**T statistics**
CPI	0.002	2.79***	0.003	2.05***
HCI	-0.47	-2.20***	-1.44	-3.73***

7. ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively.

According to the model results, all the variables show statistical significance. A detailed examination of the results shows that both inflation and the human development index are statistically significant in both models. For the panel results of 191 countries, it can be stated that inflation slightly increases CO2 consumption per national income, while the human development index decreases CO2 consumption per national income. In this context, analyzing the empirical results, a one-unit increase in inflation increases CO2 consumption per national income by 0.002 and 0.003, respectively, while an increase in the Human Development Index decreases CO2 consumption per national income by 0.47 and 1.44, respectively.

After assessing these results, it is necessary to explore the variations in these relationships at the country breakdowns. This is because various international organizations have advisory and binding decisions on carbon emissions and member countries comply with these decisions. Therefore, examining countries in breakdowns will provide us with a broader perspective and facilitate a more detailed analysis.

At this stage, we refrain from repeating individual tests and instead present the results of the two estimation methods based on groups. The results include 36 OECD countries, 19 G20 countries, 26 European Union countries and 38 Advanced countries. The model results for these country groups are presented in Table 9.

Table 9: Model Results by Breakdown 1

	OECD		G20		EU		Advanced	
Variable	FMOLS	DOLS	FMOLS	DOLS	FMOL	DOLS	FMOLS	DOLS
CPI	-0.25**	-0.001*	-0.09***	-2.60*	-	-3.01**	-0.02**	-0.002*
HCI	0.29***	0.32***	0.43***	0.33***	0.32***	0.31***	0.69**	0.90*

***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively.

Interpreting the empirical results of the model provides a clearer understanding of certain relationships. In this context, both inflation and the Human Development Index have statistically significant and positive relationships across OECD, G20, EU and advanced countries, in all models. While the country group in which inflation reduced carbon consumption the most was the EU member states, the country group that reduced carbon consumption the least was the advanced country group. The EU's proactive policies to promote sustainability and leading role in the transition to a greener economy play a role at this point. With the "Green Deal Industrial Plan" announced by the EU on February 1, 2023, a policy framework has been drawn up to ensure investments for the green transformation of the industrial sector and the transformation of the economy with competitiveness. The plan is expected to complement the ongoing industrial transformation efforts under the "European Green Deal", the "EU Industrial Strategy" and in particular the "Circular Economy Action Plan". On the other hand, the EU's announced "Draft Waste Shipment Regulation" aims to control the EU's uncontrolled waste exports to third countries, while at the same time reintroducing existing waste into the economy as a resource.

In terms of the human development index, it can be stated that advanced countries experience the largest increases in carbon consumption, while OECD and EU countries experience the smallest increases. These results are important for determining the carbon consumption per national income for advanced economies and for designing effective and appropriate measures that can be taken based on relevant organizations. Indeed, the global analysis of 191 countries is consistent with these expectations. In other words, although the increase in inflation, that is, the increase in income and expenditure as a proxy, expresses more carbon use, it is possible to observe that this relationship is reversed when some of the leading countries are analyzed. In other words, while an increase in the Human Development Index in the world's leading countries means more carbon consumption per national income, an increase in inflation reduces this ratio. This negative correlation can be explained as follows. Since the increase in inflation is generally a problem seen in underdeveloped countries, it decreases this ratio due to the low carbon consumption per national income of these countries. In addition, since developed countries tend to pursue recessionary policies during periods of high inflation, this leads to an inverse relationship between inflation and carbon consumption in countries with high carbon consumption. In addition, it can be argued that the positive relationship between the Human Development Index and carbon consumption is because countries with a high index tend to have high industrial production and therefore high carbon consumption.

Another breakdown concerns the income level of countries. The previous breakdown, however, was based on high-income developed countries. The difference between these breakdowns was presented. Here we present results and assessments for relatively underdeveloped countries. For the sample we used, 58 high-income countries, 52 upper-middle-income countries, 53 lower-middle-income countries and 26 low-income countries were selected and the model results were presented in Table 10.

Table 10: Model Results by Breakdown 2

	High-Income		Upper-Middle		Lower-Middle		High-Income	
Variable	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**	**FMOLS**	**DOLS**
CPI	-0.19**	-0.002**	0.008***	0.015*	0.022***	0.018**	0.12**	0.07**
HCI	0.44***	0.47***	-2.40***	-0.55**	-1.20***	-0.024**	-0.10**	-0.09*

8. ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively.

The empirical interpretation of the model results shows that there is a difference in the direction of the data between high-income and other income groups. Accordingly, for high-income countries, a one-unit increase in inflation reduces carbon consumption consistent with the leading economies (0.19 units), while the human development index increases carbon consumption (0.44 units). At the same time, the effect is reversed in upper-middle-income countries and the highest contribution of inflation is realized in low-income countries. In addition, the impact of the Human Development Index is most pronounced in upper-middle-income countries. In other words, for countries with declining income levels and changing macroeconomic conditions, the increase in inflation decreases carbon consumption, but the human development index increases carbon consumption.

4. A Case Study: Turkey

Evaluating the model results within the context of Turkey, a country with relatively high inflation, will be guiding for countries experiencing high inflation problems. In this context, it is important for policy makers of similar countries to establish and interpret long-term relationships between carbon emissions per national income and inflation human development index for Turkey, using the same variables between 1994 and 2021, including the study period.

Before starting the analysis with time series, it should be investigated whether the series are stationary or not. The concept of stationarity, defined as the constant mean, variance and autocovariance of a stochastic variable over time, is important in terms of making accurate predictions for the future. In practice, in investigating stationarity, Perron (1990) test, which is more effective than other methods in detecting structural breaks in the series or series, was applied and the ADF unit root test Dickey and Fuller (1979) was also applied to ensure robustness. According to the results of the stationarity tests in question, it is seen that all series are stationary at first order, not at level. Therefore, it should be asked whether there is a long-term relationship.

It is generally accepted in the literature that Johansen cointegration tests are very sensitive to the choice of lag length. As a result, the VAR (Vector Autoregression) model is applied in cointegration analysis to find the appropriate lag length (Chang and Caudill, 2005). In the cointegration analysis, 2 lag lengths were found by selecting Akaike information criterion (AIC) and Schwarz for the appropriate lag length. Long-term relationships between variables can be established with the Johansen cointegration test. The regression result of the long-term relationship is shared below.

$$\mathrm{CO2PG} = -21{,}31 + 0{,}12\,\mathrm{CPI} - 0{,}29\,\mathrm{HCI} \tag{6}$$

When the model results are examined, for Turkey, which is a country with high inflation, a one-unit increase in inflation will increase carbon consumption per national income by 0.12 units, while a one-unit increase in the human development index will reduce carbon consumption per national income by 0.29 points. In other words, in inflationary countries, the change in the human development index will have a greater impact in absolute value than the change in inflation. The reason for this is that the macroeconomic balances of countries have become more resistant to the chronic inflation problem. Likewise, for Turkey, whose development is relatively low compared to developed countries, increasing the human development index produces positive results by reducing carbon consumption. When we compare these results with countries at the upper middle income level, including Turkey, similar results emerge. This increases the reliability of our findings.

The dynamic behaviors of variables show some deviations while acting together in the long run. This is a situation that can be seen on variables that are cointegrated in the long term and are determinants of the short term (Dinardo et al., 1997). The model states that the short-term deviations between the series moving together in the long term disappear again and the series converge to the long-term equilibrium value. This situation also provides evidence for the reliability of the long-term analysis. The coefficient of the error correction term also expresses the speed of convergence of the series to the equilibrium value; Since 1/0.126=8, deviations disappear after approximately 8 years (period). As a result of the coefficient of the error term being negative and statistically significant, it was seen that the error correction term worked in this model.

5. Conclusion and Evaluations

This study examines the effects of "inflation" and "human development index" as independent variables on the dependent variable "CO2 consumption per national income". Since the country groupings in the study are based on G20, EU, Advanced, OECD, High-Income, Low-Income, Lower-Middle and Upper-Middle subdivisions, the study is of great importance with its wide range.

The study was completed with a large amount of macro data and a wide range of periods with different subgroups and classifications. Across the OECD, G20, EU and developed countries, inflation and the HDI show significant and positive relationships in all models. This implies that there is a significant relationship between carbon emissions, inflation rates and the level of human development in both medium- and long-term contexts. These empirical results are conveyed through two different analytical approaches. Analyzing the empirical results in this context, a one-unit increase in inflation increases CO2 consumption per national income by 0.002 and 0.003, respectively, while an increase in the human development index decreases CO2 consumption per national income by 0.47 and 1.44, respectively. According to the obtained findings, the conclusion that an increase in the human development index leads to an increase in CO2 emissions is consistent with the results of previous studies analyzing the relationship between the human development index and CO2 emissions, as documented in (Akbar et al., 2021), (Asongu and Odhiambo, 2019), (Sezgin et al., 2021), (Wang et al., 2019). The result that an increase in inflation reduces CO2 emissions is also in line with the findings obtained in (Rahman et al., 2022), (Nabi et al., 2020), (Moessner, 2022).

In summary, the model results show an inverse relationship between the level of human development and CO2/GDP. Broken down by country group, the country group that decreased carbon consumption the most in an inflationary environment was the EU country group, while the country group that decreased carbon consumption the least was the advanced country group. In terms of the HDI, advanced countries experience the largest increases in carbon consumption, while OECD and EU countries experience the smallest increases. The interpretation of this relationship is based on the signs and directions derived from the model results. The observation that the impact of the HDI on carbon emissions varies between countries and that these effects can differ from one country to another is consistent with the results of. (Rahman et al., 2022), (Nabi et al., 2020), (Moessner, 2022).

Within the scope of our study, the long-term relationship between carbon emissions, human development index and inflation in a wide range, based on 191 countries and a 28-year time period, was investigated by FMOLS and DMOLS methods. The difference from other similar studies (Sezgin et al., 2021), (Wang et al., 2019) are that long-term relations are made in distinctions that emphasize the income distribution of countries, as well as OECD countries, European Union countries, G20 countries and advanced countries. In addition, while examining the effect of carbon consumption on single variables, significant relationships with two different variables were examined in our study and as a result, a new understanding is revealed for carbon consumption measures that can be taken for different country groups.

The model results also show that for high-income countries, a one-unit increase in inflation reduces carbon consumption in line with patterns observed in the leading economies (0.19 units), while the human development index increases carbon consumption (0.44 units). At the same time, the effect is reversed in upper-middle-income countries and the highest contribution of inflation is realized in low-income countries. In addition, the impact of the human development index is most pronounced in upper-middle-income countries. In other words, for countries with declining income levels and changing macroeconomic conditions, the increase in inflation decreases carbon consumption, but the human development index increases carbon consumption.

The impact of inflation on carbon emissions can be examined from various perspectives. High inflation can increase economic uncertainty and price volatility, making it difficult to implement long-term strategies aimed at reducing carbon emissions. Additionally, high inflation can lead to increased energy and resource costs, which may discourage the adoption of sustainable energy alternatives. Conversely, low inflation can also influence efforts to combat climate change. Lower price increases can stimulate consumption, potentially leading to greater utilization of natural resources.

The impact of the human development index on carbon emissions can be evaluated from various perspectives. Countries with high human development indexes generally have higher levels of energy consumption and industrial production, which can lead to higher carbon emissions. These countries may be more reliant on fossil fuels to meet their energy needs. However, due to being more conscious and environmentally sensitive societies, they are inclined to prioritize environmental issues and sustainability. This inclination may facilitate the adoption of sustainable strategies and the reduction of carbon emissions. Moreover, countries with high human development indexes tend to invest more in research, innovation, and technology. These investments contribute to the development of clean energy sources and the creation of necessary infrastructure for their utilization, playing a significant role in reducing carbon emissions.

The results of the study show that the direction and magnitude of the relationship between the variables used in the model differ between groups of countries. This indicates that action plans should be differentiated according to the level of development of countries to achieve green transformation, which requires multilateral cooperation. Reducing carbon emissions is a significant goal for ensuring sustainable development. To effectively achieve this goal, optimizing production processes and raising human development levels are both essential for sustainability. The region-specific policies will yield more favorable results in the pursuit of this common goal.

Balancing economic prosperity with carbon emission reduction requires a long-term process. There are various practical steps to achieve this balance. Increasing the use of "Green Energy" supports economic prosperity while reducing carbon emissions. Energy consumption can be reduced by enhancing energy efficiency in buildings and facilities. Government support for incentives for public transportation and low-emission vehicles promotes sustainable transportation. It is important to use carbon pricing mechanisms to increase the cost of fossil fuels and incentivize clean energy. Consumers should be supported in their product and service choices considering environmental impacts. Investment in afforestation projects or renewable energy production can be made to balance carbon emissions. Various programs should be organized to raise awareness and provide education about the effects of carbon emissions in businesses and communities.

The results derived from the above model and analysis are comprehensive and insightful. Here, only the empirical findings were presented relevant to the contributions of specific country groupings to carbon consumption. In this context, further studies on the inverse of these groups, i.e. non-OECD and non-G20 countries, may be instructive for future studies. In addition, there is potential to redesign this study using a geographic classification based on continents and regions.

References

Adekoya, O. B., Olabode, J. K. & Rafi, S. K. (2021). Renewable Energy Consumption, Carbon Emissions and Human Development: Empirical Comparison of the Trajectories of World Regions, *Renewable Energy*, 179(C), 1836-1848. DOI: 10.1016/j.renene.2021.08.019.

Afolayan, O. T. (2020). Carbon Emissions, Human Capital Investment and Economic Development in Nigeria, *International Journal of Energy Economics and Policy*, 10(2), 427-437. DOI: https://doi.org/10.32479/ijeep.8476.

Akbar, M., Hussain, A., Akbar, A. & Ullah, I. (2021). The Dynamic Association Between Healthcare Spending, CO2 Emissions, and Human Development Index in OECD Countries: Evidence from Panel VAR Model, *Environment, Development and Sustainability*, 23(2), 10470-10489. DOI: https://doi.org/10.1007/s10668-020-01066-5.

Anand, S. & Sen, A. (1994). Human Development Index: Methodology and Measurement. New York, Human Development Report Office Occasional Papers.

Angeris, G., Kao, H.-T., Chiang, R., Noyes, C. & Chitra, T. (2021). An analysis of Uniswap Markets, *Cryptoeconomic System*, 1(1), 1-25. DOI: https://doi.org/10.21428/58320208.c9738e64.

Appiah, M., Amoasi, R. & Frowne, D. I. (2019). Human Development and Its Effects on Economic Growth and Development, *International Research Journal of Business Studies*, 12(2), 101-109. DOI: https://doi.org/10.21632/irjbs.

Asongu, S. A. & Odhiambo, N. M. (2019). Environmental Degradation and Inclusive Human Development in Sub-Saharan Africa, *Sustainable Development*, 27(1), 25-34. DOI: https://doi.org/10.1002/sd.1858.

Ayyoub, M., Chaudhry, I. S. & Farooq, F. (2011). Does Inflation Affect Economic Growth? The Case of Pakistan, *Pakistan Journal of Social Sciences (PJSS),* 31(1), 51-64. Retrieved from: https://pjss.bzu.edu.pk/index.php/pjss/article/view/93.

Bedir, S. & Yilmaz, V. M. (2016). CO2 Emissions and Human Development in OECD Countries: Granger Causality Analysis with a Panel Data Approach, *Eurasian Economic Review*, 6(1), 97-110. DOI: https://doi.org/10.1007/s40822-015-0037-2.

Berisha, E., Gupta, R. & Meszaros, J. (2020). The Impact of Macroeconomic Factors on Income Inequality: Evidence from the BRICS, *Economic Modelling*, 91, 559-567. DOI: https://doi.org/10.1016/j.econmod.2019.12.007.

Caporale, G. M. & Chui, M. K. (1999). Estimating Income and Price Elasticities of Trade in a Cointegration Framework, *Review of International Economics*, 7(2), 254-264. DOI: https://doi.org/10.1111/1467-9396.00161.

Chang, T. & Caudill, S. B. (2005). Financial Development and Economic Growth: The Case of Taiwan, *Applied Economics*, 37(12), 1329-1335. DOI: https://doi.org/10.1080/0003684042000338702.

Craig, B. & Rocheteau, G. (2008). Inflation and Welfare: A Search Approach, *Journal of Money, Credit and Banking*, 40(1), 89-119. Retrieved from: https://www.jstor.org/stable/25096241.

Datta, K. & Mukhopadhyay, C. K. (2011). Relationship between Inflation and Economic Growth in Malaysia-An Econometric Review, *International Conference on Economics and Finance Research*, 4(1), 415-419. Retrieved from: https://www.studocu.com/row/document/university-of-professional-studies/corporate-finance/relationship-between-inflation-and-economic-growth-in-malaysia-an-econometric-review/9358393.

Deger, M. K. & Pata, U. K. (2017). The Symmetric and Asymmetric Causality Analysis between Foreign Trade and Carbon Emissions in Turkey, *Doguş University Journal*, 18(1), 31-44. Retrieved from: https://dergipark.org.tr/tr/download/article-file/2152130.

Dickey, D. A. & Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, 74(366), 427-431. DOI: http://dx.doi.org/10.2307/2286348.

Dinardo, J., Johnston, J. & Johnston, J. (1997). *Econometric Methods*, (Fourth Edition) McGraw-Hill Companies, Inc.

Enders, W. (2015). *Applied Econometric Time Series,* (Fourth Edition) New York (US): University of Alabama.

Gokal, V. & Hanif, S. (2004). *Relationship Between Inflation and Economic Growth*, Suva: Economics Department, Reserve Bank of Fiji Working Paper, No. 2004/04.

Goswami, A., Kapoor, H. S., Jangir, R. K., Ngigi, C. N., Nowrouzi-Kia, B. & Chattu, V. K. (2023). Impact of Economic Growth, Trade Openness, Urbanization and Energy Consumption on Carbon Emissions: A Study of India, *Sustainability*, 15(11), 9025. DOI: https://doi.org/10.3390/su15119025.

Hirvilammi, T. (2020). The Virtuous Circle of Sustainable Welfare as a Transformative Policy Idea, *Sustainability*, 12(1), 391. DOI: http://dx.doi.org/10.3390/su12010391.

Im, K. S., Pesaran, M. H. & Shin, Y. (2003). Testing for Unit Roots in Heterogeneous Panels, *Journal of Econometrics*, 115(1), 53-74. DOI: https://doi.org/10.1016/S0304-4076(03)00092-7.

Islam, M. M., Alharthi, M. & Murad, M. W. (2021). The Effects of Carbon Emissions, Rainfall, Temperature, Inflation, Population, and Unemployment on Economic Growth in Saudi Arabia: An Ardl Investigation, *Plos One*, 16(4), 1-21. DOI: https://doi.org/10.1371/journal.pone.0248743.

Kalantari, S., Kazemipoor, H., Sobhani, F. M. & Molana, S. M. H. (2022). Designing Sustainable Closed-Loop Supply Chain Network with Considering Spot-To-Point Inflation and Carbon Emission Policies: A Case Study, *Computers & Industrial Engineering*, 174(1), 108748. DOI: http://dx.doi.org/10.1016/j.cie.2022.108748.

Kangas, O. (2010). One Hundred Years of Money, Welfare and Death: Mortality, Economic Growth and the Development of the Welfare State in 17 Oecd Countries 1900–2000, *International Journal of Social Welfare*, 19(1), 42-59. DOI: https://doi.org/10.1111/j.1468-2397.2010.00735.x.

Kasperowicz, R. (2015). Economic Growth and CO2 emissions: The ECM Analysis, *Journal of International Studies*, 8(3), 91-98. DOI: https://doi.org/10.14254/2071-8330.2015/8-3/7.

Kim, D.-H. & Lin, S.-C. (2023). Income Inequality, Inflation and Financial Development, *Journal of Empirical Finance*, 72(1), 468-487. DOI: https://doi.org/10.1016/j.jempfin.2023.04.008.

Kuznets, S. (1955). Economic Growth and Income Inequality, *The American Economic Reviews*, 45(1), 1-28. Retrieved from: https://www.jstor.org/stable/1811581.

Liu, Y. & Hao, Y. (2018). The Dynamic Links between CO2 Emissions, Energy Consumption and Economic Development in the Countries along "The Belt And Road", *Science of the Total Environment*, 645(10), 674-683. DOI: https://doi.org/10.1016/j.scitotenv.2018.07.062.

Lucas, J., Robert E. (2000). Inflation and Welfare, *Econometrica*, 68(2), 247-274. DOI: https://doi.org/10.1111/1468-0262.00109.

Marín-Rodríguez, N. J., González-Ruiz, J. D. & Botero, S. (2023) A Wavelet Analysis of the Dynamic Connectedness among Oil Prices, Green Bonds, and CO2 Emissions, *Risks*, 11(1), 1-21. DOI: https://doi.org/10.3390/risks11010015.

Moessner, R. (2022). Evidence on Climate Policy, Carbon Dioxide Emissions and Inflation, *International Journal of Global Warming*, 28(2), 136-151.

Mohmmed, A., Li, Z., Arowolo, A. O., Su, H., Deng, X., Najmuddin, O. & Zhang, Y. (2019). Driving Factors of CO2 Emissions and Nexus with Economic Growth, Development and

Human Health in the Top Ten Emitting Countries. Resources, *Conservation and Recycling*, 148(5), 157-169. DOI: https://doi.org/10.1016/j.resconrec.2019.03.048.

Musarat, M. A., Alaloul, W. S., Liew, M., Maqsoom, A. & Qureshi, A. H. (2021). The Effect of Inflation Rate on CO2 Emission: a Framework for Malaysian Construction Industry, *Sustainability*, 13(3), 1562. DOI: https://doi.org/10.3390/su13031562.

Nabi, A. A., Shahid, Z. A., Mubashir, K. A., Ali, A., Iqbal, A. & Zaman, K. (2020), "Relationship between Population Growth, Price Level, Poverty Incidence, and Carbon Emissions in a Panel of 98 Countries", *Environmental Science and Pollution Research*, 27(2), 31778-31792. DOI: https://doi.org/10.1007/s11356-020-08465-1.

Pedroni, P. (1999). Critical Values for Cointegration Tests in Heterogeneous Panels with Multiple Regressors, *Oxford Bulletin of Economics and Statistics*, 61(S1), 653-670. DOI: https://doi.org/10.1111/1468-0084.0610s1653.

Pedroni, P. (2001). Fully Modified OLS for Heterogeneous Cointegrated Panels. In Nonstationary Panels, Panel Cointegration, And Dynamic Panels, 15(1), *Emerald Group Publishing Limited*, 93-130. DOI: https://doi.org/10.1016/S0731-9053(00)15004-2.

Pedroni, P. (2004). Panel Cointegration: Asymptotic and Finite Sample Properties of Pooled Time Series Tests with an Application to the Ppp Hypothesis, *Econometric Theory*, 20(3), 597-625. DOI: https://doi.org/10.1017/S0266466604203073.

Perron, P. (1990). Testing for a Unit Root in a Time Series with a Changing Mean. *Journal of Business & Economic Statistics*, 8(2), 153-162. DOI: https://doi.org/10.2307/1391977.

Phillips, P. C. & Hansen, B. E. (1990). Statistical Inference in Instrumental Variables Regression with I (1) Processes, *The Review of Economic Studies*, 57(1), 99-125. DOI: https://doi.org/10.2307/2297545.

Rahman, S. U., Faisal, F., Sami, F., Ali, A., Chander, R. & Amin, M. Y. (2022). Investigating the Nexus Between Inflation, Financial Development, and Carbon Emission: Empirical Evidence from FARDL and Frequency Domain Approach, *Journal of the Knowledge Economy*, 1-27. DOI: https://doi.org/10.1007/s13132-022-01076-w.

Runtunuwu, P. C. H. (2020). Analysis of Macroeconomic Indicators and It's Effect on Human Development Index (HDI), *Society*, 8(2), 596-610. DOI: https://doi.org/10.1007/10.33019/society.v8i2.246.

Sadiq, M., Shinwari, R., Usman, M., Ozturk, I. & Maghyereh, A. I. (2022). Linking Nuclear Energy, Human Development and Carbon Emission in Brics Region: Do External Debt and Financial Globalization Protect The Environment?, *Nuclear Engineering and Technology*, 54(9), 3299-3309. DOI: https://doi.org/10.1016/j.net.2022.03.024.

Saikkonen, P. (1992). Estimation and Testing of Cointegrated Systems by an Autoregressive Approximation, *Econometric Theory*, 8(1), 1-27. DOI: https://doi.org/10.1017/S0266466600010720.

Sezgin, F. H., Bayar, Y., Herta, L. & Gavriletea, M. D. (2021). Do Environmental Stringency Policies and Human Development Reduce CO2 Emissions? Evidence from G7 and BRICS Economies, *International Journal of Environmental Research and Public Health*, 18(13), 1-13. DOI: https://doi.org/10.3390/ijerph18136727.

Singh, K. & Kaur, J. (2022). Do Energy Consumption and Carbon Emissions Impact Economic Growth? New Insights From India Using ARDL Approach, *OPEC Energy Review*, 46(1), 68-105. DOI: https://doi.org/10.1111/opec.12223.

Stock, J. H. & Watson, M. W. (1993). A Simple Estimator of Cointegrating Vectors in Higher Order Integrated Systems, *Econometrica: Journal of the Econometric Society*, 61(4), 783-820. Retrieved from: https://www.princeton.edu/~mwatson/papers/Stock_Watson_Ecta_1993.pdf.

Tunalı, H. & Ozkan, I. (2016). An Empirical Analysis of the Relationship Between Consumer Confidence Index and Consumer Price Index, *Journal of Economic Policy Researches*, 3(2), 54-67. Retrieved from: https://dergipark.org.tr/en/download/article-file/207713.

UNDP. (2020). Human Development Report 2020: The Next Frontier Human Development and the Anthropocene, https://www.undp.org/turkiye/publications/2020-human-development-report, (10/01/2024).

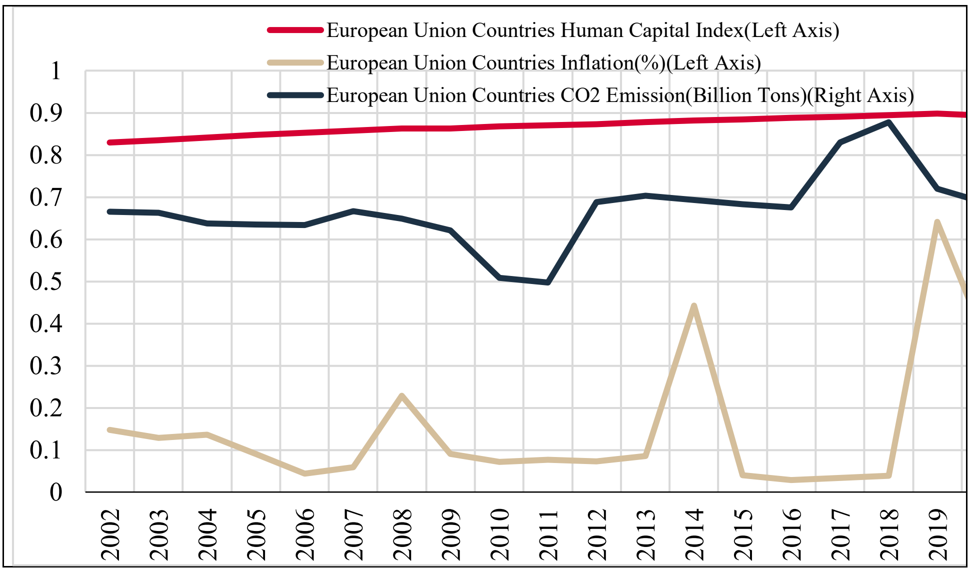
Van den Berg, H. (2016). *Economic Growth and Development*, USA: World Scientific Publishing Company. DOI: https://doi.org/10.1142/9058.

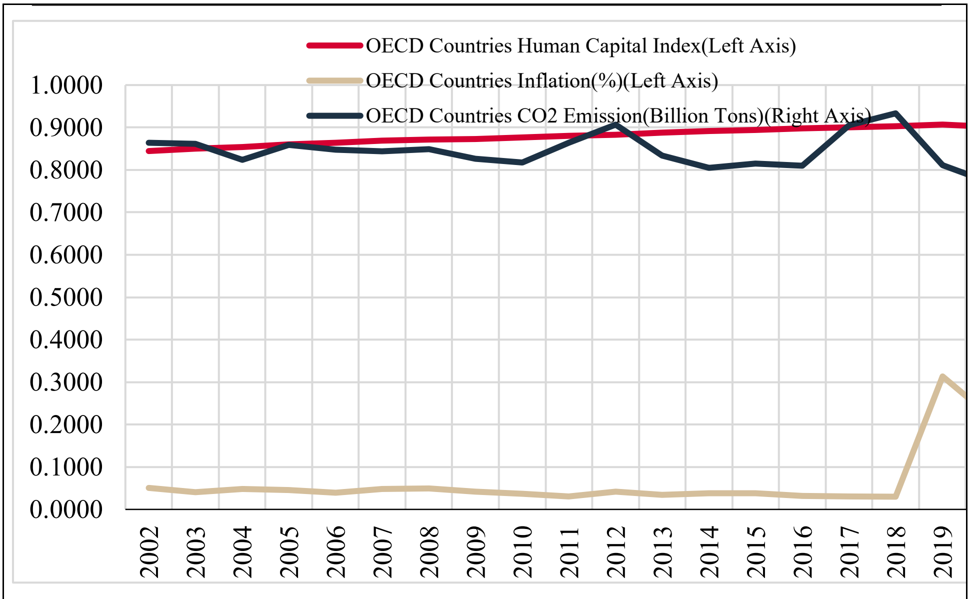
Wang, Z., Rasool, Y., Asghar, M. M. & Wang, B. (2019). Dynamic Linkages among CO2 Emissions, Human Development, Financial Development, and Globalization: Empirical Evidence Based on PMG long-run panel estimation, *Environmental Science and Pollution Research*, 26(36), 36248-36263. DOI: https://doi.org/10.1007/s11356-019-06556-2.

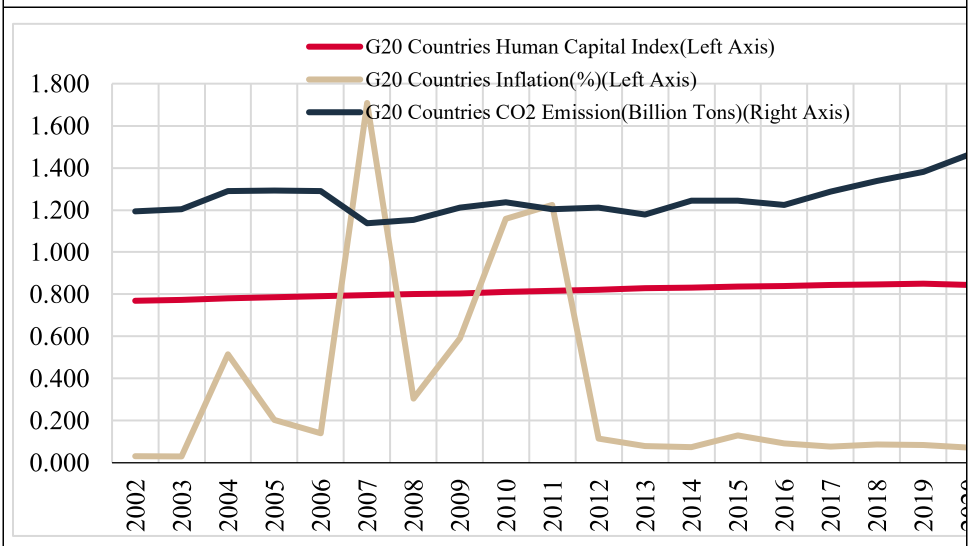
Yang, W.-P., Yang, Y. & Xu, J. (2008). The Impact of Foreign Trade and Fdi on Environmental Pollution, *China-USA Business Review*, 7(18), 1-11.

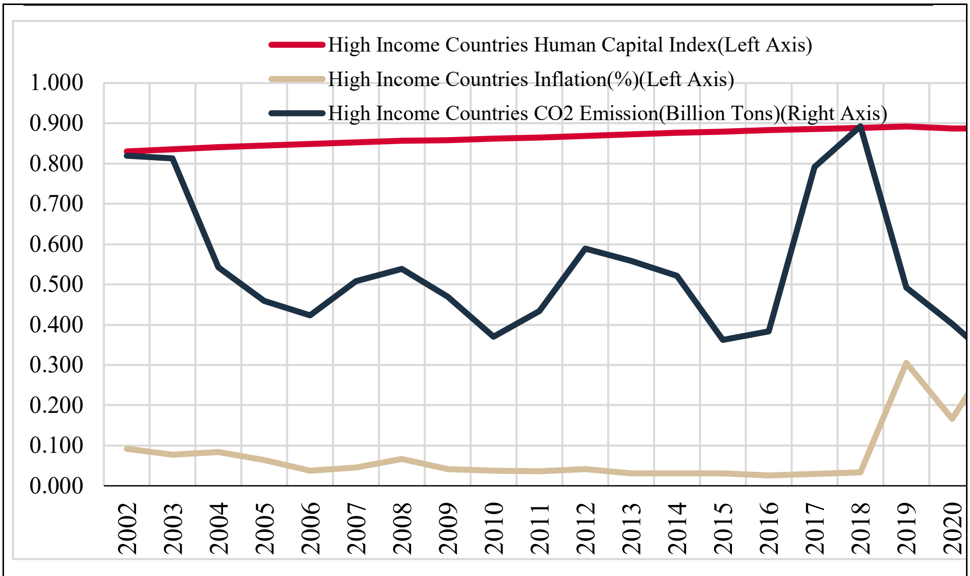
Zheng, J. & Sheng, P. (2017). The Impact of Foreign Direct Investment (FDI) on the Environment: Market Perspectives and Evidence From China, *Economies*, 5(1), 1-15. DOI: https://doi.org/10.3390/economies5010008.

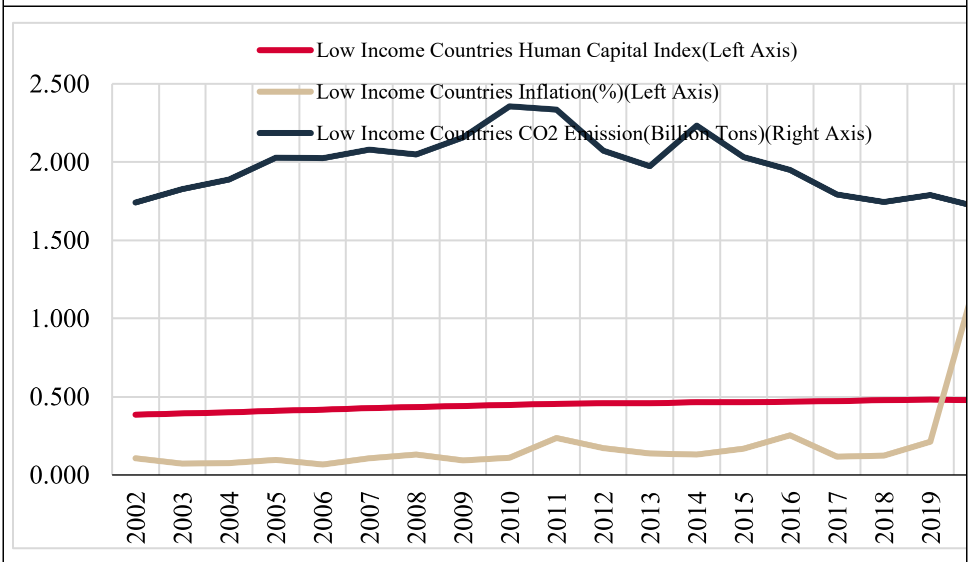
Appendix 1: Human Development Index Based on Selected Countries - Inflation (%) Average Data*

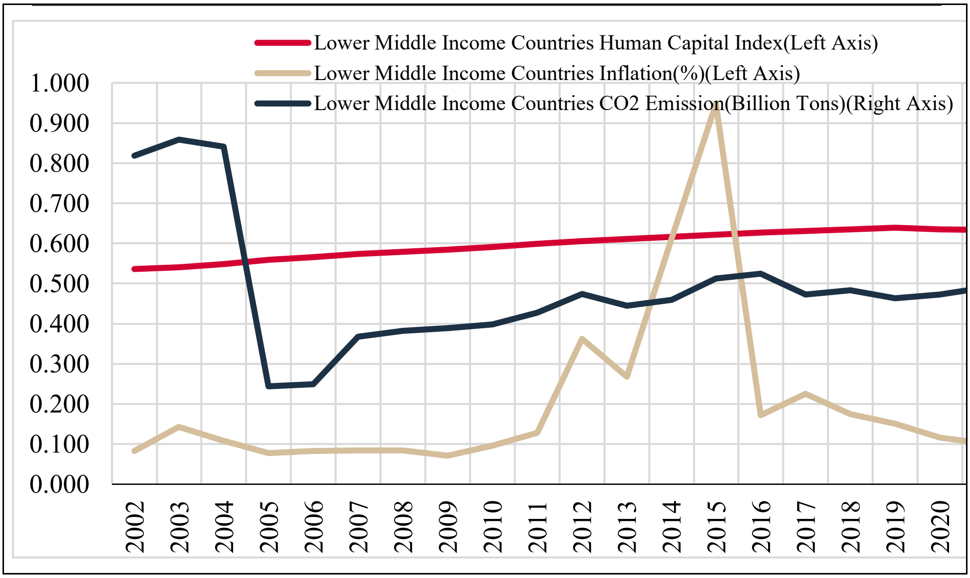



OECD Countries Human Capital Index(Left Axis)
OECD Countries Inflation(%)(Left Axis)
OECD Countries CO2 Emission(Billion Tons)(Right Axis)
1.0000
0.9000
0.8000
0.7000
0.6000
0.5000
0.4000
0.3000
0.2000
0.1000
0.0000
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019


G20 Countries Human Capital Index(Left Axis)
G20 Countries Inflation(%)(Left Axis)
G20 Countries CO2 Emission(Billion Tons)(Right Axis)
1.800
1.600
1.400
1.200
1.000
0.800
0.600
0.400
0.200
0.000
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019


High Income Countries Human Capital Index(Left Axis)
High Income Countries Inflation(%)(Left Axis)
High Income Countries CO2 Emission(Billion Tons)(Right Axis)
1.000
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020


Low Income Countries Human Capital Index(Left Axis)
Low Income Countries Inflation(%)(Left Axis)
Low Income Countries CO2 Emission(Billion Tons)(Right Axis)
2.500
2.000
1.500
1.000
0.500
0.000
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019



* The variables used in the model were calculated by the authors based on the arithmetic averages of the countries according to the country classifications mentioned in the related figure title.