PROBLEMY EKOROZWOJU/ PROBLEMS OF SUSTAINABLE DEVELOPMENT

SUBMITTED: 7.02.2025, ACCEPTED: 15.03.2025, PUBLISHED ON-LINE: 01.07.2025
2025, 20(2): 195-212, DOI: 10.35784/preko.7242

The Impact of Ecological Footprint, Energy Consumption and Economic Stability on Happiness: Evidence from BRICS-T Countries

Wpływ śladu ekologicznego, zużycia energii i stabilności gospodarczej na szczęście: Dowody z krajów BRICS-T

Seher Suluk[1], Yusuf Ekrem Akbaş[2]

Adıyaman University, Faculty of Economics and Administrative Sciences,
Department of Economics, Adıyaman, Turkey
[1]E-mail: ssuluk@adiyaman.edu.tr, ORCID: 0000-0002-3253-1098
[2]E-mail: yeakbas@adiyaman.edu.tr, ORCID: 0000-0002-9355-2802

Abstract
The main objective of this study is to analyze the impact of ecological footprint, fossil fuel energy consumption, renewable energy consumption and economic stability on happiness in BRICS-T countries for the years between 2005-2023 with the help of methods that take into account cross-section dependence and also can be used for heterogeneous panels. In this context, Dynamic SUR and AMG estimators are used to determine whether there is a long-run relationship among the variables. As a results of the analysis, there is a difference for individual and panel results. The individual results show that the variables considered in the analysis are statistically significant and there are differences among countries. Also, panel results indicate that factors that increase environmental pollution, such as an increase in ecological footprint and fossil fuel energy consumption negatively affect happiness, while reducing environmental pollution like a rise in renewable energy consumption, and improvement in economic conditions, like an increase in economic stability increases happiness.

Key words: happiness, ecological footprint, economic stability, renewable energy consumption, fossil fuel energy consumption, BRICS-T countries

Streszczenie
Głównym celem niniejszego badania jest analiza wpływu śladu ekologicznego, zużycia energii z paliw kopalnych, zużycia energii odnawialnej i stabilności gospodarczej na szczęście w krajach BRICS-T w latach 2005-2023 za pomocą metod, które uwzględniają zależność przekrojową, a także mogą być stosowane do heterogenicznych paneli. W tym kontekście dynamiczne estymatory SUR i AMG zostały wykorzystywane do określenia, czy istnieje długoterminowy związek między zmiennymi. Wyniki analizy różnią się w przypadku wyników indywidualnych i panelowych. Wyniki indywidualne pokazują, że zmienne uwzględnione w analizie są statystycznie istotne i istnieją różnice między krajami. Ponadto wyniki panelowe wskazują, że czynniki zwiększające zanieczyszczenie środowiska, takie jak wzrost śladu ekologicznego i zużycie energii z paliw kopalnych, negatywnie wpływają na szczęście, podczas gdy zmniejszenie zanieczyszczenia środowiska, takie jak wzrost zużycia energii odnawialnej, oraz poprawa warunków ekonomicznych, takich jak wzrost stabilności gospodarczej, zwiększają poziom szczęścia.

Słowa kluczowe: szczęście, ślad ekologiczny, stabilność gospodarcza, zużycie energii odnawialnej, zużycie energii z paliw kopalnych, kraje BRICS-T

1. Introduction

The subject of happiness is a topic of research in a wide array of academic fields, from psychology to sociology, from political science to economics (Toigo and Mattos, 2021). Studies on happiness have become quite important in the economic literature. It can be said that the happiness literature dates back to ancient Greek times by the works of Aristotle. Aristotle defined happiness as a central purpose and goal of human life. However, an important study on happiness research in the field of economics was conducted by Easterlin (1974). Easterlin was the first economist to conduct an empirical analysis on whether income contributes to greater happiness. According to Easterlin, the rise in income increases happiness only up to a certain point (Majeed and Mumtaz, 2017). On the other hand, Veenhoven, another pioneer in the field of studies of happiness, argue that an increase in income also increases happiness (Kapçak, 2023).

Happiness reflects a person's subjective assessment of the person's life as a whole (Jin et al., 2020). Happiness can be expressed as an emotional state of joy, satisfaction and contentment accompanied by positive feelings (Wang et al., 2022). Happiness, which is a subjective term that can vary from person to person, is the ultimate goal that people want to achieve. Besides, happiness is an evaluation of all parts of a person's life, including past experiences and future expectations (Rehdanz and Maddison, 2005). As a matter of fact, every individual and society wants a happy, peaceful and meaningful life and aims to increase their level of happiness. A rise in the income of individuals will enable them to buy more goods and services, thus improving their living standards and thereby making them happier. However, it can be said that economic growth and money alone do not bring greater happiness, but social and environmental factors also affect the level of happiness. As a matter of fact, there are many factors that affect the level of happiness, such as health, work life, income level, welfare level, positive social relations, order, education, freedom, security, environment etc. Over time, the number of studies empirically investigating the influences of different variables on happiness, other than economic growth and income, has increased.

The world economy has experienced significant growth over the past centuries but at the same time, polluting greenhouse gas emissions have increased at almost the same pace (Jin et al., 2020). Global greenhouse gas emissions increased by 1.2% from 2021 to 2022. The main drivers of the overall increase in CO_2 emissions are industrial processes and fossil fuel combustion, which account for approximately two thirds of current greenhouse gas emissions (UNEP, 2024). The rising use of fossil fuel energy sources has harmful effects on all living things, such as global warming and environmental pollution. Therefore, due to the economic, social, environmental and political problems caused by increasing fossil fuel consumption, the issue of switching to renewable energy sources, which are alternative energy sources, has come to the agenda (Dikmen and Kara, 2024). Ecological footprint, developed by Mathis Wackernagel and William Rees in the 1990s, can be defined as a method that measures the rate of individuals' use of natural resources and environmental damage, and with this method, the extent to which individuals use nature can be examined. From this point of view, the environmental demand of individuals is calculated and biological capacity can be determined (Yağış, 2024). A rise in the ecological footprint corresponds to an increase in environmental problems like environmental pollution. Environmental pollution, which negatively affects human life in various ways and causes a decrease in general well-being, is a serious problem that has been causing concern for years. Pollution lead to health problems, diminishing people's quality of life and endangers all other living things (Lele, 2013).

People's happiness is likely to be influenced by environmental conditions including aesthetics and appearance, and living in green environments can be expected to be associated in a positive way with happiness and life satisfaction (Silva et al., 2012; Kley and Dovbishchuk, 2021). In other words, environmental quality has an impact on human psychology and it can be said that it has a relationship with happiness. People who live in areas with higher environmental quality and are encircled by a green and beautiful scenery are more likely to be happier than those who live in a polluted environment with lower environmental quality. It seems that extreme climate events and natural hazards have a greater influence on happiness than income and money. Such events might have a seriously negative effect on physical and mental well-being. Areas with greener environments show higher life expectancy and well-being of their residents (Apergis and Majeed, 2021). On the other hand, environmental pollution negatively affects people's happiness.

Energy has been one of the fundamental factors of economic and social development throughout human history. With increasing economic growth, rising living standards and urbanization, the need for energy is increasing day by day. This energy need is met mainly by fossil fuel energy sources. Fossil fuels, which have been predominantly used from past to present have brought both environmental and economic problems with them, and have reached dimensions that cannot be ignored. Therefore, it is widely recognized that turning to renewable energy sources will contribute to making development sustainable (Yıldırım and Nuri, 2018: 131). Increasing use of renewable energy sources, reducing environmental pollution, and using energy resources efficiently are important for sustainability (Seydioğulları, 2013: 25). In other words, the increasing energy demand must be met in a sustainable manner and without destroying the nature. At this point, the sustainable development strategy has been put forward and has become important since then. Sustainable development which was first clearly stated in 1987 in Our Common Future or the Brundtland Report is defined as *development that meets the needs of the present without compromising the ability of future generations to meet their own needs* (Strange and Bayley, 2008: 24). According to a study by Oxford University, sustainable development makes people happier, and progress towards the Sustainable Development Goals (SDGs) set out by the United Nations is positively correlated with well-being (World Happiness Report, 2020). In brief, it can be said that there is a connection between sustainable development and happiness. Because since sustainable development involves integrating economic growth, social equality, and environmental protection, it can be expected that it will contribute to the construction of a healthier and more balanced society, thus having a significant impact on people's happiness.

According to some studies, it is accepted that the happiness and welfare of societies largely depend on progress in sustainable development. O'Brien (2005) defines sustainable happiness as the pursuit of happiness that contributes to global welfare, society, and the individual without exploiting other people, the environment, or future generations. It has also been stated that this type of happiness depends on sustainability. Sustainable development advocates have argued that happiness depends on many factors, and that it can be achieved through a combined focus on economic, social, and environmental dimensions (Aksoy and Bayram Arlı, 2019: 2). To give an example; according to a study conducted by Karaçor and Mirza (2018), it was determined that achieving sustainable development goals have a positive influence on the society's welfare. According to other studies, improving happiness might benefit sustainability. Besides, happier countries are on the average also more sustainable (Zidansek, 2007: 892-896). The Sustainable Development Goals were put forward by the United Nations in 2015. The SDGs, which consists of 17 goals and 169 targets, aim to build a more sustainable world by addressing a number of social, economic and environmental problems to be fulfilled worldwide by 2030. The SDGs also include SDG 3: Good Health and Well-Being, SDG 7: Affordable and Clean Energy, SDG 8: Decent Work and Economic Growth, SDG 11: Sustainable Cities and Communities, and SDG 13: Climate Action (United Nations, 2025). These goals will contribute to the increase of social happiness while moving towards sustainable development by focusing on both protecting the environment and improving the quality of life and well-being of people. Indeed, steps taken in areas such as better health, cleaner energy, job opportunities, sustainable cities and communities, and besides combating climate change will affect people. Achieving these goals can enhance the overall happiness level of society.

Happiness, which is a significant indicator that reflects the quality of people's livelihood can be affected by factors such as individual characteristics, social environment and natural environment (Liu et al., 2019; Zheng and Yang, 2019). Numerous research studies have looked into the effects of external environmental and human behavioral factors on happiness. Those elements can be divided into two: micro and macro effects. Micro effects include demographic factors of individuals such as gender, age, personal health, while weather effects, such as temperature, sunlight, climate change, and the societal socio-economic environment are considered macro effects. Studies have shown that multiple factors concurrently affect people's happiness, and the variations happen in different persons, cities and countries. According to a previous study, the distribution of happiness among countries may alter due to climate change (Peng et al., 2016).

The main purpose of this study is to analyze the impact of ecological footprint, fossil fuel energy consumption, renewable energy consumption, and economic stability on happiness for BRICS-T (Brazil, Russia, India, China, South Africa and Turkey) countries. In the study, the data are annual and cover the period of 2005-2023. Panel data analysis that takes cross-section dependence and heterogeneity into account is used in the study. Since no study has been found analyzing the effect of ecological footprint, fossil fuel energy consumption, renewable energy consumption and economic stability on happiness for BRICS-T countries, the study is expected to fill this gap in the literature. The contribution of this study to the literature emerges at the point of the methodology and variables used. It is observed that in previous studies on the subject, dynamic SUR and Augmented Mean Group (AMG) estimator were not used as it is in this study. In this context, an extensive analysis is made in this study. In addition, it is also expected that this study will contribute to the literature in terms of the variables used in the analysis section. As a matter of fact, as a result of the literature review, no study was found that linked happiness with economic stability. In other words, it is noteworthy that the economic stability variable is not used in studies on happiness. In fact, it can be said that economic stability also affects happiness. Economic stability is much more comprehensive term than terms such as growth and development, which provide information about a country's level of development. It is thought that this study is important in terms of investigating the connection between the variables in question for BRICS-T countries from the point of enabling policy makers to determine effective policies as a result of the obtained findings.

The study is structured as follows: The second section following the introduction discuss energy and climate policies of BRICS-T countries. Afterward, literature review on the subject is included. Then, the econometric method and data set used in the study are introduced in the fourth section. Subsequently, the findings obtained from the analysis and the discussion of the findings are given in the fifth section. The study concludes with conclusion and policy recommendations.

2. Energy and Climate Policies of BRICS-T Countries

Emerging economies such as BRICS-T countries have pursued economic growth-oriented policies for years with less emphasis on environmental sustainability. Economic progress in these countries is heavily dependent on energy use as it largely affects economic growth. In recent decades, energy demand in BRICS-T countries has risen considerably due to various reasons, such as population level, industrialization, and urbanization. However, numerous policy makers and environmental scholars have noted that this economic progress in these countries has negatively affected the environmental quality (Samour et al., 2023: 2). It can be said that providing reliable energy supply, expanding energy accessibility, and minimizing environmental impacts are among the challenging issues for BRICS-T countries. At the same time, in order for encourage sustainable development, BRICS-T countries have adopted a number of action plans, made significant commitments, supported the implementation of the United Nations' 2030 Agenda for Sustainable Development, became parties to the United Nations Framework Convention on Climate Change (UNFCCC), signed Kyoto Protocol, and the Paris Agreement, which aims to limit the increase in global average surface temperature to 2 degrees Celsius, and if possible, to keep it below 1.5 degrees Celsius, in order to prevent the climate crisis (Nguyen and Khominich, 2023; Gerasimchuk et al., 2019: 4; https://www.mfa.gov.tr; WWF, 2021: 2; Khare et al., 2023). However, considering that this group of countries is among the largest emitters worldwide due to their huge production and consumption of fossil fuels (Downie and Williams, 2018), it can be said that concerns about environmental problems still continue.

In this context, Brazil is home to the Amazon Forest, a crucial ecosystem in maintaining biodiversity, and regulating the global climate. But deforestation in the Amazon exacerbates environmental degradation, leading to decline in species and natural resources in the region. The Brazilian Amazon experienced 2.3% deforestation from 2021 to 2022. The ongoing deforestation in the Amazon leads to increased greenhouse gas emissions (de Morais et al., 2024; Feitosa et al., 2023). Brazil's greenhouse gas emissions increased by 19% between 2005 and 2019. The country is among the largest emitters of greenhouse gas emissions in Latin America. Oil was Brazil's largest energy source between 2005 and 2021 (European Parliament, 2022: 2). Besides, as seen in Figure 1, Brazil's renewable energy consumption increased between 2005 and 2023, and the share of renewable energy sources in the country's energy matrix was well above the global average in 2022. More than 80% of Brazil's electricity comes from hydropower. In 2021, Brazil's share of renewables in primary consumption reached 46%, with hydropower generation making up two-thirds of the renewable energy. While hydropower is expected to remain significant in Brazil, the share of solar and wind is expected to rise until 2030. Brazil also aims to reach 45% renewable energy by 2030, and achieve climate neutrality by 2050 (https://investinbrasil.com.br; Khare et al., 2023; European Parliament, 2022: 2).

Russia, which is highly dependent on fossil fuels and possesses the world's largest gas reserves is the world's second-largest natural gas producer after the United States, and the largest exporter of gas. However now is under sanctions due to war on the Ukraine and the amount of export is shrinking. Renewable energy sources in Russia mostly come from hydropower (Climate Transparency, 2022a; IEA, 2025a). Russia introduced the Transport Strategy Until 2030 in November 2021, which aims to decrease transport emissions. This strategy includes measures for energy-efficient or electric vehicles, low-carbon infrastructure, and alternative fuels. However, the country has withdrawn some environmental protection and emission reductions measures in 2022 (CAT, 2025a). The Russian government aims to raise the share of renewables and increasing their proportion of the total installed capacity to 10% by 2040 (Proskuryakova, 2022: 3). By 2060, Russia has committed to achieve net zero greenhouse gas emissions (CAT, 2025a).

India's energy mix, which is mostly based on coal and oil is predominantly fossil fuels in 2021 (Climate Transparency, 2022b). In this context, India, along with China, the United States and the European Union is among the countries that emit the most greenhouse gas emissions in the world (CRS, 2023). India identified the significance of renewables as sustainable energy source in the early 1970s, and energy generation from renewable sources has become even more crucial in recent times due to heavy reliance on petroleum fuels imports, high coal prices in the domestic market, volatility of the oil market, growing population, and energy demand (Pathak and Shah, 2019: 509). India has made considerable progress in diversifying its energy mix over the past decade, experiencing growth in its renewable energy sector, and the country has set a target of 500 GW of non-fossil fuel-based energy by 2030 (https://www.investindia.gov.in; Khare et al., 2023). At COP27, India presented its first Long-term Strategy for Low Carbon Development, and to ensure a framework for achieving net zero emissions by 2070, a *net zero emissions* bill was introduced (CAT, 2025b).

The rising energy needs of China are mostly met by renewable energy sources, natural gas, and electricity, but coal continues to be a major fuel source in the energy mix (IEA, 2025b; IEA, 2025c). The total greenhouse gas emissions of China have risen by 268% between 1990-2019 (Climate Transparency, 2022c). In 2019, hydropower accounted for 27.21%, wind energy for 33.76%, and solar photovoltaic power plants for 34% of installed capacity (Basso and Viola, 2022: 131). Ahead of COP26 in Glasgow in October 2021, China has set a goal to peak CO_2 emissions before 2030, reduce carbon intensity by 65% by 2030, and achieve carbon neutrality by 2060 (Guilhot, 2022; IEA, 2025c).

The total greenhouse gas emissions of South Africa have risen by 59% between 1990 and 2019. As a matter of fact, approximately 92% of South Africa's energy mix consists of fossil fuels, most of which is coal (Climate Transparency, 2022d). In 2021, the majority of renewable energy supply comes from bioenergy (IRENA, 2024). In 2024, the Climate Change Bill, South Africa's first legislation specifically aimed at addressing the impacts and consequences of climate change was signed into law. The law in question sets limits for major emitters (CCPI, 2025). One of the parts of South Africa's National Development Plan 2030 is to transition towards a green and climate resilient economy. The country has pledged to reduce its greenhouse gas emissions by 2030, and achieve carbon neutrality by 2050 (Qu et al., 2023).
Turkey's energy mix consists mostly of fossil fuels, and greenhouse gas emissions have risen by 127% from 1990 to 2019 (Climate Transparency, 2022e). Turkey is a net energy importer and is particularly dependent on fossil fuels such as oil and natural gas. Turkey has significant renewable energy potential, and as of the end of 2020, hydro, wind, and solar accounted for the majority of the country's renewable energy sources (IEA, 2021: 11; https://www.invest.gov.tr). Turkey has set a net zero target by 2053 (CAT, 2025c).
However, according to assessments made by Climate Action Tracker, the net zero target of all countries in the BRICS-T group, except South Africa is evaluated as poor. It was stated that South Africa's net zero target was not evaluated because target information is incomplete.

3. Literature Review

This section summarizes some studies that address the issue of happiness. First of all, if we come to the studies that investigate the relationship between happiness and environment, Welsch (2006) studied the relationship between happiness and pollution in 10 European countries. In the study, the happiness variable is represented by average self-reported well-being. It was revealed that air pollution plays a statistically significant role as a predictor of inter-country and inter-temporal differences in subjective well-being. Majeed and Mumtaz (2017) analyzed the happiness-environmental relationship for 99 countries. The study covers the period 1980-2015 and OLS, Pooled OLS, 2SLS and GMM techniques were used as empirical methods. According to the findings, while species protecion and marine protected areas raise happiness levels, CO_2 emissions have a strong negative effect on happiness. Moreover, it was discovered that life satisfaction levels are improving by economic affluence. Noubissi Domguia and Poumie (2019) analyzed the impact of environment on happiness for 30 African countries from 2006 to 2014 using OLS, GMM and Estimate fixed-effect panel threshold model and found that happiness is influenced by environment quality. According to the linear model, the degradation of environment increases happiness and the Estimate fixed-effect panel threshold model showed that the relation between greenhouse gas and happiness are quadratic. It was concluded that environment has a negative impact on happiness of people in Africa in the long run. The influence of environmental quality on happiness depends on the income per capita level and the level of greenhouse gas emissions. Yunani et al. (2020) studied the effect of the three dimensions of life quality (per capita income, human development and happiness) on the ecological footprint in the context of ASEAN countries using PCSE and GMM estimations. In the study, ecological footprint is the dependent variable. As a result of the analysis, it was found that ecological footprint is significantly influenced by happiness, per capita income and human development. Toigo and Mattos (2021) investigated the subjective well-being and environmental performance relationship using the log-log regression model and found that happiness is directly impacted by environmental performance. Bonasia et al. (2022) analyzed the nexus between environmental protection expenditure and happiness in European countries for the period from 1997 to 2019. A dynamic panel heterogeneity analysis through an autoregressive distributed lag model is employed, using three different estimators such as the dynamic fixed effect, the mean group and the pooled mean group estimators. Besides, Westerlund cointegration tests was also applied. According to the findings of the analysis, the linkage between environmental protection expenditure and happiness in the long run was found. However, the unemployment rate impacts happiness in a negative way both in the short and in the long run. In the study where the ecological footprint variable is the dependent variable and the happiness variable is represented by Happy Planet Index, Kapçak (2023) investigated how happiness, economic growth, human development index, unemployment rate, inflation rate, and corruption perception index affected the ecological footprint for Turkey, Brazil, China, India, Russia and South Africa. The study covers the years from 2007 to 2019. According to the results of the study, the Happy Planet Index reduces the ecological footprint in Russia and Turkey, and human development index reduces the ecological footprint in Brazil, India and South Africa. On the other hand, it has been determined that economic growth in China and India, and inflation rate, unemployment rate and corruption perception index in Turkey increase the ecological footprint. However, it has also been found that the unemployment rate in Brazil and inflation in Russia increase the ecological footprint. As a result, it has been concluded that different variables have an impact on the ecological footprint of the countries in question. Khasanah and Suryanto (2023) analyzed the impact of per capita income, HDI, and air pollution on community happiness in the context of nine countries in the ASEAN region from 2015 to 2019. Panel data regression analysis and random effect model was used as econometric methods in the study. As a result, it was indicated that HDI has a positive and insignificant impact on happiness, and air pollution has a negative and insignificant effect on happiness. Besides, per capita income positively and significantly affects happiness. It was concluded that a rise in per capita income cause an increase in the happiness index. Wang et al. (2023) investigated the connection between innovation, ecological footprint, globalization, and subjective well-being in the form of happiness in OECD countries for the period of 2008-2020. The investigation also considered the consumption of renewable energy and population density. FGLS, Quantile, and Bootstrap Quantile regression was used in the study. The relationship between ecological footprint and globalization was found to be nonlinear, with negative impacts on subjective well-being at high levels of ecological footprint and globalization. The moderating influence of innovation, on the other hand, was also found to lessen these unfavourable effects, indicating that innovation can help to offset the detrimental influences of ecological footprint and globalization on subjective well-being. Ostrowska et al. (2024) who studied the happiness-renewable energy nexus, used panel data models to investigate whether renewable energy affects happiness and economic growth for 25 European Union countries from 2012 to 2022. It was concluded that the growing share of renewable energy in the energy mix positively influence economic growth and happiness of citizens. However, a significant positive effect was recorded only in solar share energy, wind share energy and economic growth. Besides, practically every form of renewable energy was included, and all had a notable positive impact on the happiness level. Aldieri et al. (2019) took innovation into account and studied the nexus between eco-innovation and happiness for 10 European countries for the period of 1981-2011 using panel data models. It was concluded that there is a positive relationship between eco-efficiency and happiness, linking countries' overall well-being to environmental circumstances, the pace at which they adopt eco-innovations, and the relative efficacy of the latter.

Many studies have also been conducted using happiness and macro variables. From this point of view, for example, Li and Lu (2009) examined the influence of overall happiness of citizens on economic growth across countries. In the analysis, life-satisfaction index and happy-life index were the two variables to measure happiness. In the study where the dependent variable was GDP per capita, it was concluded that happiness has a positive causal impact on economic growth. Donath and Oprea (2020) analyzed the effect of the GDP/capita, financial inclusiveness and human development on the happiness index from 2012 to 2018 for selected high, middle and low-income countries. According to the findings, happiness is strongly related to GDP/capita as a measure of economic growth, the HDI as an index of social capital. However, a negative correlation between happiness and ICT, as a proxy for financial inclusion was found. By utilizing panel-based qualitative choice method, Efeoğlu and Azgün (2021) investigated the impact of democracy on happiness level in BRIC and MIST countries spanning the period 2013-2018 and found that democracy is more effective at higher happiness levels and is higher likely to influence the higher level of happiness. Kanaujiya and Maurya (2022) analyzed the link between happiness and development for 125 countries using panel data method for the period of 2012-2016. According to the findings, it was found that development cause happiness. In addition, nations experiencing long episodes of high economic growth show high positive increase in happiness. By using panel data analysis, Giansyah et al. (2023) analyzed the influence of inflation, dependency ratio, population density, and GDP per capita on the happiness index in the context of ASEAN-9 for the period of 2015-2021. According to the findings, happiness index is affected by inflation, dependency ratio, population density, and GDP per capita simultaneously. While happiness index is positively and significantly influenced by GDP, population density, inflation and dependency ratio are not significant to the happiness index. Öksüz (2023) studied the effect of social expenditures on happiness for 25 OECD countries by panel data analysis using the data from 2008 to 2019 and found that social expenditures have a statistically significant and positive effect on happiness. Yan et al. (2023) analyzed the impact of financial services and environmental technologies on happiness using ARDL and QARDL models. The authors revealed that there is a positive impact of financial services, environmental technologies, financial development, national income, and education on happiness both in the short and in the long term. The favourable long-run effects of financial services and environmental technologies on happiness at most quantiles was also found. According to the long-term Wald test results, there is an asymmetric impact of all variables on happiness, while in the short-term, excluding education, all other variables exert asymmetric effects on happiness.

4. Data and Methodology

In this study, the effect of ecological footprint (EF), renewable energy consumption (REC), fossil fuel energy consumption (FEC) and economic stability (ES) on the happiness index (HI) between 2005-2023 in BRICS-T countries were analyzed. HI and ES were used as index values. EF was used as per capita consumption (Gha). FEC and REC were used as per capita consumption (kWh). HI, EF, FEC, and REC data were used in logarithmic form. Since there was a problem of multicollinearity in the percentage data of FEC and REC, the logarithm of the total energy consumption was evaluated. Data were used based on their availability in databases. Data for the HI index were obtained from the World Happiness Report electronic database. EF data were obtained from the Global Footprint Network electronic database. REC and FEC were obtained from the World Bank electronic database

(WDI). The ES, which consists of GDP per capita, economic growth, inflation rate, budget balance/GDP and current account balance/GDP subsectors, was calculated by the authors.[1]
Based on this information, the model to be estimated in the study is given below:

$$HI_{it} = \gamma_1 + \gamma_2 EF_{it} + \gamma_3 FEC_{it} + \gamma_4 REC_{it} + \gamma_5 ES_{it} + u_{it} \tag{1}$$

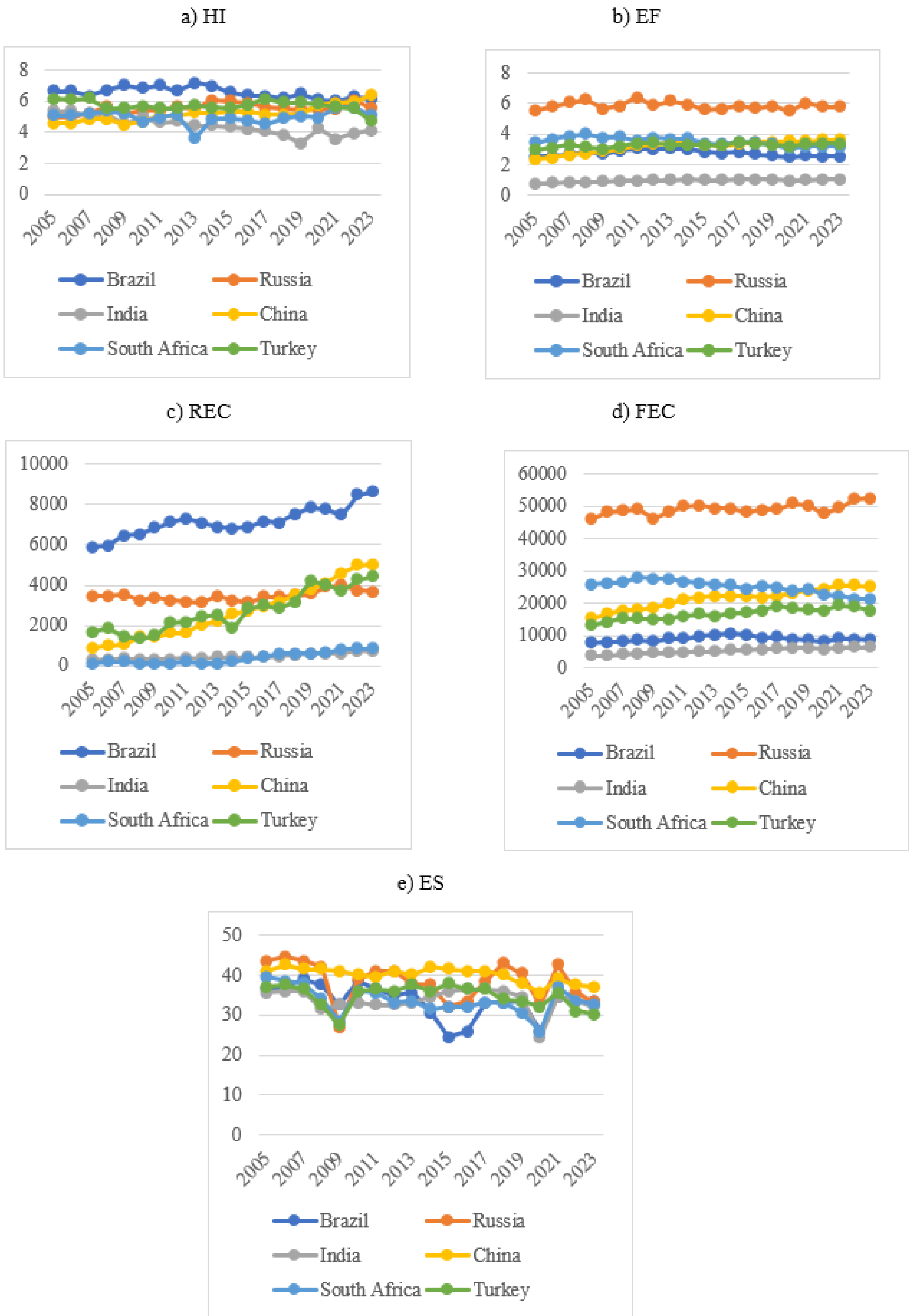

Figure 1. The trend behavior of HI, EF, FEC, REC, ES in BRICS-T

[1] For detailed information on the calculation of ES, see Table A2 in the Appendix.

In Equation 1, HI represents the happiness index used as the dependent variable in the study, and EF, FEC, REC, and ES represent ecological footprint, fossil fuel energy consumption, renewable energy consumption and economic stability, respectively. γ and *u* represent the constant term and iid represents the error term with the process.

A graphical presentation of original values of variables are shown in sub-sections (a, b, c, d, and e) of Figure 1 to evaluate any trend behavior.

Figure 1 indicates the level values of the variables on the left vertical axis and the change of these variables over time on the right vertical axis. The happiness index is shown in part a of Figure 1. Accordingly, while the happiness index in Russia and China shows an increasing trend over time, the happiness index in Brazil, India and Turkey shows a decreasing trend. It was observed that South Africa's happiness index was the same at the beginning and end of the year covered in the study. The ecological footprint series shown in part b of Figure 1 shows that there is no significant increase or decrease trend in this series in the BRICS-T countries but it is generally seen to follow a horizontal course. It can be said that this situation shows that there has been no major development, especially in environmental sustainability during the period in question. Among BRICS-T countries, the ecological footprint of Russia, India, China and Turkey is seen to increase from 2005 to 2023. This situation leads to environmental degradation. In order to achieve sustainable development, it is significant to reduce the ecological footprint, which is considered an important indicator of environmental sustainability. The renewable energy consumption series shown in part c of Figure 1 shows that this series exhibits an increasing trend in each of the BRICS-T countries during the study period 2005-2023. In particular, Brazil's renewable energy consumption appears to be higher than other BRICS-T countries. Brazil is also the country with the lowest ecological footprint after India, especially in recent years. Besides, Brazil is one of the countries with the highest happiness index among BRICS-T countries during the period in question. The fossil fuel energy consumption series in part d was observed to have increased in the same period in five countries except South Africa. Russia is by far the country that uses the most fossil fuels, so its ecological footprint is higher than other BRICS-T countries. The increase in fossil fuel energy use, which is one of the main causes of environmental pollution, causes the balance of ecosystems to be disrupted. This situation leads to both the depletion of natural resources and the threat to the health of humans and other living things. For this reason, reducing fossil fuel energy consumption plays a critical role for sustainable future. A striking feature of the graphs is that although the BRICS-T countries' share of renewable energy consumption has increased, there has been no decline in their ecological footprint. One of the reasons for this may be that the share of fossil fuel energy consumption has increased and the share of renewable energy consumption has not increased sufficiently. Finally, the economic stability index shown in part e of Figure 1 shows that this index follows a mixed course in the BRICS-T countries in general. This situation shows that the economies of the relevant countries have experienced vulnerabilities over time. The figure displays that the economic stability index of all countries included in the analysis decreased, especially in 2008-2009 and 2020. It can be said that this situation is due to the global economic crisis that emerged in 2008 and the COVID-19 pandemic that emerged in 2019, which continued in 2020, respectively. Because both the 2008-2009 global economic crisis and the COVID-19 pandemic brought about socio-economic problems such as unemployment, decreased purchasing power, and economic contraction.

4.1. Methodology

In this study, methods that take into account cross-section dependence and also can be used for heterogeneous panels were used to investigate the impact of ecological footprint, fossil fuel and renewable energy consumption, and economic stability on the happiness index. For the analysis, firstly, the descriptive statistics of the series of variables used in the study were tested. Then, panel unit root tests were applied to determine the series' stationarity. Afterward, the existence of cointegration linkage was tested. Finally, the impact of the independent variables on the happiness index, which is the dependent variable of the study was estimated.

4.1.1. Panel Unit Root Test

The PANICCA test used in the study, developed by Reese and Westerlund (2016) is a panel unit root test based on common factor modeling and cross-section dependence. PANICCA test was developed as a new test that combines the PANIC test of Bai and Ng (2004) that tests the stationarity of the residuals and factors separately, and the single and multi-factor tests based on taking the difference from the cross-section means by Pesaran et al. (2007) (Reese and Westerlund, 2016).

The data generation process of the PANICCA test is given as follows:

$$Y_{it} = \alpha_i^{'} D_{tp} + \gamma_i^{'} F_t + e_{it} \qquad i = 1, 2, ...N; \qquad t = 1, 2....T \tag{2}$$

In equation (2), e_{it} is the residual; F_t (r x 1) is the common factor vector; γ_i (r x 1) is the factor loading coefficients vector; $D_{t,p}=(1,\ldots,tp)'$, (p + 1) x 1 is the dimensional deterministic components vector. *p=0* represents the model with constant, p=1 represents the model with trend.

In the PANICCA unit root test application, which states that there is a unit root under the null hypothesis, three test statistics were suggested by Bai and Ng (2010) for the p=0 and p=1 models, namely P_a, P_b and the PMSB test statistic developed by Sargan-Bhargava (1983) with panel modification (Reese and Westerlund, 2016).

$$P_{a,0} = \frac{\sqrt{NT\left(\hat{p}_0^{+} - 1\right)}}{\sqrt{2\phi_0^4 / \hat{\omega}_\varepsilon^4}} \sim N(0,1) \tag{3}$$

$$P_{b,0} = \frac{\sqrt{NT\left(\hat{p}_0^{+} - 1\right)}}{\sqrt{\phi_\varepsilon^4 / [\hat{\omega}_\varepsilon^8 N^{-1} T^{-2} \sum_{i=1}^{N} \left(\hat{e}_{i-1}^1\right)' \hat{e}_{i-1}^1]}} \sim N(0,1) \tag{4}$$

$$PMSB_0 = \frac{\sqrt{N[N^{-1} T^{-2} \sum_{i=1}^{N} \left(\hat{e}_{i-1}^1\right)' \hat{e}_{i-1}^1 - \hat{\omega}_\varepsilon^2 / 2]}}{\sqrt{\phi_\varepsilon^4 / 3}} \sim N(0,1) \tag{5}$$

4.1.2. Panel Cointegration Test

The panel cointegration test used in the study, put forward by Gengenbach, Urbain and Westerlund (GUW-2016), is based on the error correction model using the common factor structure. The data generation process of the GUW (2016) panel cointegration test is given in equation (6):

$$\Delta y_{it} = d\delta_{yx_i} + \alpha_{y_i} y_{it-1} + \omega_{it-1}\gamma_i + \upsilon_i \pi_i + \varepsilon_{yx_i} = \alpha_{y_i} y_{it-1} + g_i^d \lambda_i + \varepsilon_{yx_i} \tag{6}$$

Under the null hypothesis $\left(H_0 : \alpha_{yi} = 0\right)$ the t statistic of this test, which indicates that there is no cointegration, is defined as follows:

$$t_{\alpha_{yi}} = \frac{\hat{\alpha}_{yi}}{\hat{\sigma}_{\hat{\alpha}_{yi}}} \tag{7}$$

The panel test statistics of the model with unit test statistics as above are the average of the unit test statistics.

$$\bar{t}_{\alpha_{yi}} = \frac{1}{N} \sum_{i=1}^{N} t_{\alpha_{yi}} \tag{8}$$

4.1.3. Panel Coefficient Estimator

The first estimator used to estimate the coefficients of the model in the study, Dynamic SUR, developed by Mark et al. (2005), is based on the assumption of long-run cross-section dependence in the balance errors and has an asymptotic distribution. In this method, Wald statistics distributions with restrictive chi-square can be conveniently constructed to test cross-equation restrictions. This estimator is implemented in two phases. Firstly, the regressor in each equation is regressed on the leads and lags of the first difference of the regressors from all equations. In this way, the endogeneity problem is eliminated. Lastly, SUR strategy is implemented to the errors obtained in the first phases. Dynamic SUR is a parametric method for estimating multiple cointegrated regressions. Moreover, this method is suitable for both homogeneous and heterogeneous panel applications. This method is applicable both in environments where the cointegrating vectors are homogeneous across equations and in environments where they are not (Mark et al., 2005).

Another estimator applied to estimate the coefficients in the model and for the robustness of the Dynamic SUR Method is the Augmented Mean Group (AMG). The AMG estimator provided by Eberhardt and Bond (2009) also takes into consideration cross-section dependence and homogeneity problems. The AMG estimation can be derived as averages of the individual country estimates as follows:

$$AMG - Stage(i) \Delta y_{it} = \phi' \Delta X_{it} + \sum_{t=2}^{T} c_t \Delta D_t + e_{it} \tag{9}$$

$$AMG - Stage(ii) y_{it} = \gamma_i + \phi_i' X_{it} + c_i t + d_i \hat{\mu}_t^{\bullet} + \omega_{it} \tag{10}$$

$$\hat{\mu}_t^{\bullet} = \hat{c}_t \tag{11}$$

$$\hat{\phi}_{AMG} = N^{-1} \sum_i \hat{\phi}_i \tag{12}$$

In the equations above, γ_i is constant and e_{it}, ω_{it} are error terms of stage (1) and stage (2), respectively.

5. Empirical Findings

In order to better evaluate the data of the variables, the descriptive statistics of the variables were tested and the correlation relationship between the variables was examined. After these analyses, cross-section dependence and homogeneity were tested in the panel data set consisting of BRICS-T countries. Then, unit root tests were used to test the stationarity of the series in the country group in question. After testing the stationarity of the series, it was tested whether there was a long-run relationship among the dependent and independent variables in the study model, and finally the study model was estimated.

Table 1. Descriptive statistics and correlation matrix

	HI	**EF**	**ES**	**REC**	**FEC**
Mean	1.6491	3.57000	1.0577	7.353552	9.70256
Median	1.6380	3.5835	1.18620	7.3014	9.5245
Maximum	1.9657	3.7954	1.8522	4.522	10.860
Minimum	1.1783	3.1986	-0.2390	0.3255	8.210
Std.Dv.	0.1521	0.1257	0.5500	1.245	0.741
Skewness	-0.2664	-0.77188	-0.9675	1.4874	-1.5090
Kurtosis	3.5093	3.7395	3.2303	3.7328	3.8018
Observation	108	108	108	108	108
	HI	**EF**	**ES**	**REC**	**FEC**
HI	1	0.3883	-0.0577	0.65258	-0.1211
EF	0.3883	1	0.27620	-0.2071	0.1843
ES	-0.0577	0.27620	1	-0.05880	-0.0210
REC	0.6525	-0.20717	-0.05880	1	0.1635
FEC	- 0.1211	0.18431	-0.02104	0.1635	1

Descriptive statistics of variables and correlation relationship results among the variables for BRICS-T countries are shown in Table 1. The maximum value of the happiness index is 1.96. Besides, the minimum value of the happiness index is 1.17 and the standard deviation is 0.1521. According to these results, the happiness index in BRICS-T countries does not change significantly. Additionally, the median and mean of the variable in question are 1.6380 and 1.6491, respectively. These results show that there is no outliers problem in terms of happiness index in BRICS-T countries. The descriptive statistics of the ecological footprint, economic stability, renewable energy consumption, and fossil fuel energy consumption data are also similar to the descriptive statistics results of happiness. The maximum and minimum values and the mean and median values of these four variables are close to each other and the standard error values are low. The skewness and kurtosis values of these variables are negative and greater than 3, respectively. This result shows that all five variables do not have normal distribution and are leptokurtic.

When the correlation relationship among the variables in the model is evaluated, it is seen that the correlation coefficients are not very high. This result shows that there is no multicollinearity problem in the study model.

After the descriptive statistics and correlation relationship are evaluated, the cross-section dependence developed by Pesaran et al. (2004) and homogeneity test developed by Pesaran et al. (2008) are applied. The results of these tests are shown in Table A1.

According to Table A1, the null hypothesis expresses that no cross-section dependence for the variable is rejected in BRICS-T countries. The problem of cross-section dependence in both the variables and the model shows that when a shock occurs in any of the BRICS-T countries for any variable in the model, the other countries in question are also affected by this shock. Therefore, this result indicates that BRICS-T countries are affected by each other in terms of economy and energy use. Also, the results of homogeneity test show that the alternative hypothesis expresses the heterogenous panel is accepted. After determining the cross-section dependence and homogeneity panel unit root test was used for testing the stationarity of the variables. The results of panel unit root test related to each variable are shown in Table 2.

Table 2. Panel unit root test results for constant model

Variables	Level		
	Pa	Pb	PMSB
HI	0.270	0.344	0.125
EF	0.530	0.410	0.330
REC	0.068	0.091	0.150
FEC	0.230	0.190	0.140
ES	0.810	0.690	0.685
	1. Difference		
DHI	0.000***	0.000***	0.001***
DEF	0.000***	0.000***	0.000***
DREC	0.000***	0.000***	0.000***
DFEC	0.000***	0.000***	0.000***
DES	0.032**	0.023**	0.048**

Note: ***, **, and * indicate statistical significance at the 1, 5, and 10%, respectively. Values in parentheses indicate probability values.

PANICCA unit root test results indicate that the null hypothesis that the series contains a unit root cannot be rejected for HI. According to this result, the HI series contains a unit root. The unit root test results of the differenced series are given at the bottom of Table 2. According to these results, the null hypothesis that the series contains a unit root for the differenced HI variable is rejected. In this context, the HI series became stationary when the first difference was taken. Therefore, the stationarity order of the HI series is I(1). When the level value of the EF, REC, FEC, and ES series is evaluated like the HI series, the null hypothesis of these four series cannot be rejected and when the differences of the variables in question are taken, it is seen that they become stationary. These results show that the stationarity order of all five series are I(1).

The fact that the series contain a unit root shows that the shocks that may occur in the series are not temporary and therefore, shocks can be eliminated with appropriate policies. Moreover, the stationarity level of all series are I(1), which enables the analysis of the cointegration relationship between the series. Within the scope of the study, the existence of a long-run relationship between the variables was analyzed with the panel cointegration test developed by Gengenbach, Urbain and Westerlund (2016). The results of this test are given in Table 3.

Table 3. Panel cointegration test results

d.y	Coef.	T-bar	P-value
Y(t-1)	-0.261	-3.382	0.032**

Note: ***, **, and * indicate statistical significance at the 1, 5, and 10%, respectively.

The findings of the panel cointegration test show that the null hypothesis of no cointegration is rejected. In this context, there is a long-run relationship among the variables in the model where the dependent variable is happiness index and the independent variables are fossil fuel energy consumption, renewable energy consumption, ecological footprint and economic stability.

The existence of a cointegration relationship among variables allows the estimation of model coefficients. The estimation of the model was carried out with two different methods, namely Dynamic SUR developed by Mark et al. (2005) and AMG estimator developed by Eberhardt and Bond (2009). The results of Dynamic SUR and AMG estimators are shown in Tables 4 and 5, respectively.

Table 4. The results of Dynamic SUR Estimator

Country	FEC	REC	EF	ES
Brazil	-0.696*** (0.025)	0.241 (0.286)	-0.318 (0.498)	0.302* (0.185)
Russia	-0.520*** (0.011)	0.051 (0.079)	-0.028 (0.093)	-0.008 (0.086)
India	-0.482*** (0.033)	0.520** (0.263)	0.006 (0.212)	0.262 (0.304)
China	-0.495*** (0.021)	0.182 (0.180)	-0.297* (0.181)	0.102 (0.175)
South Africa	-0.459*** (0.021)	0.153 (0.172)	-0.252** (0.104)	0.582*** (0.182)
Turkey	-0.531*** (0.004)	0.459*** (0.070)	-0.362*** (0.058)	0.269*** (0.032)
Panel	-0.546*** (0.008)	0.033* (0.022)	-0.036** (0.017)	0.049** (0.023)

Note: ***, **, and * indicate statistical significance at the 1, 5, and 10%, respectively. Values in parentheses indicate standard error values.

The panel results of the Dynamic SUR estimator, which shows the long-run effect of the regressors in the model on the dependent variable, show that all four variables are statistically significant, while the individual results show that there are differences among countries. Firstly, according to the panel results, fossil fuel energy consumption and ecological footprint are significant and negative, while renewable energy consumption and economic stability are significant and positive. Accordingly, increases in fossil fuel energy consumption and ecological footprint negatively affect the happiness index, on the other hand, increases in renewable energy consumption and economic stability increase the happiness index and vice versa. Individual results differ from the panel results for each country, except for fossil fuel energy consumption. For example, renewable energy consumption is significant and positive only in India and Turkey, while it is insignificant in the other four countries. Therefore, increases in renewable energy consumption increase the happiness index in India and Turkey, while an increase in renewable energy consumption has no impact on happiness in the other four countries. While the ecological footprint is significant and negative in China, South Africa and Turkey, it is statistically insignificant in Brazil, Russia and India. Therefore, changes in the ecological footprint do not affect the happiness index in these three countries.

Finally, economic stability is significant and positive in Brazil, South Africa and Turkey, but insignificant in Russia, India and China. Thus, an increase in economic stability increases the happiness index in Brazil, South Africa and Turkey, but has no effect on the happiness index in Russia, India and China.
The findings of the Dynamic SUR estimators are shown above. For the robustness of the results of the estimator, the coefficient estimate of the model was also estimated with the AMG method and these estimation results are shown in Table 5.

Table 5. The results of AMG Estimator

Country	FEC	REC	EF	ES
Brazil	-.0004276* (.0002123)	0.56483 (.74839)	-0.1824*** (0.0601)	.01477 (.0205)
Russia	-.49606*** (.1301)	0.1114*** (0.021445)	.2253 (.2810)	0.0306** (.0155)
India	-.3839 (.45929)	-.6011 (.4730)	-0.450*** (0.102)	-.0292 (.0240)
China	-0.598** (0.281)	.2849 (.3513)	-0.465** (0.227)	-0.115 (0.149)
South Africa	-0.6350* (.363)	.1943 (.390)	.3079 (.417)	-.0240 (.02059)
Turkey	-.5322*** (.1831)	0.5832*** (.2136)	-0.112 (.582)	0.0571*** (.02023)
Panel	-.0002753*** (.00009384)	0.00054** (0.00025)	-0.720* (0.410)	.04210* (.02460)

Note: ***, **, and * indicate statistical significance at the 1, 5, and 10%, respectively. Values in parentheses indicate standard error values.

The panel results of the AMG estimator shown in Table 5 confirm the results of the Dynamic SUR estimator. Accordingly, fossil fuel energy consumption and ecological footprint are statistically significant and negative, while renewable energy consumption and economic stability are significant and positive. These results show that increases in fossil fuel energy consumption and/or ecological footprint in BRICS-T countries reduces the happiness index in that country group, and vice versa. On the other hand, the findings in Table 5 show that increases in renewable energy consumption and economic stability increase happiness across the BRICS-T group of countries, and vice versa. The individual test results in the upper part of Table 4 do not differ significantly from the individual results of the Dynamic SUR estimator. For instance, fossil fuel energy consumption is insignificant only in India, but it is significant and negative in the other five countries. These results suggest that rises in fossil fuel energy consumption reduce happiness in each of the BRICS-T countries except India. According to the individual test results of the ecological footprint, which is another variable that negatively affects happiness, the ecological footprint is significant and negative in Brazil, India and China, while it is insignificant in the other three countries. Thus, rises in the ecological footprint decrease happiness in Brazil, India and China, but have no impact on happiness in Russia, South Africa and Turkey.
The results of renewable energy consumption and economic stability, which have a positive influence on happiness, do not differ significantly from the results of the Dynamic SUR estimator for variables that positively affect happiness. For example, individual test results of renewable energy consumption show that increases in renewable energy consumption in Russia and Turkey increase happiness in these two countries, while changes in renewable energy consumption in the other four countries (Brazil, India, China and South Africa) do not affect happiness in these four countries. Finally, according to the individual test results of the coefficient of the economic stability variable, economic stability is significant and positive only in Russia and Turkey. However, the coefficient of the economic stability variable is insignificant in the other four countries (Brazil, India, China and South Africa). Therefore, changes in economic stability affect happiness only in Turkey and Russia, but not in Brazil, India, China and South Africa.
The results of the AMG estimator applied for the robustness of the Dynamic SUR estimator results generally confirm the Dynamic SUR results. Panel results for both estimators show that fossil fuel energy consumption and ecological footprint negatively affect happiness, while renewable energy consumption and economic stability affect happiness in a positive way. Individual test results show that the results of both estimators do not differ significantly and that the difference is due to the country and not the direction of the relationship. All these results show that the increase in renewable energy consumption and the improvement in economic conditions are extremely important in affecting the happiness of individuals in BRICS-T countries. In addition, the findings of both estimators show that increasing environmental pollution due to the increase in ecological footprint and fossil fuel energy consumption negatively influence happiness. Therefore, it can be concluded that factors that increase en-

vironmental pollution, such as the increase in ecological footprint and fossil fuel energy consumption have a negative impact on happiness in BRICS-T countries in general. On the other hand, reduction in environmental pollution and improvement in economic conditions, such as an increase in renewable energy consumption and a rise in economic stability increase happiness in BRICS-T countries. It can be said that the negative impact of the ecological footprint on happiness is consistent with the findings of Wang et al. (2023) in the literature. At the same time, the findings of the positive influence of renewable energy consumption on happiness is parallel to the work of Ostrowska et al. (2024).

The significant and positive relationship between renewable energy consumption and happiness index obtained in the study can be explained by the fact that renewable energy increases the quality of life. This relationship between renewable energy consumption and happiness coincides with the United Nations' SDG 3 *Good Health and Well-being* and SDG 7 *Affordable and Clean Energy*. Renewables help increase energy efficiency and ensure reduce air pollution. Moreover, renewable energy sources reduce CO_2 emissions and provide environmentally friendly energy consumption. These developments increase the quality of air, allowing people to have better quality air conditions, thus improving the quality of life. The rise in the quality of life contributes to people being happier. In addition, renewable energy sources are easy to install systems as they do not require high technology compared to other energy systems and are a very economical energy solution in the long term as they provide lifelong use. Therefore, with the increase in the use of renewable energy sources, external dependency in energy production will decrease. Renewable energy production is of great importance in terms of sustainability, as it is easy to install and less costly than other energy systems and provides lifelong use. The significant and negative relationship between fossil fuel energy sources and ecological footprint and the happiness index can be explained by the exact opposite of the significant and positive relationship between renewable energy sources and the happiness index. The increase in fossil fuel energy sources increases CO_2 emissions and thus increases air pollution. Hence, the rise in fossil fuel energy consumption also increases the ecological footprint. The increase in the ecological footprint reduces air quality, causing people to experience poorer air conditions, thus reducing their quality of life. The decrease in quality of life leads people to become unhappier. The decline in the use of fossil energy resources along with the increase in the use of renewables is an important development in sustainability, and contributes to this issue. In this respect, as seen in Figure 1, it can be said that the BRICS-T countries' increasing focus on renewable energy in the 2005-2023 period contributes to sustainable development.

Another finding of the study, the significant and positive relationship between economic stability and happiness index can be explained by purchasing power. This relationship between economic stability and the happiness index also coincides with the United Nations' SDG 8 *Decent Work and Economic Growth*. Economic stability also includes price stability and economic growth. The long-term development of the inflation rate in single digits prevents the prices of goods and services that individuals will purchase to meet their needs from increasing too much. Increased economic growth increases the income levels of individuals in the relevant country. The rise in the income levels of individuals and the fact that the prices of goods and services do not rise, increases their purchasing power. Therefore, ensuring economic stability allows individuals to meet their own personal needs, enabling them to meet the needs of the present without compromising the ability of future generations to meet their own needs. This development also makes a positive contribution to sustainable development. Thus, increasing economic stability can contribute to individuals feeling happy by increasing their level of well-being. The significant and positive relationship between economic stability and happiness index can be explained in this way. In fact, according to Figure 1, the economic stability index has generally decreased in BRICS-T countries between 2005 and 2023. In addition, it is seen that there was a decrease in the happiness index in the same period. These developments are likely to be influenced by the global economic crisis experienced in 2008, COVID-19 pandemic experienced in 2020, and the recent war between Russia and Ukraine. As mentioned above, the decrease in economic stability may negatively affect sustainable development by causing individuals to decrease their ability to meet their personal needs.

In addition to all these relationships among renewable energy consumption, economic stability, and happiness, the positive relationship between renewable energy and economic stability and happiness shows that the pro-environment policies implemented and the policies implemented to ensure economic stability are interconnected. Increasing economic stability indicates that countries have reached a certain income level. In high-income countries, the use of high-tech and environmentally friendly technologies is higher. Hence, the countries with high income are expected to be more environmentally friendly. In this situation, explained by the Environmental Kuznets Curve (EKC) hypothesis, when countries have low income, their primary goal is growth, not the environment. Therefore, the use of environmentally friendly technology and the use of high technology is lower in low-income countries. This development causes countries to pollute the environment more in the production process up to a certain income level and after this income level, to pollute the environment less in the production process due to the use of higher and environmentally friendly technology. This finding shows that the policies to be implemented for economic growth and stability are in harmony with environmentally friendly policies. As a matter of fact, the fact that the economic stability shown in item e in Figure 1 has a general downward trend between 2005 and 2023, and the ecological footprint shown in item b as a general upward trend shows that the ecological footprint and air pollution have increased along with the deterioration in economic conditions in the BRICS-T countries during the period in question. These developments show that the economic policies implemented to increase economic stability and the policies implemented to reduce environmental pollution have not been successful.

6. Conclusion

Recently, the factors affecting happiness are among the topics researched in the literature. It is generally seen that the level of happiness is associated with variables such as economic growth, development, CO_2 emissions, as well as other socio-economic variables. However, it is noteworthy that the connection between happiness and economic stability has not been investigated in the literature. Therefore, this study differs from studies in the literature at this point and with the methods used in the analysis. In this context, this study empirically analyzed the impact of ecological footprint, fossil fuel energy consumption, renewable energy consumption, and economic stability on happiness in the context of BRICS-T countries. The study covers the period 2005-2023 and annual data were used. In the analysis, methods that take into account cross-section dependence and can be used for heterogeneous panels were used. In this connection, firstly, PANICCA panel unit root test was performed to determine whether the series contain a unit root, that is, whether they are stationary or not, and it was seen that the series were not stationary at the level, but became stationary when the first difference was taken. As a result, it was found that the stationary order of all the series are I(1). Then, the panel cointegration test developed by Gengenbach, Urbain and Westerlund (2016) was applied to investigate whether there is a long-run relationship between the variables. According to the results obtained, it was determined that there is a cointegration, that is, long-run relationship among the happiness index and the ecological footprint, fossil fuel energy consumption, renewable energy consumption, and economic stability. Afterward, Dynamic SUR developed by Mark et al. (2005) and AMG estimator methods developed by Eberhardt and Bond (2009) were used to estimate the model coefficients. It can be said that the panel results obtained from these two estimation methods are parallel and the results support each other. As a result, when evaluated in general, it can be said that the ecological footprint and the increase in fossil fuel energy consumption, which cause an increase in environmental pollution in BRICS-T countries, negatively affect happiness, while rise in renewable energy consumption and economic stability have a positive influence on happiness.

It has been found that ecological footprint and fossil fuel energy consumption negatively affect happiness, while renewable energy consumption and economic stability have a positive influence on happiness. Based on the empirical findings, policies to improve environmental quality should be implemented. Fossil fuel consumption produces more CO_2 emissions. Since the ecological footprint is also an indicator of air pollution, the rise in CO_2 emissions also increase the ecological footprint. Therefore, fossil fuel consumption increases the ecological footprint much more than renewable energy consumption. The increase in the ecological footprint will reduce air quality as it will increase air pollution. Hence, the quality of life and happiness of individuals decreases. For these reasons, in order for people to have a better life and to achieve the United Nations' SDG 3 *Good Health and Well-being* and SDG 7 *Affordable and Clean Energy*, fossil fuel energy consumption that causes environmental pollution should be abandoned, and the most suitable environmentally friendly energy sources for the country should be identified and emphasis should be given to these in order to meet the energy needs. Since a healthy and good environment will increase happiness, the use of environmentally friendly energy sources that cause less environmental pollution than fossil fuels will be effective in increasing the level of happiness. Nevertheless, it should not be forgotten that living in a healthy environment is a basic human right. Another finding is that economic stability has a positive impact on happiness. Therefore, it is important to implement policies aimed at ensuring economic stability. Because economic instability can bring uncertainty and cause confidence in the economy to be shaken. This situation can negatively affect the entire society. For example, economic instability can lead to a decrease in investments, which is one of the basic elements of economic growth. As a matter of fact, investors will not prefer to invest in countries with unstable, uncertain and risky economy, but rather prefer to invest in more stable and secure countries. This will prevent further job creation in the country where investment is not preferred and will have a negative influence on economic growth. However, in environments where the economy is not stable, entrepreneurs will cautious about realizing their ideas, projects and investments due to the risk element, and innovation will also decrease. As a result, it is important to create effective policies for people's happiness and well-being. As a matter of fact, happy individuals can establish healthy relationships in their social lives and can be more productive in their business lives. The influence of the increase in economic stability on happiness can also be explained by environmental conditions, as stated in the empirical findings section. As countries' energy consumption increases up to a certain income level, their CO_2 emissions and ecological footprint will increase. After a certain income level, the increase in energy consumption reduces CO_2 emissions and the ecological footprint. This development, known as the EKC hypothesis is related to the technology used in energy consumption. Countries with low income levels do not pay much attention to environmental conditions when using the energy they need for their growth. After a certain income level, CO_2 emissions and ecological footprint will decrease as there will be more environmentally friendly technologies and people with more environmental awareness. Correspondingly, people's quality of life and happiness also increases. Therefore, policy makers in BRICS-T countries should

implement monetary and fiscal policies that will enhance economic stability. Implementing economic policies that increase economic growth, reduce inflation rates, and take into account budget and current account balances can contribute to the happiness of individuals. While implementing these practices, each country within the BRICS-T should develop and implement an energy policy that is less damaging to the environment according to its own economic dynamics, as this will also contribute to sustainable environmental conditions. In addition, increased economic stability is an important development for sustainable development. Besides, increased economic stability is in line with the United Nations' SDG 8 *Decent Work and Economic Growth*. In light of all these developments, in order for BRICS-T countries to achieve sustainable development and to achieve the United Nations' SDG 8 *Decent Work and Economic Growth*, it is of great importance that each country develops its policies in line with economic, social, and environmental sustainability goals, taking into account the differences in their economic structures and the diversity in their energy policies.
In the future, other socio-economic variables that may affect happiness can be investigated and studies can be conducted on similar topics for different countries or country groups using different methods, thus contributing to the literature.

References

1. AKSOY F., BAYRAM ARLI N., 2019, Evaluation of sustainable happiness with Sustainable Development Goals: Structural equation model approach, *Sustainable Development* 1-8, https://doi.org/10.1002/sd.1985.
2. APERGIS N., MAJEED M. T., 2021, Greenhouse gas emissions and cross-national happiness: A global perspective, *Air Quality, Atmosphere & Health* 14(8), 1289-1300, https://doi.org/10.1007/s11869-021-01019-5.
3. BASSO L., VIOLA E., 2022, Are the BRICS engaged in the low carbon transition?, *CEBRI Journal* 1(4), 123-151.
4. BONASIA M., SIMONE E. D., D'UVA M., NAPOLITANO O., 2022, Environmental protection and happiness: A long-run relationship in Europe, *Environmental Impact Assessment Review* 93, 106704.
5. ALDIERI L., BRUNO B., VINCI C. P., 2019, Does environmental innovation make us happy? An empirical investigation, *Socio-Economic Planning Sciences* 67, 166-172.
6. BAI J., NG S., 2004, A panic attack on unit roots and cointegration, *Econometrica* 72(4), 1127-1177, https://doi.org/10.1111/j.1468-0262.2004.00528.x.
7. BAI J., NG, S., 2010, Panel unit root tests with cross-section dependence: A further investigation, *Econometric Theory* 26(4), 1088-1114, https://doi.org/10.1017/S0266466609990478.
8. CAT (Climate Action Tracker), 2025a, *Russian Federation: Policies and action,* https://climateactiontracker.org/countries/russian-federation/policies-action/ (05.03.2025).
9. CAT (Climate Action Tracker), 2025b, *India: Net zero targets,* https://climateactiontracker.org/countries/india/net-zero-targets/#:~:text=Target%20year%20%E2%80%93%20India%20aims%20to,key%20sectors%20of%20the%20economy (05.03.2025).
10. CAT (Climate Action Tracker), 2025c, *Turkey: Net zero targets*, https://climateactiontracker.org/countries/turkey/net-zero-targets/ (05.03.2025).
11. CCPI (Climate Change Performance Index), 2025, *South Africa,* https://ccpi.org/country/zaf/ (05.03.2025).
12. CLIMATE TRANSPARENCY, 2022a, *Russia. Climate Transparency Report: Comparing G20 climate action,* https://www.climate-transparency.org/wp-content/uploads/2022/10/CT2022-Russia-web.pdf.
13. CLIMATE TRANSPARENCY, 2022b, *India. Climate Transparency Report: Comparing G20 climate action*, https://www.climate-transparency.org/wp-content/uploads/2022/10/CT2022-India-Web.pdf.
14. CLIMATE TRANSPARENCY, 2022c, *China. Climate Transparency Report: Comparing G20 climate action*, https://www.climate-transparency.org/wp-content/uploads/2022/10/CT2022-China-Web.pdf.
15. CLIMATE TRANSPARENCY, 2022d, *South Africa. Climate Transparency Report: Comparing G20 climate action*, https://www.climate-transparency.org/wp-content/uploads/2022/10/CT2022-South-Africa-Web.pdf.
16. CLIMATE TRANSPARENCY, 2022e, *Turkey. Climate Transparency Report: Comparing G20 climate action,* https://www.climate-transparency.org/wp-content/uploads/2022/10/CT2022-Turkey-Web.pdf.
17. CRS, 2023, *India: Climate change issues,* CRS.
18. DE MORAIS, I. L. L., DE LIMA A. A., SANTOS I. N. L. D, MENESES C., DA SILVA R. F., LOPES R., RAMOS S. L. F., DE AGUIAR A. V., WREGE M. S., LOPES M. T. G., 2024, Climate change impact on the distribution of forest species in the Brazilian Amazon, *Sustainability* 16, 3458, https://doi.org/10.3390/ su16083458.
19. DONATH L., OPREA I., 2020, The inclusive finance factor of happiness, *Journal of Public Administration, Finance and Law* 18, 139-149.
20. DOWNIE C., WILLIAMS M., 2018, After the Paris Agreement: What role for the BRICS in global climate governance?, *Global Policy*, https://doi.org/10.1111/1758-5899.12550
21. EBERHARDT M., BOND S., 2009, Cross-section dependence in nonstationary panel models: A novel estimator, *MPRA Paper, No. 17692*, University Library of Munich, Germany.
22. EFEOĞLU R., AZGÜN S., 2021, Demokrasi ve mutluluk: BRIC ve MIST ülkeleri üzerine bir araştırma, *Çankırı Karatekin Üniversitesi İktisadi ve İdari Bilimler Fakültesi Dergisi* 11(1), 333-349.
23. EUROPEAN PARLIAMENT, 2022, *Brazil's climate change policies: State of play ahead of COP27,* European Parliamentary Research Service.
24. FEITOSA T. B., FERNANDES M. M., SANTOS C. A. G., DA SILVA R. M., GARCIA J. R., FILHO R. N. D. A., FERNANDES M. R. D. M., DA CUNHA E. R., 2023, Assessing economic and ecological impacts of carbon stock

and land use changes in Brazil's Amazon Forest: A 2050 projection, *Sustainable Production and Consumption* 41, 64-74, https://doi.org/10.1016/j.spc.2023.07.009.
25. GENGENBACH C., URBAIN J-P., WESTERLUND J., 2016, Error correction testing in panels with common stochastic trends, *Journal of Applied Econometrics* 31(6), 982-1004.
26. GERASIMCHUK I., KÜHNE K., ROTH J., GEDDES A., OHARENKO Y., BRIDLE R., GARG V., 2019, *Beyond fossil fuels: Fiscal transition in BRICS. Report,* The International Institute for Sustainable Development.
27. GIANSYAH R. W., SAMBODO H., BINARDJO G., SUHARNO S., 2023, Happiness index in ASEAN-9 2015-2021: Macroeconomic and demographic perspectives, *Economics Development Analysis Journal* 12(4), 537-547.
28. GLOBAL FOOTPRINT NETWORK, 2024, *Ecological Footprint*, https://www.footprintnetwork.org (10.07.2024).
29. GUILHOT L., 2022, An analysis of China's energy policy from 1981 to 2020: Transitioning towards to a diversified and low-carbon energy system, *Energy Policy* 162, 112806, https://doi.org/10.1016/j.enpol.2022.112806.
30. IEA, 2021, *Turkey 2021: Energy policy review*, International Energy Agency.
31. IEA, 2025a, *Energy system of Russia,* https://www.iea.org/countries/russia (03.03.2025).
32. IEA, 2025b, *Energy system of China*, https://www.iea.org/countries/china (03.03.2025).
33. IEA, 2025c, *China: World energy investment 2024*, https://www.iea.org/reports/world-energy-investment-2024/china (03.03.2025).
34. INVEST, 2025, https://www.invest.gov.tr/en/sectors/pages/energy.aspx (03.03.2025).
35. INVEST IN BRASIL, 2025, https://investinbrasil.com.br/content/portaldoinvestidor/us/home/why-brazil.html (03.03.2025).
36. INVEST IN INDIA, 2025, https://www.investindia.gov.in/sector/renewable-energy (03.03.2025).
37. IRENA, 2024, *Energy profile: South Africa*, Irena.
38. JIN Z., ZENG S., CAO C., MA H., SUN D., 2020, Impacts of pollution abatement projects on happiness: An exploratory study in China, *Journal of Cleaner Production* 274, 122869, https://doi.org/10.1016/j.jclepro.2020.122869.
39. KANAUJIYA K. S., MAURYA N. K., 2022, Does development lead to happiness?, *IASSI Quarterly: Contributions to Indian Social Science* 41(4), 498-515.
40. KAPÇAK S., 2023, Gelişmekte olan ülkelerde mutluluk ve ekonomik büyümenin ekolojik ayak izi üzerindeki etkisi, *Avrasya Sosyal ve Ekonomi Araştırmaları Dergisi* 10(2), 136-146.
41. KARAÇOR Z., MİRZA E., 2018, Sustainable development and life satisfaction relationship: A cross country study, *International Journal of Innovative Science, Engineering & Technology* 5(11), 52-61.
42. KHARE V., JAIN A., BHUIYAN M. A., 2023, Perspective of renewable energy in the BRICS country, *e-Prime – Advances in Electrical Engineering, Electronics and Energy* 5, 100250, https://doi.org/10.1016/j.prime.2023.100250.
43. KHASANAH L., SURYANTO, 2023, The impact of air pollution on the happiness index of ASEAN communities, *8th International Conference on Climate Change, IOP Conference Series: Earth and Environmental Science* 1165, 012044.
44. KLEY S., DOVBISHCHUK T., 2021, How a lack of green in the residential environment lowers the life satisfaction of city dwellers and increases their willingness to relocate, *Sustainability* 13(7), 3984, https://doi.org/10.3390/su13073984.
45. LELE F. F., 2013, *Happiness and the environment: Finding out a relationship*, Master's Dissertation in Environmental Economics and Management.
46. LI B., LU Y., 2009, *Happiness and development: The effect of mental well-being on economic growth,* The 2009 Conference on Improving the Human Destiny, Lingnan University, Hong Kong, 11-12 June 2009.
47. LIU Y., LI R.-L., SONG Y., ZHANG Z.-J., 2019, The role of environmental tax in alleviating the impact of environmental pollution on residents' happiness in China, *International Journal of Environmental Research and Public Health* 16(22), 4574, https://doi.org/10.3390/ijerph16224574.
48. MAJEED M. T., MUMTAZ S., 2017, Happiness and environmental degradation: A global analysis, *Pakistan Journal of Commerce and Social Sciences,* 11(3), 753-772.
49. MARK N. C., OGAKI M., SUL D., 2005, Dynamic seemingly unrelated cointegrating regressions, *Review of Economic Studies* 72(3), 797-820, http://dx.doi.org/10.1111/j.1467-937X.2005.00352.x.
50. MFA, 2025, https://www.mfa.gov.tr/bm-iklim-degisikligi-cerceve-sozlesmesi.tr.mfa (05.03.2025).
51. NGUYEN D. H., KHOMINICH I. P., 2023, The measurement of green economic quality in the BRICS countries: Should they prioritize financing for environmental protection, economic growth, or social goals?, *Russian Journal of Economics* 9(2), 183-200, https://doi.org/10.32609/j.ruje.9.101612.
52. NOUBISSI DOMGUIA E., POUMIE B., 2019, National happiness and environment quality in Africa, *MPRA Paper No. 96580*.
53. O'BRIEN C., 2005, Planning for sustainable happiness: Harmonizing our internal and external landscapes, *Rethinking Development: 2nd International Conference on Gross National Happiness*, Antigonish, Nova Scotia, Canada.
54. OSTROWSKA A., KOTLINSKI K., MARKOWSKI L., 2024, Does renewable energy matter for economic growth and happiness?, *Energies* 17(11), 2619.
55. ÖKSÜZ M., 2023, Seçilmiş OECD ülkelerinde sosyal harcamaların toplumun mutluluk düzeyi üzerindeki etkisi, *Uluslararası Sosyal Bilimlerde Yenilikçi Yaklaşımlar Dergisi* 7(1), 27-45.
56. PATHAK L., SHAH K., 2019, Renewable energy resources, policies and gaps in BRICS countries and the global impact, *Frontiers in Energy* 13, 506-521, https://doi.org/10.1007/s11708-018-0601-z.
57. PENG Y.-F., TANG J.-H., FU Y., FAN I., HOR M.-K., CHAN T.-C., 2016, Analyzing personal happiness from global survey and weather data: A geospatial approach, *PLOS ONE* 11(4), e0153638, doi:10.1371/journal.pone.0153638.

58. PESARAN M. H., 2007, A simple panel unit root test in the presence of cross-section dependence, *Journal of Applied Econometrics* 22(2), 265-312, https://doi.org/10.1002/jae.951.
59. PESARAN M. H., YAMAGATA T., 2008, Testing slope homogeneity in large panels, *Journal of Econometrics* 142(1), 50-93, https://doi.org/10.1016/j.jeconom.2007.05.010.
60. PROSKURYAKOVA L., 2022, *Russia's renewable energy sector: Policy recommendations,* BSR policy briefing series.
61. QU H., SUPHACHALASAI S., THUBE S., WALKER S., 2023, South Africa carbon pricing and climate mitigation policy, *IMF Selected Issues paper,* International Monetary Fund, Washington D.C.
62. REESE S., WESTERLUND J., 2016, Panicca: Panic on cross-section averages, *Journal of Applied Econometrics* 31(6), 961-981.
63. REHDANZ K., MADDISON D., 2005, Climate and happiness, *Ecological Economics* 52(1), 111-125, https;//10.1016/j.ecolecon.2004.06.015.
64. SAMOUR A., ADEBAYO T. S., AGYEKUM E. B., KHAN B., KAMEL S., 2023, Insights from BRICS-T economies on the impact of human capital and renewable electricity consumption on environmental quality, *Scientific Reports* 13, 5245, https://doi.org/10.1038/s41598-023-32134-1.
65. SARGAN J. D., BHARGAVA A., 1983, Testing residuals from least squares regression for being generated by the Gaussian random walk, *Econometrica* 51(1), 153-174, https://doi.org/10.2307/1912252.
66. SEYDİOĞULLARI H. S., 2013, Sürdürülebilir kalkınma için yenilenebilir enerji, *Planlama* 23(1), 19-25.
67. SILVA J., KEULENAER F. DE, JOHNSTONE N., 2012, Environmental quality and life satisfaction: Evidence based on micro-data, *OECD Environment Working Papers, No. 44*, OECD Publishing.
68. STRANGE T., BAYLEY A., 2008, *Sustainable development: Linking economy, society, environment*, OECD.
69. TOIGO C. H., MATTOS E. J., 2021, Happier and greener? The relationship between subjective well-being and environmental performance, *International Journal of Social Economics* 48(12), 1697-1717.
70. TURAL DİKMEN A., BEDİR KARA S., 2024, Yükselen piyasa ekonomilerinde CO_2 emisyonu, yenilenebilir enerji tüketimi ve ekonomik büyüme ilişkisi, *Eskişehir Osmangazi Üniversitesi İktisadi ve İdari Bilimler Dergisi* 19(2), 415-433.
71. UNEP, 2024, *Emissions gap report 2023*, https://www.unep.org/interactives/emissions-gap-report/2023/#section-1 (26.07.2024).
72. UNITED NATIONS, 2025, *The 17 Sustainable development goals,* https://sdgs.un.org (27.02.2025).
73. WANG Y., ARSHED N., GHULAM SHABEER M., MUNIR M., REHMAN H. U., KHAN Y. A., 2023, Does globalization and ecological footprint in OECD lead to national happiness, *PLOS ONE* 18(10), e0288630.
74. WELSCH H., 2006, Environment and happiness: Valuation of air pollution using life satisfaction data, *Ecological Economics* 58(4), 801-813, https://doi.org/10.1016/j.ecolecon.2005.09.006.
75. WORLD BANK, 2024, https://data.worldbank.org (10.07.2024).
76. WORLD HAPPINESS REPORT, 2020, *Sustainability makes people happier, research finds*, https://worldhappiness.report/news/sustainability-makes-people-happier-research-finds (27.02.2025).
77. WORLD HAPPINESS REPORT, 2024, *Happiness index*, WHP.
78. WWF, 2021, *10 soruda Türkiye ve Paris iklim anlaşması,* World Wildlife Found.
79. YAĞIŞ O., 2024, Ekonomik büyüme ve sanayileşmenin ekolojik ayak izine etkileri: Asimetrik nedensellik analizi, *International Journal of Social Inquiry* 17(1), 87-104.
80. YAN L., TAO T., ULLAH S., 2023, Internet financial services, environmental technology, and happiness: Implications for sustainable development, *PLOS ONE* 18(11), e0287673.
81. YILDIRIM O., NURİ F. İ., 2018, Yenilenebilir enerji ve sürdürülebilir kalkınma ilişkisi, *Journal of International Banking, Economy and Management Studies* 1(1), 105-143.
82. YUNANI A., DALLE J., MIAR, MAULIDA S., 2020, Can life quality dimensions alter ecological footprint for sustainability of ASEAN countries? Role of per capita income, happiness and human development, *Journal of Security and Sustainability Issues* 10, 242-252.
83. ZHENG Y., YANG R. Y., 2019, Environmental regulation, public participation and happiness: Empirical research based on Chinese general social survey of 2015, *Applied Ecology and Environmental Research* 17(4), 9317-9332, http://doi.org/10.15666/aeer/1704_93179332.
84. ZIDANSEK A., 2007, Sustainable development and happiness in nations, *Energy* 32, 891-897, 10.1016/j.energy.2006.09.016.

Appendix

Table A1. The results of cross section-dependncy and homogeneity test

Variable	**CD_{LM}**		**CD_{LM2}**		**CD_{LMadj}**	
	t-stat.	**p-value**	**t-stat.**	**p-value**	**t-stat.**	**p-value**
HI	**-2.79*** **	**0.003**	**9.744*** **	**0.000**	**5.922*** **	**0.000**
FEC	**-2.51*** **	**0.006**	**2.710*** **	**0.004**	**3.644*** **	**0.000**
REC	**2.137** **	**0.016**	**-1.610***	**0.054**	**4.582*** **	**0.000**
ES	**2.123** **	**0.017**	**-2.664*** **	**0.004**	**6.616*** **	**0.000**
EF	**-2.49*** **	**0.006**	**2.274** **	**0.011**	**3.25*** **	**0.001**
Model	**36.56*** **	**0.000**	**3.938*** **	**0.000**	**12.085*** **	**0.000**
Delta-tilde	**4.688*** 0.000**					
Delta-tilde-adj	**5.220*** 0.000**					

*** and ** indicate the significance at 1% and 5% level, respectively.

The economic stability index (ES) was developed by the editors of the International Country Risk Guide (ICRG) in 1992 and consists of five sub-indicators. These sub-indicators are; GDP per capita, economic growth/GDP, inflation rate (%), budget balance/GDP and current account balance/GDP (Howell, 2014). To calculate the index, each sub-indicator is given a score from zero (0) to predetermined maximum value. The sum of the scores of these subcomponents is between 0-50. In general, the economic risk rating indicates that 0% and 24.9% is very high risk (very low stability), 25% and 29.9% is high risk (low stability), 30% and 34.9% is medium risk (average stability), 35% and 39.9% is low risk (high stability), and 40% and above is very low risk (very high stability) (PRS-ICRG, 2022: 20).

The subcomponents of the economic stability index and information on its calculation are shown in Table A2.

Table A2. Economic stability/risk index subcomponents, source: PRS Group, ICRG Methodology, 2022.

Subcomponents	Description	Score Range
GDP per capita	It is calculated as a percentage of the average of the total GDP per capita of all countries in the ICRG.	0-5
Economic Growth Rate (%)	The annual change in GDP at constant annual prices is calculated as a percentage increase or decrease.	0-10
Inflation Rate (%)	Annual percentage change in the consumer price index.	0-10
Budget Balance/GDP (%)	It is calculated as the central government budget balance in a given year as a percentage of GDP in the same year.	0-10
Current Account Balance/GDP (%)	It is calculated as the current account balance in a given year as a percentage of GDP in the same year.	0-15