Triangular nexus among entrepreneur, energy policy and economic policy uncertainties: A symmetric and asymmetric evidence of inclusive sustainable development goal (SDGs)

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The paper is written by the three authors named in the Title page. Hence, **Lucy** wrote the intro-literature while **Firat** wrote the methodology, and **Edmund** wrote discussion and conclusion with abstract.

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Abstract

This is inclusive study of Turkish sustainable development. Our study seeks to study Turkish sustainable development amidst policy uncertainty towards its energy policy and progressive economic performance. Dual analyses of symmetric (Dynamic Ordinary Least Square-DOLS) and asymmetric (Non-linear autoregressive distributed lag-NARDL) approaches with granger causality estimate were adopted for clear and in depth analysis of this study. We adopt Turkish data of 1985 to 2017 for the accommodation of both short term and long term analysis. From both approaches, entrepreneur activities and renewable energy policy are observed mitigating ecological footprint thereby impacting favourable to the environmental performance of Turkey, while the economic policy uncertainties has no mitigating force against the ecological footprint. The impact of economic growth on the environment comes in stages through inverted Environmental Kuznets Curve (EKC) hypothesis. Also, findings from granger causality attest to the findings from both symmetric and asymmetric by establishing a two-way granger causality between entrepreneur and ecological footprint which shows that the entrepreneur has a great influence in impacting ecological footprint.Renewable energy is found mitigating environmental damage through a one-way granger causality from renewable to ecological footprint. Hence, policy is advised to be framed towards enhancing entrepreneurial activities and renewable energy sector with technological innovation in order to achieve Turkish climate goals

Keywords: economic growth; economic policy uncertainty; entrepreneur; energy policy; Turkey's sustainability; Dual methods (symmetric and asymmetric)

1. Introduction

Political stability plays a major role in improving economic growth, and aids in the establishment of a cohesive and continuous path toward long-term development. As countries depend steadily on one another in industry and migration, when there is economic instability, it affects more countries because these vulnerabilities spread across industries and national borders. Economic instability negatively affect economic activities in Turkey (Sahinoz and Cosar, 2018). Economic stability is achieved with an absence of economic and financial crises, huge fluctuations in economic activities, high inflation, inconsistency in currency and financial markets. Therefore, increase the cost of living for citizens and impedes economic growth (peel-valuewalk, 2021).

A stable political environment aids to build a well organize route toward sustainable economic development. However, a poor political environment, may result in government collapse and political upheaval. Sahinoz and Erdogan, (2018) defined policy uncertainty as the inability to foresee future economic measures as well as the repercussions of existing policies. However, many economies frequently encounter uncertainty regarding the content, timing, and impact of policy choices. Uncertainty has a wide-ranging impact on the economy, lowering economic growth, increasing unemployment, and influencing consumer and investment decisions (Barrero et al., 2017; Bloom, 2009). Furthermore, numerous studies have shown that increased policy uncertainty has a negative impact on the environment by increasing CO_2 emissions (Adedoyin et al., 2021; Anser et al., 2021). Political stability is required for the necessary shift to convert our economy to an environmentally sustainable one (Steve Cotton, 2021). According to Jirasavetakul and Spilimbergo, (2018), Economic policy uncertainty (EPU) might be viewed as an early warning sign of a recession. The spikes in the EPU index indicate that the Turkish EPU is mostly influenced by US policies, as opposed to policies of other foreign countries. It has been emphasized that economic growth is strongly connected to environmental quality. Where environmental quality has a direct impact on human welfare, higher earnings are connected with less degradation (Brock and Taylor, 2010; Almeida et al., 2017). However, where environmental damage costs can be externalized, economic progress tends to result in a gradual worsening of environmental quality. Turkey's economy is expanding with a focus on the energy and infrastructure sectors, as well as investments to ensure stability in the economy. Economic activities such as industrial and entrepreneurial activities, agriculture and service sectors, manufacturing, and transportation equipment all contribute to environmental pollution through overusing energy resources, which raises emissions. Turkish economy is one of the fastest growing economy in the OECD nations, with a rapid increase in greenhouse gas (GHG) emissions (climate scorecard 2020). Several innovative actions have been identified in the Turkish economy. Turkey has recently advanced in ensuring economic stability, developing the ability to innovate and encourage renewable energy consumption to establish stability in the economy. Adoption of renewable energy resources is one of the most critical global needs for economic stability and achieving low carbon emissions (Umar et al., 2020). The majority of the results on the effect of renewable energy on environmental quality are positive (Khan, 2020), but other studies suggested a negative impact of renewable energy on the environment (Liu et al., 2017).Sustainable energy sources (*e.g. hydropower, solar, biofuels, wind, and geothermal) provide* adequate and alternative energy. These sources are limitless, and they are primarily domestic and renewable energy sources. According to the climate scorecard (2020), Turkey's

energy demand has risen in tandem with its population, necessitating a greater reliance on imported energy. The policy makers emphasizes the importance of encouraging the use of domestic energy and renewable energy to minimize expenses and the negative impact on the environment (Pata, 2018). Turkey has a massive hydropower energy source, which is the country's main renewable energy resource, and it has ambitions to provide energy security and a quality environment. The country's location between Europe and Asia, surrounded by the Mediterranean, Black Sea, and Aegean, provides the government with an opportunity to expand its energy generation capability (Ozturk, 2007). According to the Turkey Renewable Energy Market, (2021), Turkey has an abundance of hydropower resources, with a capacity of over 28.5 GW (20.5 GW from reservoirs and 8 GW from river plants) and more than 50% of total renewable energy coming from hydro energy. The proportion of hydropower is expected to grow indefinitely to reduce imports and usage of fossil fuels (Turkey Renewable Energy Market, 2021).

According to Odonkor and Amoah-Darkwah, (2019) entrepreneurial activities are the primary source of economic growth in an economy. Entrepreneurial activities through small and medium enterprises contributes more than 50 percent to the Turkish economic growth. Entrepreneurship is a vital source of a country's development and enhance revenue generation, and also promotes social obligation (Gerceker and Ozel, 2014; Urbano and Aparicio, 2016 for Turkey). Turkey is ranked the world's second most entrepreneurial economy, trailing only India, which was ranked first due to its ability to achieve high viability, subsidies and experts, and large volume of early-startups business activities (Global Entrepreneurial Report, 2020). Turkey draws high level of early startups businesses, and its growth is dependent on the success of its business owners and the value of its environment. Environmental degradation and global warming have been identified as the most significant global issues. For a long time, environmental degradation has had a detrimental impact on sustainable development, and efforts have been made around the globe to lessen its impact on upcoming economic sustainability. As a leading industrial country with increasing population and urbanization, Turkey has encountered environmental difficulties that have hampered its economic growth and stability. Climate change, deforestation, and water-related difficulties are some of the challenges that can arise (European Environmental Agency, 2015).

Against this background, the present study seeks to investigate the environmental performance of Turkey towards achieving its sustainable development goals (SDGs). In the course of working towards achieving its sustainability, Turkish authorities have initiated some plans such

as boosting its renewable energy sectors specifically with a target of increasing solar to 10 GW and 16 GW by 2030. As remarked, Turkey has an abundance of hydropower resources integrating the initiated plan of expanding solar and other renewables are expected to aid the country's climate ambition. Part of Turkey's climate ambition is to reduce its national emissions at 21% below what it calls a business-as-usual scenario, equivalent to 999 MtCO2e, by 2030; however, with current policies, its emissions are projected to be between 730-884 MtCO2e in 2030. Turkey is among countries yet to ratify its Paris agreement But considering the anticipated role and impact of policy uncertainty and economic performance through the domestic entrepreneurial activities on the environment, it is worth researching the possible effect of the mentioned instruments in determining the country's environmental performance. Turkey is currently at a crossroads in terms of its policy to cut carbon emissions while also boosting domestic energy sources in order to meet its energy needs for economic operations. For a clear understanding of the success of this goal and the possibility of achieving a balanced sustainable development, we adopt some important economic features (political instability proxy by economic policy uncertainties, entrepreneurship, renewable energy, and economic growth) of Turkey which are important in determining both economic and environmental development of the country. Economic policy uncertainty is considered a risk in which government policies and regulatory outcomes are not clear for the near future. This phenomenon affects investors' confidence, and may lead businesses and individuals to delay spending and investments because of uncertainty in the market. We adopt a dual scientific analyses for clear and in-depth exposition and understanding of our study. The dual methodology will aid the readers to understand the connection that exist amongst the selected instruments in different dimensions. Comparing the different methods will help in clear understanding of the findings in this study. The novelty of our work is anchored on the quantitative measure and analysis of the impact of entrepreneur activities in Turkey in determining the environmental performance of the country towards its sustainability goal. Again policy instability and uncertainty seems to be overlooked in the analysis of environmental performance by many energy cum environmental economist, hence, as part of the motivations and novelty of this study we incorporate the quantitative measure and analysis of economic policy uncertainties in determining the environmental performance of Turkey towards its sustainable development goals. Our study seeks to add to the existing literature in the following ways: a. by introducing and quantifying entrepreneur activities in Turkey in the energy-environment-economic performance nexus, b. also introducing and quantifying economic policy uncertainty of Turkey in the energy-environment-economic performance

nexus, c. interacting entrepreneur activities, economic policy uncertainties, renewable energy and economic growth in determining environmental performance in pursuit of sustainable development goals. The above mentioned points accommodated the objective of our study which is to expose the environmental implication of entrepreneurial activities and policy uncertainty in Turkey. By incorporating the above mentioned in the existing literature, the present study will set the pace and serve as a frontline in measuring and analyzing environmental performance towards achieving sustainable development in the global scope. To our knowledge, this present study comes first in quantifying entrepreneur activities along line of economic policy uncertainties in energy-environment-economic performance nexus. We apply different scientific methodologies in this present study. The current work investigates this link in a novel way by examining the asymmetry relationships among variables using the non-linear autoregressive distributed lag (NARDL) model. For great insight and clear explanation of the findings from the interactions of the selected instruments, we adopt a dual principle of symmetric (dynamic ordinary least square-DOLS) and asymmetric (nonlinear autoregressive distributed lag-NARDL). NARDL will expose both positive and negative shocks of the explanatory variables to the dependent variable, while DOLS will serve as a robust check to the findings from the NARDL which will aid in policy recommendation towards the achievement of sustainable development. NARDL displays the relationship among the variables in a decomposed manner which implies showing both positive and negative effects (shocks) of the explanatory variables on the endogenous instrument. Unlike linear methods, asymmetric (non-linear) methods includes both positive and negative effects of the exogenous variables on endogenous instruments. Also, to compare with existing methods like Engle and Granger (1987) and Johansen (1991), NARDL method is convenient for any size of sample without special requirement in order of integration like other methods. Moreover, NARDL framework enables testing for hidden cointegration (Granger and Yoon, 2002). NARDL has the ability to by-pass collinearity issues because of its orderliness in lag selection. Also, methodologies (*such as structural break with conventional unit root tests other diagnostic tests with asymmetric tests for long run relationship among the instruments*) were also used. Diagnostic tests were equally applied in our study to ascertain the suitability of econometric estimation and analysis. The study period was chosen based on the availability of data from 1985 to 2017.

The other parts of this study are built as follows: Section 2 provides a thorough review of past studies. The third section contains the data and methodology. Section four discusses the

estimation results as well as the economic consequences. The final section of the study concludes with policy implications.

2. Literature Review

Past studies have discussed the related topic by reviewing the role of political instability, renewable energy, and entrepreneurship on atmospheric sustainability in a variety of countries and regions. But only a few have include entrepreneurial activities in their analysis. The studies reviewed revealed notable trend with the outcomes stating that there is still no consensus about the results of the variables. As a result, the title has become more intriguing, and substantial contributions for mutual understanding have been produced. Few studies had analyzed the influence of political instability on environmental quality. Omri et al., (2015) explored the effects of political instability, oil corruption, on environmental quality in MENA countries from 1995 to 2011 employing the static and dynamic panel data test. The results indicates negative relationship between political instability and CO_2 emissions, which implies high political instability improve environmental quality. Al-Mulali and Ozturk, (2015) examined the effects of political stability, energy consumption, industrial development, trade openness on ecological footprint of MENA countries using the Pedroni cointegration and Fully Modified Ordinary Least Square (FMOLS) test from 1996 to 2012. The results indicated political stability reduces environmental degradation while the other variables increases it. Fredriksson and Syensson, (2003) examined the degree of political instability and corruptibility on the environment. Indicated that when the degree of corruption is low, political instability affect the environment negatively, but affect the environment positively when corruption is high. However, high corruption lessen environmental quality and environmental quality improves as political instability soar. Furthermore, the study of Adger et al., (2002) stated that social stability leads to environmental degradation. Galinato and Galinto, (2011) examined the effects of political stability, corruption control on environmental degradation. Indicated that as political stability increases, it reduces the CO_2 emissions. Conca and Wallace, (2009) stated that increase in environmental pollutions may hinder socio-political stability. Danish and Khan, (2020) stated that EPU negatively affect environmental quality but strengthens the harmful effect of energy force on CO_2 emissions. Yu et al., (2021) examines the impacts of EPU on CO_2 emissions in China. The results show that EPU has a positive effect on CO_2 emissions. Anser et al., (2021) explored the influence of uncertainty index on CO_2 emissions in the top ten carbon emitter countries. Indicated that an increase in the world uncertainty index mitigates CO_2 emissions in the short run (*the period when general price level, contractual wages, and expectations do not*

fully adjust) and increases it in the long run (*the period when the previously mentioned variables adjust fully to the state of the economy*). Zakari et al., (2021) showed a positive relation of EPU and CO_2 emission for 22 OECD nations. Applying the Bootstrap ARDL approach, Syed and Bouri, (2021) examined the influence of EPU on CO_2 emissions in the US. The results indicates that EPU raises CO_2 emission in the short run, while in the long run its plunges environmental degradation.

Energy consumption is an important part of any economy's economic and environmental sustainability in order to enhance productivity. Many studies have been conducted to investigate the relationship between energy use and environmental sustainability, using both renewable and nonrenewable energy sources. Some of the findings indicated a favorable association, while others discovered a negative relationship between energy usage and environmental quality. According to Philip et al. (2021), energy use has a negative impact on the environment. Applying the ARDL and the Vector Error Correction Model (VECM) approach from 1965 to 2016, Karasoy and Akçay, (2019) explored the influence of renewable and nonrenewable energy consumption on CO_2 emissions in Turkey. The results shows that renewable energy consumption minimize carbon emissions. Furthermore, Liu et al., (2017), there is a negative link between renewable energy and carbon emissions. The increased use of renewable energy has an impact on environmental degradation.

Over the years, few researchers had explored the influence of entrepreneurship activities on environmental sustainability. Nakamura and Managi, (2020) examined the influence of entrepreneurship on environment quality. The study concluded that the outcome varies for different economies, and also indicated that entrepreneurial activities negatively impact the environment more in low-income economies compare to high-income economies. However, Shepherd and Patzett, (2011) explored the impact of entrepreneurship on environmental quality. The outcome indicated that entrepreneurship lessen environmental pollutions. Similarly, York and Venkataraman, (2010) also indicated that entrepreneurship influences the environment negatively.

The majority of the econometric models presented in the literature review (in Table 1) tried to broaden the analysis of the political instability-renewable energy-environmental degradation link with relevant variables. Thus, we look at the short and long run effects of the instruments on Turkish environment quality with a dual scientific analysis. Most of the studies mentioned in the literature review employ only one methodology to analysis the interaction effect of the selected variables on environment, while the present study adopts NARDL with unique feature

of decomposing the impact of explanatory variables on the dependent variable. Moreover, multiple methods are also adopted for the purpose of robust check on the findings of the main techniques. However, there is no consensus in the literature about the direction of the researched variables on environmental quality.

Table 1: Review of political instability (economic policy uncertainties), entrepreneurship, energy consumption, and the environmental quality**.**

Authors	Time	Region of study	Variables	Models	Outcomes
Chu and Le, 2021	1997-2015	G7 countries	EPU, GDP, RE, EFP,	FMOLS	High EPU reduces environmental degradation
Adedoyin and Zakari, 2020	1985-2017	UK	EPU, EC, CO_2 emissions	ARDL bound test	EPU reduces pollution in the short run
Adams et al., 2020	1996-2017	10 resource rich countries	EC, EPU, CO_2, GDP, geopolitical risk	PMG-ARDL	EPU reduces CO_2 in the long run EC and GDP increases CO_2 emissions
Shabir et al., 2021	2001-2019	24 developed and developing countries	EPU, FDI, CO_2, EC, GDP, TO	PVECM	EPU influences CO_2. FDI enhances the environment
Adedoyin et al., 2021	1996-2014	Sub-Saharah Africa	GDP, RE, NRE, EPU, CO_2	FMOLS and DOLS	EPU influences CO_2 emission. GDP and NRE increases CO_2
Liu and Zhang, 2021	2003-2017	China	EPU, CO_2, EC, GDP	STIRPAT Model.	EPU influences CO_2 emission

Sharif et al., (2020)	1965Q1-2017Q4	Turkey	EFP, REC, NREC, GDP	Quantile ARDL approach	renewable energy lessens ecological footprint and confirmed the EKC hypothesis
Bölük and Mert, (2015)	1961–2010	Turkey	CO_2, REC, GDP	ARDL approach	REC enhances environmental quality
Alola, (2019)	1997-2014	16-EU economies	NREC, REC, EFP, GDP	Panel PMGADL model	NRE reduces environmental quality while RE enhances the environment
Khan, (2020)	2001-2018	Nordic counties	RE, TO, GDP, CO_2	DCCE model	RE improves environmental quality
Mahalik et al., (2021)	1990–2015	BRICS	REN, NREC, GDP, Primary education, CO_2	GMM techniques	Renewable energy consumption reduces carbon emissions
Asongu, (2019)	2002-2017	40 African countries	REC, CO_2, FD, TO	fixed effects regressions and quantile fixed effects regressions	renewable energy decreases carbon emissions
Dogan and Seker, (2016)	1985-2011	40 Countries	CO_2, GDP, REC, NREC, TO, FD	panel estimation techniques	Increase in renewable energy consumption

					decreases carbon emissions
Youssef et al., (2018)	2001-2014	17 African countries	CO_2, ENTR, GDP, EC, FD, TO	Panel data	ENTR influences CO_2.
Riti et al., (2015)	2000-2012	Nigeria	ENTR, CO_2, GDP, HD, and service sector	FMOLS	ENTR influences CO_2 emissions
Dhahri and Omri, (2018)	2001-2012	20 developing countries	ENTR, CO_2, GDP, HD	FMOLS and DOLS techniques	ENTR negatively contribute to the environmental conditions.
Omri A, (2018)	2001-2011	69 countries	ENTR, CO_2 emission, GDP, TO, EC, FD, and HD	FMOLS	ENTR causes more pollution in low-income countries
Philip et al. (2021)	1985-2016	Turkey	ENTR, EU, FD, GDP, TO, CO_2	NARDL	ENTR influences CO_2 emissions.
He et al., 2020	2015-2017	67 countries	CO_2, ENTR, GDP, APS, NES	Panel analysis	ENTR enhance environmental quality

Note: *CO_2- carbon dioxide emissions, GDP- gross domestic product, EPU-, EFP- ecological footprint, EC- energy consumption, REC- renewable energy consumption, ENTR- entrepreneurship, TO- trade openness, FD- financial development, HD- human development, FDI- foreign direct investment, FMOLS- fully modified ordinary least square, and DOLS- dynamic ordinary least square, NARDL- nonlinear autoregressive distributed lag model.*

Source: Authors compilation

2.1 Theoretical insight of the impact of entrepreneurial activities

Theoretically, entrepreneurial activities have been discovered influencing the environmental performance in different economies in a mix fashion (positive and negative). Entrepreneurial activities in some countries (mostly developed countries) are sometime associated with technological innovations for ease of doing business, hence, mediate positively on the environmental performance (Dhahri and Omri. 2018). Newly startups businesses tend to develop and engage in innovative means of executing their businesses for easy breakthrough in their different locations. In contrast to this finding, entrepreneurial activities in most of the developing countries are found degenerating their environmental qualities due to limited access to improved technologies and innovations. Youssef et al., (2018) employed EKC model to study the implication of entrepreneurial activities on the environmental performance of some African countries, and found negative influence on their environmental performance.

3. Data and Methodology

Given the heterogeneity of outcomes in the literature, this study aims to investigate the short run and long run asymmetric association of economic policy uncertainties and entrepreneurial activities with environmental quality. This relationship was scrutinized with the help of economic performance and renewable energy use. The economic performance was indicated with real gross domestic product (GDP) and hydropower energy use was employed to indicate renewable energy in our estimation. Also, the ecological footprint was used as dependent variable to indicate the environmental quality, while the total number of newly established businesses are considered as proxy to the entrepreneurial activities. This has been used in other literature (De Clercq et al., 2012; Honjo and Nakamura, 2019 and Hessels et al., 2008) as the proxy to entrepreneurial activities. This measures the attitudes and personal attributes towards the early business start-ups and new business investments. The details about the measurements and the sources of obtained data are portrayed in Table 2. Study period is selected based on the availability of the data from 1985 to 2017.

Table 2: Description of Variables

Variables	Measurement	Sources
Ecological footprint (EFP)	global hectare- gha	Global Footprint Network
Entrepreneurship (ENT)	Total number of newly established businesses	Union of Chambers and Commodity Exchanges of Turkey (TOBB)
Economic performance (Y)	Gross domestic product (GDP) - constant at 2010 US$	World Bank-WDI
Renewable Energy use (HP)	Hydropower energy use-kg of oil equivalent (kgoe)	BP statistical review of world energy

Economic policy uncertainty index (PI)	Global Economic Policy Uncertainty

Source: Authors Compilation

Moreover, to investigate the long run association among investigated variables, the following model was generated.

EFP= *f (ENT, Y, HP, PI)* *(1)*

The variables in the equation 1 are transformed into the logarithmic form in the subsequent equations (2-13) in order to decrease the heterogeneity level of the variables and increase strength of the outcome. Then, as a precondition to estimate the model, augmented Dickey and Fuller (ADF) (Dickey and Fuller, 1979) and Phillips and Perron (PP) (Phillips and Perron, 1988) unit root tests were employed to examine the integration order of investigated variables. After that, dual empirical analyses with both symmetric (dynamic ordinary least square-DOLS) and asymmetric (nonlinear autoregressive distributed lag-NARDL) approaches in short run and the long run periods were utilized. The main purpose of using NARDL model, as constructed by Shin et al., (2014), is to obtain the proper and robust outcomes for small sample size. Moreover, NARDL does not require same order of integration for investigated variables whilst it can decompose the effect into positive and negative shocks for explanatory variables. The general representation of the impacts of positive and negative shocks of exogenous variables on the quality of environmentcan be presented below.

$$\ln EFP_t = \alpha_0 + \beta_1 \ln ENT_t^+ + \beta_2 \ln ENT_t^- + \beta_3 \ln Y_t^+ + \beta_4 \ln Y_t^- + \beta_5 \ln HP_t^+ + \beta_6 \ln HP_t^- + \beta_7 \ln PI_t^+ + \beta_8 \ln PI_t^- + \varepsilon_t \quad (2)$$

Where α_0 stands for intercept, βs depicts for the coefficients of positive and negative shocks of examined variables, and ε_t indicates for the error term of estimations in time t. Besides this relationship in NARDL framework can be presented in below equation.

$$\begin{aligned}\Delta \ln EFP_t &= \eta_0 + \theta_1 \ln EFP_{t-1} + \beta_2 \ln ENT_t^+ + \beta_3 \ln ENT_t^- + \phi_4 \ln Y_t^+ + \phi_5 \ln Y_t^- + \varphi_6 \ln HP_t^+ + \varphi_7 \ln HP_t^- + \chi_8 \ln PI_t^+ + \chi_9 \ln PI_t^- \\ &+ \sum_{j=1}^{n-1} (\gamma_1 \Delta \ln EFP_{t-1}) + \sum_{j=0}^{n_2} (\mu_j \Delta \ln ENT_{t-j}^+ + \mu_j \Delta \ln ENT_{t-j}^-) + \sum_{j=0}^{n_3} (\pi_j \Delta \ln Y_{t-j}^+ + \pi_j \Delta \ln Y_{t-j}^-) + \sum_{j=0}^{n_4} (\omega_j \Delta \ln HP_{t-j}^+ + \omega_j \Delta \ln HP_{t-j}^-) \quad (3) \\ &+ \sum_{j=0}^{n_4} (\psi_j \Delta \ln PI_{t-j}^+ + \psi_j \Delta \ln PI_{t-j}^-) + \upsilon_t\end{aligned}$$

Where EFP, ENT, Y, HP and PT represent ecological footprint, entrepreneurial activities, economic growth, hydropower energy and policy uncertainty. Moreover, by adding the error correction term (ECT) and the short term elasticities can be estimated by utilizing the following equation

$$\Delta \ln EFP_t = \eta_0 + \sum_{j=1}^{n-1}(\gamma_1 \Delta \ln EFP_{t-1}) + \sum_{j=0}^{n_2}(\mu_j \Delta \ln ENT_{t-j}^{+} + \mu_j \Delta \ln ENT_{t-j}^{-}) + \sum_{j=0}^{n_3}(\pi_j \Delta \ln Y_{t-j}^{+} + \pi_j \Delta \ln Y_{t-j}^{-}) + \sum_{j=0}^{n_4}(\omega_j \Delta \ln HP_{t-j}^{+} + \omega_j \Delta \ln HP_{t-j}^{-})$$
$$+ \sum_{j=0}^{n_4}(\psi_j \Delta \ln PI_{t-j}^{+} + \psi_j \Delta \ln PI_{t-j}^{-}) + \Theta ECT_{t-1} + \upsilon_t \quad (4)$$

As it was shown in equation (2) the positive and negative shocks and their effects on dependent variable can be decomposed as follows

$$\ln ENT_t = \ln ENT_0 + \ln ENT_t^{+} + \ln ENT_t^{-} \quad (5)$$

$$\ln Y_t = \ln Y_0 + \ln Y_t^{+} + \ln Y_t^{-} \quad (6)$$

$$\ln HP_t = \ln HP_0 + \ln HP_t^{+} + \ln HP_t^{-} \quad (7)$$

$$\ln PI_t = \ln PI_0 + \ln PI_t^{+} + \ln PI_t^{-} \quad (8)$$

Where $\ln ENT_0$, $\ln Y_0$, $\ln HP_0$ and $\ln PI_0$ denote the initial random value. Moreover, $\ln ENT_t^{+} + \ln ENT_t^{-}$, $\ln Y_t^{+} + \ln Y_t^{-}$, $\ln HP_t^{+} + \ln HP_t^{-}$ and $\ln PI_t^{+} + \ln PI_t^{-}$ accumulate positive and negative shocks, respectively and signify partial sum process in estimation. They can be also defined as follows:

$$\ln ENT_t^{+} = \sum_{j=1}^{t} \Delta \ln ENT_j^{+} = \sum_{j=1}^{t} \max(\Delta \ln ENT_j, 0), \ln ENT_t^{-} = \sum_{j=1}^{t}(\Delta \ln ENT_j, 0) + \varepsilon_t \quad (9)$$

$$\ln Y_t^{+} = \sum_{j=1}^{t} \Delta \ln Y_j^{+} = \sum_{j=1}^{t} \max(\Delta \ln Y_j, 0), \ln Y_t^{-} = \sum_{j=1}^{t}(\Delta \ln Y_j, 0) + \varepsilon_t \quad (10)$$

$$\ln HP_t^{+} = \sum_{j=1}^{t} \Delta \ln HP_j^{+} = \sum_{j=1}^{t} \max(\Delta \ln HP_j, 0), \ln HP_t^{-} = \sum_{j=1}^{t}(\Delta \ln HP_j, 0) + \varepsilon_t \quad (11)$$

$$\ln PI_t^{+} = \sum_{j=1}^{t} \Delta \ln PI_j^{+} = \sum_{j=1}^{t} \max(\Delta \ln PI_j, 0), \ln PI_t^{-} = \sum_{j=1}^{t}(\Delta \ln PI_j, 0) + \varepsilon_t \quad (12)$$

The WALD test was utilized to test the long run symmetry ($\gamma^{+} = \gamma^{-}$) and asymmetry ($\gamma^{+} \neq \gamma^{-}$). The effects of asymmetric cumulative dynamic multipliers on dependent variable of a unit change in positive and negative shocks of independent variables can be acquired as follows.

$$m_h^+ = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln ENT_{t-1}^+}, m_h^- = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln ENT_{t-1}^-},$$
$$m_h^+ = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln Y_{t-1}^+}, m_h^- = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln Y_{t-1}^-}, \qquad h=0,1,2,3..... \qquad (13)$$
$$m_h^+ = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln HP_{t-1}^+}, m_h^- = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln HP_{t-1}^-},$$
$$m_h^+ = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln PI_{t-1}^+}, m_h^- = \sum_{j=0}^{h} \frac{\delta \ln EFP_{t+j}}{\delta \ln PI_{t-1}^-},$$

Where h→∞, $m_h^+ \to \xi^+$ and $m_h^- \to \xi^-$, where ξ^+ and ξ^- are accounted as $\xi^+ = -\beta^+ / \rho$ and $\xi^- = -\beta^- / \rho$, respectively. Where $\xi^- = -\beta^- / \rho$ is the speed of adjustment.

Furthermore, the consistency of the results was confirmed by using Dynamic Ordinary least squares model and cumulative sum of recursive residuals (CUSUM) and cumulative sum of recursive residuals squares (CUSUMsq) stability tests were utilized to test the consistency and goodness of fit of NARDL model. Also, the required reliability tests were employed for our estimation. Lastly the direction of causal relationship among investigated variables was explored with Granger causality test.

4. Empirical Results

As mentioned before, the short and long run asymmetric association of economic policy uncertainty and entrepreneurship with environmental quality were aimed to be examined by using symmetric (dynamic ordinary least square-DOLS) and nonlinear asymmetric (nonlinear autoregressive distributed lag-NARDL) approaches. Besides, these relationships were examined by decomposing into positive and negative shocks incorporating with economic performance and renewable energy use for the period of 1985-2017. To this end, as a precondition of the symmetric and asymmetric models, Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests were utilized. The results, in Table 3, indicate that all investigated variables are stationary at their first difference. In other words, all variables are integrated order one.

Table 3: Stationarity Test Results

Variables	***ADF***		***PP***	
	Level	Δ	**Level**	Δ
lnEFP	-1.053	-8.995***	-1.164	-12.250***
lnENT	-1.897	-5.251***	-1.918	-5.251***

lnY	0.284	-6.154***	0.809	-6.314***
lnHP	-2.460	-7.136***	-2.441	-8.048***
lnPI	-2.305	-5.429***	-2.623	-9.284***

Note: (1) All variables were tested with only intercept. (2)*** stands for the significance level at 1%.

Source: Authors Computation

This allows us to test the long run steady state association of investigated variables. To this end, Bounds test was utilized and the results indicates that the calculated F-statistic (6.647) is greater than the upper bound at 1% significance level. This proves the long run steady state association of investigated variables (see Table 4).

Table 4: Bound test results

		1%		**5%**		**10%**	
K	Calculated F-stat	B_L	B_U	B_L	B_U	B_L	B_U
4	6.65	4.40	5.72	3.47	4.57	3.03	4.06

Note: B_U: upper critical bound B_L: lower critical bound

Source: Authors Computation

To estimate the magnitude and direction of positive and negative shocks of independent variables on environment for the short run and long run, NARDL model was employed. The estimation results for NARDL model are reported in Table 5. The results shows that all explanatory variables are statistically significant at different significance level which indicates that all explanatory variables are the determinants of environmental quality. The magnitude of the effect and the direction of the relationship for these determinants differ for environmental quality. Thus, according to the results of short run estimates, the positive and negative shocks of entrepreneurial activities in Turkey were calculated as -0.213 and 0.074. This means that, one percent increase in entrepreneurial activities in Turkey will contribute to environmental sustainability by 0.213%, whilst a 1% decrease in entrepreneurial activities will degrade environment by 0.074% in short run. However, in the long run, these coefficients were accounted as -0.103 and 0.112, respectively. This indicates that with the adaption of new technology an increasing standards/regulations, in the long run, 1% rise in the entrepreneurial activities will contribute to environmental sustainability by 0.103%, which is lower compared to short run. Moreover, a one percent decrease in entrepreneurial activities will deteriorate environmental quality by 0.112%, on average. This effect is larger compared to short run. This suggests that, Turkey should subsidize the entrepreneurial activities and decrease the

bureaucracy for entrepreneurial activities to sustain the environment. The impact of entrepreneur activities is really surprising but could be possible through innovative actions of the merchants operating in the commercial sector of the economy. It shows that the players in the industrial cum commercial sector of the economy where majority of entrepreneurial activities take place are adopting innovative and alternative source of energy which could be the possible reason for decreasing ecological footprint in the Turkish economic activities through entrepreneur (Dhahri and Omri. 2018).This findings is in consonance with the findings by Pattberg, (2017) but contradicts the finding by Omri and Afi, (2020). The reason for this variance in their findings is not far from the policy adaptation of different countries towards moderating of the economic and environment performance. Also, time varying factors and model selection may as well contribute to the variation in these findings.

Moreover, one percent increase in economic development will cause a rise in ecological footprint by 1.87% in short run which was calculated as 0.68% for long run. This suggests the accumulation of more space (footprint) due to economic expansion which translate poor environmental quality. This also indicates that an increase in economic performance due to utilization of fossil fuels with carbon intensive technology significantly deteriorate the environment in both term with different magnitude. But thanks to the innovative style of entrepreneurial activities currently going on in Turkey which is capable of mitigating poor environment. This is confirmed with the findings from the interaction between entrepreneur activities and the environmental sustainability. On the other hand, a one percent decrease in the economic development will enhance the sustainable environment by 0.445% in short run and 0.161% in long run, on average. Therefore, Turkey should have strong legal statutes to standardize the production techniques and subsidize economic actors to act as environmentally friendly. In other words, Turkish policymakers should pursue some standards/policies to avoid allowing economic actors to operate with carbon intensive technology. This will reduce the level of environmental degradation and increase environment quality. This finding supports the findings by Philip et al., (2021) for Turkey; Udemba, (2020) for Turkey; Udemba, (2021) for UAE; Udemba, (2021) for Pakistan

On the other hand, although having some disadvantages of using renewable energy sources and many opponents protest the implementation of hydropower energy dams, the renewable energy sources mostly seen as remedy for environmental sustainability in the literature. However, existing literature have conflicting results due to investigated time period as well as the characteristics of the countries. Thus, since Turkey mostly utilized hydropower energy

compared to other renewable energy sources, the short run and long run asymmetric role of hydropower energy consumption on environmental quality has been investigated in this study. The results indicate that a one percent increase in the use of hydropower will lead to 0.281% decline in the deterioration level of environment in Turkey and this value was calculated as 0.181% in the long run. However, a one percent decline in the use of hydropower will degrade environment by 0.024% in short run and 0.013% in the long run, on average. This can be highlighted that an increase in the share of renewable energy (hydropower) sources in energy mix will help Turkey to raise environmental quality and decrease the deterioration level of environment in both term. Thus, an increase in the use of hydropower and its share in energy mix will contribute to environmental sustainability and also economic sustainability by decreasing the energy dependency in Turkish energy mix. This finding supports the findings of Alola (2019) for 16-EU economies; Sharif et al., (2020) for Turkey and Adedoyin et al., (2021) for Sub-Saharan African countries

On the other hand, economic policy uncertainties was discovered as statistically significant determinant on environmental quality. The calculated elasticities of policy (economic) uncertainty show that a once percent increase in economic policy instability refers to 0.047% rise in degradation level in short run and 0.021% in the long run, on average. Together with, a one percent decrease in the economic political instability will add to environmental quality by 0.097% in short run and 0.058% in long run. This is to say that economic policy instability in Turkey will cause uncertainties for economic actors which contributes to deterioration level of environment and decreases the environmental sustainability. Moreover, the policymakers should insist on employing more rigorous policies to sustain the economy and trigger the economic actors to increase the multiplier effect in the economy within environmental sustainability framework. Lastly error correction term was calculated as -0.757. This indicates that 75.7% of disequilibrium in environmental deterioration level in short run can be mended in the long run given the independent variables. This finding supports the findings by Liu and Zhang, (2021) for China; Chu and Le, (2021) for G7 countries; Shabir et al., (2021) for 24 developed and developing countries

Table 5: Estimation output

Short Run Coefficients				
Var	Coeff	Std. Error	t-Stat	P-value
$D(LNENT^{+})$	-0.213***	0.030	-7.057	0.0002
$D(LNENT^{-})$	0.074**	0.026	2.778	0.0273
$D(LNY^{+})$	1.870***	0.272	6.874	0.0002
$D(LNY^{-})$	-0.445*	0.221	-2.019	0.0832

D(LNHP$^+$)	-0.281***	0.055	-5.076	0.0014
D(LNHP$^-$)	0.024**	0.033	0.715	0.0497
D(LNPI$^+$)	0.047***	0.012	3.894	0.0059
D(LNPI$^-$)	-0.097***	0.016	-5.749	0.0007
ECT(-1)	-0.757***	0.292	-9.425	0.0000
Long Run Coefficients				
Var	Coeff	Std. Error	t-Stat	P-value
LNENT$^+$	-0.103***	0.013	-8.123	0.0001
LNENT$^-$	0.112***	0.011	1.686	0.0000
LNY$^+$	0.678***	0.044	15.077	0.0000
LNY$^-$	-0.161*	0.071	-2.272	0.0573
LNHP$^+$	-0.181***	0.020	-9.013	0.0000
LNHP$^-$	0.013**	0.015	0.877	0.0409
LNPI$^+$	0.021***	0.003	5.370	0.0010
LNPI$^-$	-0.058***	0.007	-7.566	0.0001
C	0.582***	0.021	27.121	0.0000

Note: ***,** and * stands for the significance levels at 1%, 5% and 10 % , respectively

Source: Authors Computation

To confirm the estimation results of NARDL model, dynamic ordinary least squares model was utilized (see Table 6). The signs of coefficients are in line with our expectations and statistically significant at different significance level. In details, on average, one percent rise in entrepreneurial activities and renewable energy use are expected to decrease the environmental deterioration level by 0.108% and 0.21%, respectively. Meanwhile, economic performance and economic policy uncertainty in Turkey are expected to increase degradation level by 2.945% and 0.027%, respectively. Furthermore, the environmental Kuznets Curve (EKC) hypothesis is valid for Turkish economic activities and environmental sustainability relations. In other words, the inverted u shaped relationship was investigated among economic performance and environmental sustainability in Turkey. This means that an increase in economic performance will deteriorate the environment and decrease the environmental quality up to threshold level at the first phase, then, for every one percent increase in economic performance of Turkey will decrease the level of environmental degradation and will improve environmental quality by 0.515%, on average.

Table 6: DOLS Estimation output

Var	**Coeff**	**Std. Error**	**t-Stat**	**P-value**
LNENT	-0.108**	0.036	-2.969	0.0179
LNY	2.945***	2.087	4.763	0.0014
LNY^2	-0.515***	0.110	-4.657	0.0016
LNHP	-0.210**	0.075	-2.771	0.0242
LNPI	0.027**	0.011	2.447	0.0401
C	-4.202***	9.682	-4.875	0.0012
R-squares:0.979			Adjusted R-squared	0.926

Note: ***, **,* indicate 0.01, 0.05 and 0.10 significance levels, respectively.

Source: Authors Computation

The diagnostic test results are given and detailed in Table 7. The results confirm the absence of heteroscedasticity (*not all of the random variables have the same variance*) and serial correlation (*weakly stationary processes, and nonzero correlation between variables at different time points*). Also, Ramsey RESET test and Jarque-Berra test shows that our model is properly specified and the investigated variables are normally distributed.

Table 7: Diagnostic Test results

Tests	Statistics	P-value
BG-LM test	0.008	0.9924
BPG	1.615	0.1900
RESET	0.319	0.7517
ARCH	0.175	0.6786
Jarque Berra Test	2.321	0.3133

Source: Authors Computation

On the other hand, the CUSUM (Figure 1) and CUSUMsq (Figure 2) stability tests (Brown et al., 1975) were utilized to check the structural stability of the models. Since the statistic is within the 5% significance level for both tests, the coefficients in the estimated models are stable.

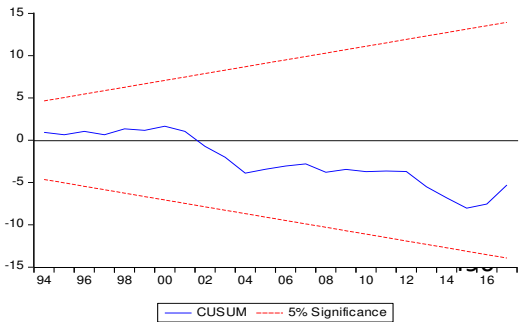

Figure 1: CUSUM Test Result

Source: Authors Computation

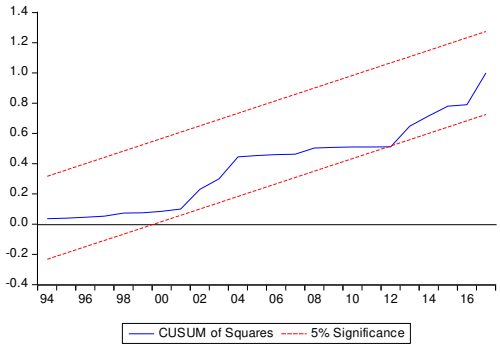

Figure 2: CUSUMsq Test Result

Source: Authors Computation

The dynamic multipliers graphs of entrepreneurial activities, economic performance, renewable energy use and economic policy uncertainty are given in Figure 3 below. The continuous black lines represents the positive shocks, while the black dashed line represents a negative shocks of investigated variables. The red dotted line designates the multipliers of explanatory variables

to environmental quality. The X-axis presents denotes the time period while vertical axis shows the range of positive and negative shocks. Figure 3 suggests the evidence of certain asymmetric adjustments of explanatory variables to the equilibrium due to decomposed positive and negative shocks in the long run. Moreover, the plots show that, the positive shocks of all explanatory variables the affects the long run adjustment more than negative shocks. In other words, the positive and negative shock lines shows the existence of the asymmetric adjustment of environmental quality to negative and positive shocks of explanatory variables at investigated time period.

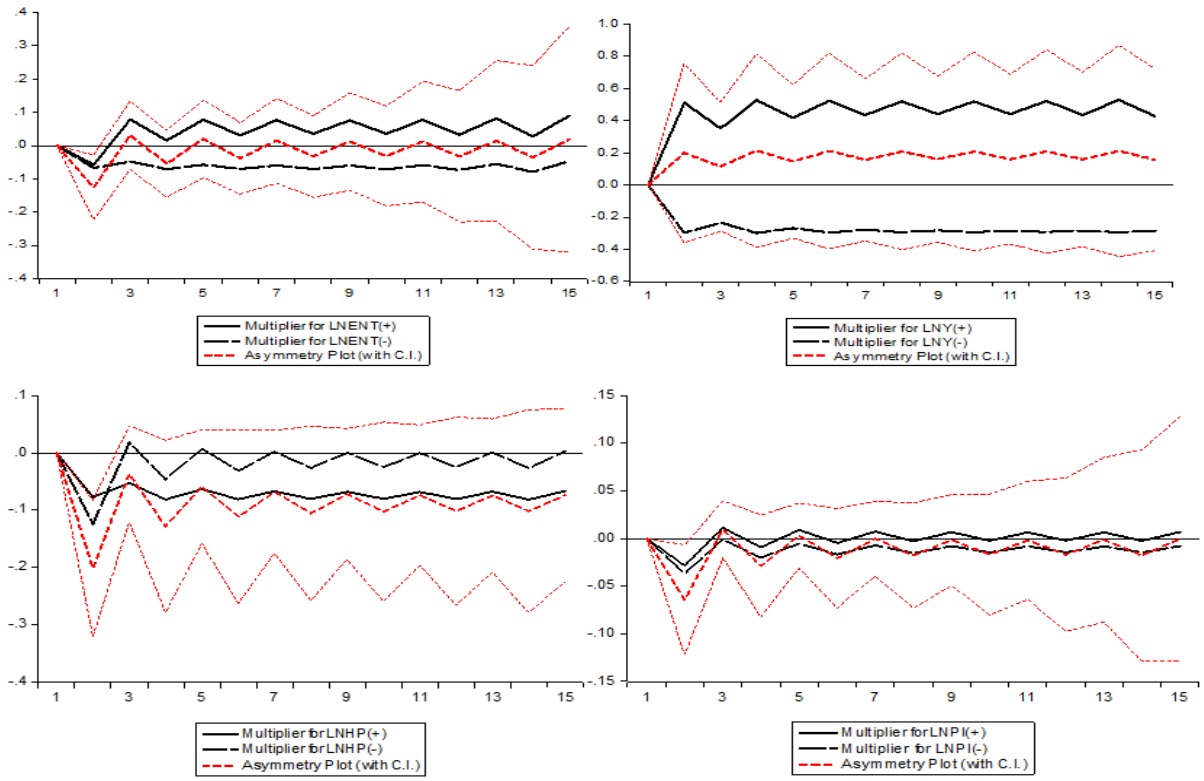

Figure 3: Dynamic multiplier graphs of ENT, Y,HP and PI

Source: Authors Computation

Lastly, the granger causality test was used to examine the causal relationship among variables. The results are depicted in Table 8. The results show feedback causal relationship of environmental quality with entrepreneurial activities and economic policy uncertainty. Moreover, another bidirectional causal relationship was found among economic performance and environmental quality. Besides, the unidirectional causal relationship was found that runs from renewable energy use to environmental quality. These prove that all explanatory variables used and stated in equation 1 are the determinants of environmental quality function. Besides,

the outcome also reveals unidirectional relationships running from renewable energy use to entrepreneurial activities and from economic policy uncertainty to entrepreneurial activities. Thus, this proves that renewable energy use and the economic policy uncertainty are the significant influencer of entrepreneurial activities in Turkey. Moreover, the bidirectional causal relationships of economic performance were explored with entrepreneurial activities and economic policy uncertainties.

In summary, due to the influence of both renewable energy and policy uncertainty on entrepreneurial activities as seen from granger causality test, the economic implication of entrepreneurial activities will tend towards positive economic performance. This suggests more jobs because of expansion of manufacturing activities due to the entrepreneurial activities, spill over effects of new skills and knowledge to small scale businesses and other firms. Hence, entrepreneurial activities are inducing sustainable economic performance together with environmental performance which points towards a sustainable development of the country.

Table 8: Granger Causality Test

Hypothesis	Test stat	p-value	Conclusion
LNENT ≠> LNEFP	2.278*	0.0967	bi-directional
LNEFP ≠> LNENT	5.829***	0.0028	
LNY ≠> LNEFP	6.233***	0.0014	bi-directional
LNEFP ≠> LNY	2.728*	0.0529	
LNHP ≠> LNEFP	4.863**	0.0508	uni-directional
LNEFP ≠> LNHP	1.195	0.3434	
LNPI ≠> LNEFP	5.700*	0.0608	bi-directional
LNEFP ≠> LNPI	2.019**	0.0134	
LNY ≠> LNENT	4.840**	0.0451	bi-directional
LNENT ≠> LNY	6.709**	0.0359	
LNHP ≠> LNENT	2.366*	0.0874	uni-directional
LNENT ≠> LNHP	1.119	0.3751	
LNPI ≠> LNENT	4.596***	0.0085	uni-directional
LNENT ≠> LNPI	1.515	0.2357	
LNHP ≠>LNY	1.123	0.3736	No granger causality
LNY ≠> LNHP	1.704	0.1884	
LNPI ≠> LNY	4.750*	0.0564	bi-directional
LNY ≠> LNPI	2.252*	0.0996	
LNPI ≠> LNHP	1.109	0.3797	No granger causality
LNHP ≠> LNPI	1.663	0.1977	

Note: ***,**,* stands for 0.01,0.05 and 0.10 significance level, respectively.

Source: Authors computation

5. Conclusion and Policy recommendation

This is a sustainability study of Turkish environmental cum economic development. Turkey is characterized with positive economic performance through its policies such as energy expansions, friendly business and commercial environment. Its energy expansion policies includes boosting and expanding its domestic fossil fuel energy source, specifically national coal energy source. Turkey is as well working towards achieving some level of renewable energy sector expansion. The basis of its renewable energy expansion is anchored on its abundance of hydropower resource, increasing its solar, wind and thermal energy sources. However, as the country is pushing towards energy expansion in furtherance of its economic development objective, the environment performance of Turkey is fallen below expectation due to impact of excessive fossil fuel energy utilization. The excessive utilization of energy source tends to expose the economy to increase level of greenhouse gas emissions. This is possible because of the industrial cum commercial oriented nature of Turkish economy which is framed with old and outdated technologies that rely on fossil fuels to power the economy. Considering the emphasis on inclusive sustainable development through United Nation's sustainable development goals (UN-SDGs), the present study seeks to investigate the ability of Turkey in achieving the inclusive sustainable development. For effectiveness of this study, we adopt the instruments (political instability proxy as economic policy uncertainties, entrepreneur activities, renewable energy and economic growth) which are unique in both Turkish economic and environment performance to expose the sustainability level of the country, and to identify the best practice of mitigating carbon dioxide emission with the selected instruments. A good combination of both symmetric and asymmetric analyses was adopted for clear and direct exposition of our study. Granger causality is also among the test and analysis adopted in our study for a robust check. From both approaches, entrepreneur activities and renewable energy policy are observed the best practice of mitigating ecological footprint at the level of 0.108% and 0.21%, respectively, thereby impacting favourable to the environmental performance of Turkey, while the economic policy uncertainties has no mitigating force against the ecological footprint. The impact of economic growth on the environment comes in stages through inverted EKC hypothesis. As remarked, impact of entrepreneur activities shows that the players in the industrial cum commercial sector of the economy where majority of entrepreneurial activities take place are adopting innovative and alternative source of energy which could be the possible reason for decreasing ecological footprint in the Turkish economic activities through entrepreneur. Also, findings from granger causality attest to the findings from both symmetric and asymmetric by establishing a two-way granger causality between entrepreneur and ecological foot print which points towards the ability of entrepreneur in curtailing the

environmental damage caused by expansion of ecological footprint. Renewable energy is found mitigating environmental damage through a one-way granger causality from renewable to ecological footprint. Also, a two-way transmission is established between economic policy uncertainties and ecological footprint which shows that the policy uncertainties has a great influence in impacting ecological footprint (positively as exposed from symmetric and asymmetric results).

Findings from our study points towards importance of the selected instruments (entrepreneur, renewable energy, economic growth and policy uncertainty) in determining the inclusive level of Turkish sustainable goals and policies are expected to be framed and executed around them. Turkey had already adopted policies (such as increasing of the country's renewable energy sector with the target of sources like wind and geothermal power, submission of its Nationally Determined Contribution (NDC) with boosting of its solar capacity to 10 GW and 16 GW by 2030) towards achieving its sustainable development goals before this present study. However, in complimentary to the existing policies, Turkish authorities can as well pursue people or public oriented policies such as massive sensitization and awareness on the importance of green and clean environment. This will expose the people into the knowledge of the effect of their actions towards the environmental development of the country. Subsidizing the activities of the investors into the renewable energy sector will help in achieving the policy of alternative energy expansion and reduce the over dependence on fossil fuel. The authorities can revisit the policy of expanding the domestic fossil fuels in a bid to discourage the excessive utilization of the sources. Technological innovation policy through research and development will help the country's climate ambition by replacing the carbon intensive technologies that are framed after fossil fuels sources, hence, it is proven that technological innovation contributes in mitigating pollution and enhance environmental quality at 0.108% for the case entrepreneurial activities.

Conclusively, our study exposes the implications of the selected instruments in determining Turkish environmental performance towards its sustainable goals. Our study and its findings has not close the research into this same topic, hence, this topic is still open for future research especially with other related variables (such as urbanization and energy implication) unique to Turkey.

Declarations

Ethics approval and consent to participate

We, the authors are giving our ethical approval and consent for this paper to be published in your Journal if found publishable

Consent to participate

We, the authors are giving our consent for participation in this paper to be published in your Journal if found publishable

Consent for publication

We, the authors are giving our consent for this paper to be published in your Journal if found publishable

Availability of data and materials

Data sources are outlined above in the table 1 and will be made available on demand

Competing interests

We, the authors hereby declare that there are no competing or conflicting interests on the paper

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The paper is written by the three authors named in the Title page. Hence, **Lucy** wrote the intro-literature while **Firat** wrote the methodology, and **Edmund** wrote discussion and conclusion with abstract.

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