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The Dynamic Implications of Globalization and Renewable Energy in Turkey: Are They Vital for Environmental Sustainability? An SVAR Analysis

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Abstract: This study aims to analyze the dynamic effect of renewable energy use and globalization on the environmental quality in Turkey by utilizing quarterly time series data spanning the period 1990- 2017. After identifying the series order of stationary by utilizing ADF test, this study makes use of SVAR model. The reason is that SVAR is powerful method in testing contemporaneous and past shock among the variables. In addition, SVAR is the powerful in variance decomposition and the possibility of observing long run forecast. The results disclose that environmental quality reacts negatively to the shocks in hydro energy and economic growth, while the globalization seems positively impact the degradation of the environment. These outcomes are consistent with relevant theories and empirical findings. The only striking result is the positive impact of bio-fuels and waste energy on the environment. Although Turkey has recently implemented a range of energy policies to promote renewable but some challenges still there, future policymaking should enhance the development in renewable and create more competitive environment for investment in the renewable market.

Keywords: Turkey, SVAR, Globalization, Renewable Energy, and Ecological Footprint

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Introduction

Today the climate changes and deterioration of the environments are the most notable menace pervades the planet, the unprecedented level of carbon emissions cause a direct threat to humans and other species. Many researchers and practitioners claim that the nations in their endeavor towards economic growth consuming a high percentage of nonrenewable energy, such as oil and natural gas. Therefore, human beings are presently confronted by two major challenges; accomplishing growth and preserving the environment (Ulucak and Ozcan, 2020; Adebayo and Kirikkaleli, 2021; Uddin et al., 2017).

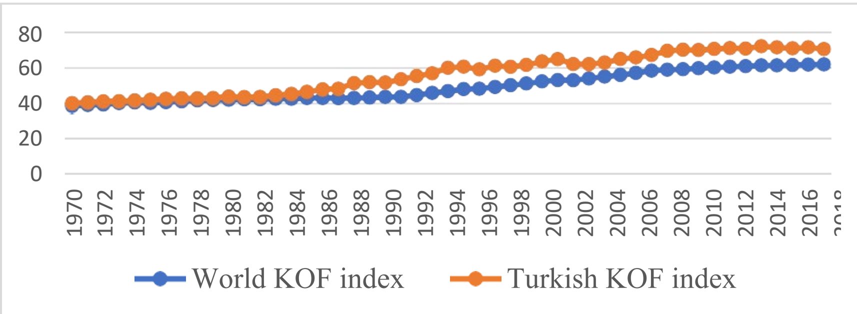
As the consequences of environmental degradation became more sever, nations have started to seek for alternative energy sources. In this regard, the renewable clean energy such as hydroelectricity, bio-fuels, wind, geothermal and solar energy have become a subject of study in the literature of energy economics. *But do renewable helpful in mitigating pollution and preserving the environment? A huge number of researches* have been conducted in this vein; however, the results are mixed and inconclusive.

In addition, most of these studies have relied on aggregated dataset of renewable energy, see for instance, Zafar et al., (2021), Umar et al., (2021), Shahbaz et al., (2019), Wang, (2019), Solarin et al., (2018), Bilgili et al., (2016), Sarkodie et al. (2020a), Ahmed et al., (2016), Adewuyi and Awodumi (2017), Gao and Zhang (2021) andSulaiman and Abdul-Rahim (2020). The aggregated data, however, does not clearly identify their respective distinct impact on the environment. In addition, most of these studies have relied on carbon dioxide emissions (CO_2) to measure the environmental damage. *Does CO_2 an adequate measure to environmental quality?*

Solarin and Bello, (2018) argued that CO_2 relates only to air pollution and excludes other pollutants impacting on soil, forests, and other environmental aspects. Therefore, the use of carbon dioxide as an indicator for environmental quality seems to be inadequate measure. They further mentioned that ecological footprint is comprehensive and widely used as an index of sustainability. It consists of six components of surface productive areas: carbon footprint, fishing ground, build-up, forest land, cropland, and grazing land. A part of the discussion on the causes of environmental degradation, the term of globalization has been introduced by many studies as a contributor to environmental deterioration directly or indirectly (Khan et al., 2019a). Although a huge number of research have been conducted in this subject, however, the researchers did not agree on specific index of globalization.

For instance, Ah-Atil et al., (2019) and Zaidi et al., (2019) used Dreher (2006) overall globalization index to examine how globalization impact the CO_2 emissions in China and Asia pacific, respectively. Adebayo and Kirikkaleli, (2021), Liu et al., (2020), Kalayci, (2019) employed the KOF Index globalization to figure out the dynamic effect of globalization on quality of environment in Japan, G7 countries and NAFTA countries respectively. But notably, KOF index is mostly used in the literature. The KOF index is firstly introduced by Dreher (2006) and updated in Dreher et al., (2008). It measures the globalization through 43 variables, the old version measures the globalization based on 23 variables. The KOF index takes into consideration economic, social, and political aspects for every country.

Figure 1. Comparison of the Turkish Globalization Index
to Average of the World Index.



Source: KOF Swiss Economic Institute: http://www.kof.ethz.ch/globalisation/

Like most of the other emerging economies, Turkey is experiencing a tremendous increase in globalization index since many decades. This can be obviously seen in figure 1. The KOF globalization index reveals a constant increase in globalization from 1980 up to 2001 which shows a slight decline in globalization Yurtkuran, (2021).

Turkey mainly depends on nonrenewable energy sources, the oil energy and coal and natural gas represents 29%, 29% and 25% from its total energy consumed in 2019, respectively. With the increasing non-renewable, the pollution is also increasing. Based on the reports released by the International Energy Agency, Turkey is among the 20 countries that emit the most carbon dioxide in the world in 2020 and ranks 15th in total CO_2 emissions. *Is this pattern of energy combination being the main reason behind the environmental degradation in Turkey?* Recently, Turkey has developed several plans to overcome the deterioration in the environment. In its 11^{th} national development plan, the priority is given the control of emissions of Greenhouse gases through increasing the capacity of renewable energy like wind, biomass, and sun energy. Furthermore, Turkey also aiming at deploying the technical hydro potentials in the power sector. *Is this renewable energy plan will be effective in mitigating the environmental deterioration?*

To addressing all these questions, this study will empirically investigate the dynamic effect globalization and reusable energy on the quality of environment in Turkey, utilizing disaggregated quarterly data of reusable energy mainly hydro energy, bio-fuel and waste, wind and solar etc and KOF globalization index, spanning period 1990-2017.

The rest of the research is organized in the following manner: part two reviews important literature on the subject. Part three presents the research methodology. Part four shows the results and discussion while the last section provides the conclusion.

Literature Evaluation

Although the interconnection between renewable and globalization is widely investigated in the literature of energy and environmental economic, however, most of these studies have relied on traditional methodologies such as OLS, DOLS, FMOLS, ARDL, Nonlinear ARDL, VAR, VECM and GMM. Most of these studies have been much critised especially VAR approach (Choleski decomposition) which has been much used as the powerful method to analyse the dynamic interaction of shocks within the function of impulse-response. However, when the traditional or unrestricted VAR is utilized, the researchers don't depend on any identification restrictions. This basically due to the assumption that all the variables in VAR system are jointly endogenous and must be treated symmetrically.

In this context, (Enders, 2015) outlined that this assumption makes the traditional VAR model almost mechanic since it lacks any direct economic interpretation by the time there is a possibility to rely on the relevant economic theories to impose restrictions on the impulse. However, instead of utilizing the unrestricted VAR model this study applies structural vector autoregression (SVAR) approach to use the relevant economic theories and empirical evidence to impose identifying restrictions.

After reviewing over thirty studies in the literature, we can affirm that no study applied SVAR model to investigate the possible effect of globalization and renewable energy on the quality of environment in Turkey. Additionally, most of the previous research have used the CO_2 as an indicator to the quality of the environment and considered aggregated data-set; however, this study will rely on ecological footprint and disaggregated quarterly data. The disaggregated data may lead to more comprehensive and effective outcomes.

Table 1. Summary of the Related Studies

Author(s)	Variables	Nation(s)	Method	Outcomes
Zafar et al. (2021(	Biomass energy and CO_2	Asia-Pacific	Panel quantile	Biomass reduces CO_2
Umar et al. (2021)	Biomass energy and CO_2	United States	FMOLS, DOLS, CCR	Biomass impact CO_2 negatively
Gao and Zhang (2021)	Biomass energy and CO_2	13 Asian Developing Countries	Panel FMOLS	Positive link between biomass energy CO_2
Rahman and Alam (2021)	Clean energy and carbon emissions	Bangladesh	ARDL	Clean energy improves the environmental quality
Jun et al. (2021)	Non-renewable and CO_2	South Asian	FMOLS	Non-renewable energy increases CO_2
Syed et al. (2021)	Nuclear energy and CO2	India	Asymmetric ARDL	Nuclear energy in long run reduces CO_2

Pata (2021)	Renewable and non-renewable energy, CO_2	USA	VECM	Renewable reduces CO2, while non-renewable increase CO_2
Obobisa et al. (2021)	Coal and natural and renewable	China	DOLS and ARDL	Renewable energy reduces CO_2
Magazzino et al. (2021)	Biomass	Germany	Quantum model	Biomass energy reducingCO_2
Adebayo and Kirikkaleli (2021)	Total renewable energy usage	Japan	Wavelet analyses	Renewable energy usage mitigates CO_2
Ibrahim and Ajide (2021)	Total renewable and non-renewable energy usage	G-7 Countries	PMG	Renewable energy mitigates pollution and non-renewable increase CO_2
Adebayo and Kirikkaleli (2021)	KOF Index	Japan	Wavelet analyses	Globalization increases CO_2 emissions
Pata (2021)	KOF Index	BRIC	Fourier ADL cointegration	Globalization increases CO_2
Aslam et al. (2021)	KOF Index, CO_2	Malaysian	ARDL, VECM	Globalization' index surges CO_2
Yurtkuran (2021)	KOF Index, CO_2	Turkey	Bootstrap ARDL	Globalization increase environmental pollution
Sulaiman and Abdul-Rahim (2020)	Biomass energy and CO_2	8 Selected African countries	PM Gand DFE panel	Biomass energy use decreases CO_2
Liu et al. (2020)	KOF Index, CO_2	G-7 Countries	Semi-parametric panel FE model	Globalization increases CO2 firstly then decreases it
Destekand-Aslan (2020)	Hydroelectricity, wind, solar and biomass)	G-7 Countries	Panel bootstrap causality	Renewable reduce CO_2 emissions

Padhan et al. (2020)	Total renewable energy consumption	OECD	Panel quantile regression	Positive effect CO_2 on renewable energy use
Sarkodie et al. (2020a)	Total renewable energy usage	Selected 47 SSA Countries	DHE technique	Renewable energy decreases GHG
Hassan et al. (2020)	Nuclear energy, CO_2	BRICS	CUP-FM, CUP-BC	Nuclear energy decreases carbon emissions
Ulucak and Ozcan (2020)	Total energy, CO_2	OECD	AMG	Renewable reduces deterioration of the environment.
Nguyen and Le (2020)	KOF Index, CO_2	Vietnam	ARDL	Globalization increases CO_2
Ah-Atil et al. (2019)	Overall globalization index. Dreher (2006), CO_2	China	NARDL	Globalization does not impact CO2 emissions
Shahbaz et al. (2019)	Overall globalization index. Dreher (2006), CO_2	Selected 87 Countries	CCA	Globalization decreases CO_2 in 16 countries
Zaidi et al. (2019)	Overall globalization index. Dreher (2006), CO_2	Asia Pacific	Wester-Lund cointegration technique	Globalization significantly reduce carbon emissions
Khan et al. (2019a)	KOF Index, CO_2	Pakistan	Dynamic ARDL	Globalization has positive effect on CO_2
Kalayci (2019)	KOF Index, CO_2	NAFTA Countries	Panel-data analysis	Positive link between economic globalization and CO_2
Khan et al. (2019b)	Total renewable energy production, CO_2	7 Association of Southeast Asian Nations	FMOLS, DOLS	Renewable energy production has a significant long-term effect on CO_2
Shahbaz et al. (2019)	Biomass energy and CO_2	G-7 Countries	GMM	Biomass increases CO_2

Wang (2019)	Biomass energy and CO_2	BRICS	GMM	Biomass behaves as a clean energy in reducing CO_2
Solarin et al. (2018)	Biomass energy and CO_2	80 Developed, developing	GMM	Biomass increases CO_2
Haseeb et al. (2018)	KOF Index, CO_2	BRICS	DSUR, FMOLS	Globalization has negative but insignificant impact to CO_2
Van and Bao (2018)	KOF Index, CO_2	Vietnam	ARDL	Globalization negatively influences CO_2
You and Lv (2018)	KOF Index, CO_2	Selected 83 countries	Spatial panel method	Environmental quality is affected positively by globalization
Adewuyi and Awodumi (2017)	Biomass energy and CO_2	Countries of West Africa	Simultaneous equation model	Biomass energy and CO_2interact positively
Ahmed et al. (2016)	Biomass energy and CO_2	Selected EU countries	Dynamic heterogeneous panel	Biomass energy is insignificantly linked to CO_2
Bilgili et al. (2016)	Renewable and waste energy	17 OECD Countries	Panel FMOLS and panel DOLS	Negative causality from renewable to CO_2
Shafiei and Salim (2014)	Total energy and CO_2	OECD	STIRPAT model	Non-renewable increase CO_2, whereas renewable decrease CO_2

Conceptual Framework

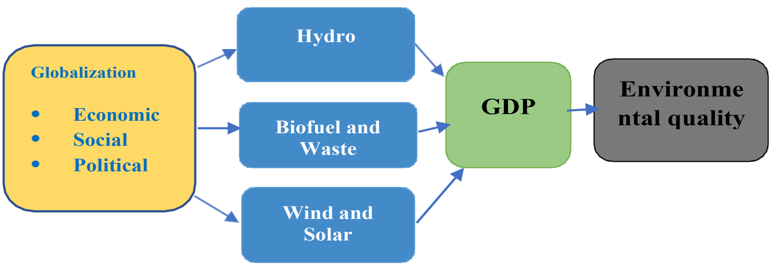
To have a better understanding to our model and its estimation, this study initially developed a framework. This study makes used of the following significant variables: hydro, wind and solar energy, bio-fuel, and waste energy, real per capita income, ecological footprint, and globalization. Our research asserts that globalization has the crossways with environmental quality.

The globalization integrates the world economies through trade and foreign direct investment, and as every country is trying to reach the highest level of growth through investment in different activities, foreign trade, and industrialization through the expansion of energy usage adversely affect the environment (Khan et al., 2019a).

In the same vein, these production activities increase economic growth which will directly cause the environmental deterioration (Boamah et al., 2017). Although the effect of renewable on the environment through industrialization has been extensively investigated in the literature but there is no consensus among the researchers. However, there is a general plausibility that the reusables are helpful in cleaning the environment (Sarkodie et al., 2020b, Shafiei and Salim, 2014, Ulucak and Ozcan, 2020, Ibrahim and Ajide, 2021, Magazzino et al., 2021, Karasoy and Akçay,2019).

Therefore, our research conceptualized that the consumption of renewable in production process, on one hand directly increases the growth of economy, and on the other hand mitigates damage in the environmental. This conceptual model is exhibited in figure 2.

Figure 2. Conceptual Framework of the Research



Source: Graphed by the authors

Research Methodology and Data

To scrutinize the dynamic impact of the renewable and globalization on environmental quality in Turkey, the current research utilizes data spanning 1990Q1-2017Q4 and SVAR approach. To solve the problem of sample size, we transformed the yearly data to quarterly data by following the technique of the E-Views program. The data transformation has been much used in the literature since it effectively reduces adjustment by point-to-point and the discrepancies in seasonality.

Table 2. Definition of the Variables

Vars.	Definition	Measurement	Source
EFP	Ecological Footprint	Global Hectares	Global Footprint Networks
GLB	Globalization	KOF Globalization Index	KOF Swiss Economic Institute
GDP	Economic Growth	Per Capita Real Income	World Development Bank
HDR	Hydro Energy	Thousands kg of Oil Equivalents (ktoe)	International Energy Agency
WIS	Wind and Solar Energy	Thousands kg of Oil Equivalent (ktoe)	International Energy Agency
BIW	Bio-fuel and Waste Energy	Thousands kg of Oil Equivalent (ktoe)	International Energy Agency

Denote X an n × 1vector of the series of interest, we can specify our SVAR approach as follows:

$$AX_t = C + A_tX_{t-1} + \cdots + A_pX_{t-p} + Be_t \qquad (1)$$

Where C is an n × 1 vector of constant parameter, A is an n × n matrix showing the contemporaneous correlations of the underlying variables, A_i for i = 1 …, p is an n × n matrix of parameters; p is the order of the vector auto-regression model; and e is an n × 1 vector of structural shocks where $E(e)\sim(0,I_n)$. If we initially multiplying equation (1) with A^{-1} and eliminating the constant parameter, we can obtain the reduced-form VAR of equation (1) as follows:

$$X_t = \Gamma_1X_{t-1} + \cdots + \Gamma_pX_{t-p} + u_t \qquad (2)$$

Where $\Gamma_i = A^{-1}A_i$ and is the reduced-form error parameters. Following equation (1) and (2) the link between the structural and reduced-from error terms or shocks can written as follows:

$$u_t = A^{-1}Be_t \quad or \quad Au_t = Be_t \tag{3}$$

Equation (3) is termed as the AB model. When testing the dynamic effect of structural shocks on the variables in X, we firstly estimate the reduced-from in equation (2) since the structural vector auto-regression SVAR as appears in equation (1) cannot be estimated directly due to existence of contemporaneous correlations between the structural error terms and values of the variables. The identification of structural shocks from reduced-from innovation is constructed by imposing identifying restrictions on matrix A and B since the reduced-form error terms are composites of structural shocks (Ibrahim and Sufian, 2014).

Generally, most of the studies that have utilized SVAR approach have adopted the traditional strategy of Sims' (1980) recursive approach which have the foundation of Cholesky decomposition. However, this approach has a huge limitation in that it requires ordering specification of the variables as a prerequisite, and the outcomes may be sensitive to the way the variables are ordered. Therefore, in this study we follow an alternative approach by applying pertinent economic theories and empirical evidence to impose identifying restrictions on our matrices. As can be clearly seen in table 2, our main vector auto-regression system consists of six variables (seeequation 4).

$$lnEFP_t = \alpha_0 + \alpha_1 lnHDR_t + \alpha_2 lnWIS_t + \alpha_3 lnBIW_t + LnGLB + LnGDP + e_t \tag{4}$$

Table 2 presents type and the definition of each variable, their sources, and measures. All the series are transformed to the natural logarithm to avoid the extreme values of the underlying variables. Based on equation (3), to identify the structural shocks the following restrictions on A and B matrices are imposed:

$$\begin{bmatrix} 1 & -\alpha_{12} & -\alpha_{13} & -\alpha_{14} & \alpha_{15} & -\alpha_{16} \\ 0 & 1 & \alpha_{23} & \alpha_{24} & \alpha_{25} & \alpha_{26} \\ 0 & 0 & 1 & \alpha_{34} & \alpha_{35} & \alpha_{36} \\ 0 & 0 & 0 & 1 & \alpha_{45} & \alpha_{46} \\ 0 & 0 & 0 & 0 & 1 & \alpha_{56} \\ 0 & 0 & 0 & 0 & 0 & 1 \end{bmatrix} \begin{bmatrix} u_t^{LnEFP} \\ u_t^{LnHDR} \\ u_t^{LnWIS} \\ u_t^{LnBIW} \\ u_t^{LnGLB} \\ u_t^{LnGDP} \end{bmatrix} =$$

$$\begin{bmatrix} \beta_{11} & 0 & 0 & 0 & 0 & 0 \\ 0 & \beta_{22} & 0 & 0 & 0 & 0 \\ 0 & 0 & \beta_{33} & 0 & 0 & 0 \\ 0 & 0 & 0 & \beta_{44} & 0 & 0 \\ 0 & 0 & 0 & 0 & \beta_{55} & 0 \\ 0 & 0 & 0 & 0 & 0 & \beta_{66} \end{bmatrix} \begin{bmatrix} e_t^{LnEFP} \\ e_t^{LnHDR} \\ e_t^{LnWIS} \\ e_t^{LnBIW} \\ e_t^{LnGLB} \\ e_t^{LnGDP} \end{bmatrix} \quad (5)$$

The first row which will be the focus of the subsequent analysis, is drawn from the recent studies by Destek and Aslan, (2020), Liu et al., (2020), Sarkodie et al., (2020), Yurtkuran, (2021), Shahbaz et al., (2018), Khan et al., (2019). These studies have reached to the outcomes that the reusable's energy sources are helpful in cleaning the environment. The first raw suggests that ecological footprint reacts contemporaneously to renewable (hydro energy, wind / solar energy, bio-fuels / waste energy), globalization, and economic growth. Therefore, the first row expects that ecological footprint responds negatively to renewable and positively to globalization. Based on the EKC argument, the ecological footprint is expected to respond negatively to growth (GDP). The EKC theory postulates that at the earliest stage of the economic growth environment deteriorates due to air pollution, deforestation, and many other pollutants, with an increase in per capita income economy starts to develop and environmental deterioration declines (Shahbaz et al., 2018). In row 2, 3 and 4, the renewable are also assumed to react contemporaneously to other series in the VAR system and expected to react positively to globalization and GDP (Boamah et al., 2017). Their specifications are in line with the general plausibility that countries are trying to reach the highest level of economic development through investment, foreign trade, and industrialization through the expansion of energy usage (Khan et al., 2019).

Rows 5 and 6 describe the reaction of the globalization and economic growth to the contemporaneous shocks in other variables in the system. These specifications are also based on the belief that energy consumption is vital to any trade or investment activities and production process. Though, they are expected to react positively to renewable and negatively to environmental quality (Ulucak and Ozcan, 2020, Ibrahim and Ajide, 2021, Magazzino et al., 2021, Karasoy and Akçay, 2019). But since we are not aiming at estimating the dynamic impact of renewable on the globalization or economic growth, we assume that the globalization and economic growth respond to the other variables with the lag and the mostly regards the first row of equation (5). Considering the identification in equation (5) the impulse-response analysis can be considered as ground of inferences. It exposes the dynamic response of each endogenous variable in the VAR system to a shock in other variables. This dynamic process enables us to see the impact of a unit shock on one variable on present and future values of itself and the other variables. Meanwhile, the variance decompositions fractionate the forecast error variance of the underlying variable to variations of itself and other variables in the system.

Results and Discussion

In this part of the, the discussion to the empirical findings is presented: Firstly, the investigation of descriptive statistics that measures the dispersion and central tendency is evaluated. Table 3 indicates that economic growth mirrors the highest average, followed by bio-fuels and waste energy, hydro energy, wind and solar energy, globalization and ecological footprint. All series show negative Skewness except hydro, wind and solar energy and economic growth. The normal distribution that evaluated by Kurtosis indicator confirms that all underlying series demonstrate normal distribution.

Table 3. Descriptive Statistic Test

	LNEFP	LNHDR	LNWIS	LNBIW	LNGLB	LNGDP
Mean	0.475847	8.120867	7.307118	8.578285	4.160753	9.145360
Median	0.438488	8.127820	7.133488	8.623532	4.156727	9.076420
Maximum	0.786492	8.662332	9.227197	8.883363	4.278666	9.614143
Minimum	0.182544	7.575585	6.133398	8.016978	3.942117	8.811155
S. deviation	0.179683	0.281993	0.856982	0.285485	0.090921	0.239319
Skewness	-0.034241	0.087793	0.628615	-0.556751	-0.465584	0.368748
Kurtosis	1.704319	2.422870	2.401648	1.945090	2.348173	1.873360
Jarque-Bera	7.645795	1.652757	8.804715	10.68528	5.867621	8.235034
Probability	0.021864	0.437631	0.012248	0.004783	0.053194	0.016285
Sum	51.86728	885.1744	796.4759	935.0331	453.5221	996.8442
Sum Sq. D.	3.486899	8.588157	79.31710	8.802193	0.892805	6.185563
Observations	109	109	109	109	109	109

The Augmented Dickey-Fuller test was utilized to test the stationary of our series. As can be observed the series are evaluated in their level as well as first-difference. The findings of ADF test in table 4 show that the all the variables are integrated at I(I).

Table 4. Stationary Tests

Variables	I(0)	I(I)	Summary
LNEFP	-0.311528	-3.059129**	I(I)
LNHDR	-2.098334	-3.315539**	I(I)
LNWIS	1.615939	-2.356988***	I(I)
LNBIW	1.450639	-3.273118***	I(I)
LNGLB	-1.992462	-3.723602*	I(I)
LNGDP	0.263951	-3.063538*	I(I)

1% 5% 10% level of significance are illustrated by *, ** and *** correspondingly

After presenting the stationary properties, the study moves to explore the cointegration relationship among the underlying variables. The concept of cointegration was firstly introduced by Engle and Granger (1987) to investigate the relationship between a set of variables within a dynamic framework in long-term.

Nkoro and Uko, (2016) claims that cointegration shows the existence of a long-run equilibrium among underlying economic time series that converges over time and provides a stronger statistical and economic foundation for empirical error correction model. Therefore, the cointegration test cannot be overlooked to confirm the long run meaningfulness of the model. If no meaningful relationship is found, then the model is spurious and will give misleading outcomes.

Table 5 portrays the cointegration test outcomes. The study makes used of Johansen cointegration method. It shows that the existence of the long-run relationship among our study series since the Trace and the Max-Eigen Statistic values are less that Critical Value (0.05).

After the identification of the possible existence of cointegration relationship by following the Johansen cointegration approach, the analysis then proceeds to estimate the structural vector auto-regression model (SVAR). Table 6 portrays the findings of SVAR model. We have estimated the reduced-form VAR with the lag order based on SC information criteria.

Based on estimated VAR equation (3) we imposed the restriction as seen in equation (5) to identify the structural shocks. These parameters' estimates are presented in table 7. It should be noted that as the estimated coefficients of matrix A are expressed on the same side of equation, the negative sign should be interpreted adversely.

Table 5. Cointegration Test

Trace				
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None *	0.335422	134.4504	103.8473	0.0001
At most 1 *	0.255370	91.13847	76.97277	0.0028
At most 2 *	0.181420	59.88254	54.07904	0.0139
At most 3 *	0.170893	38.66300	35.19275	0.0203
At most 4	0.122201	18.79792	20.26184	0.0785
At most 5	0.045914	4.982114	9.164546	0.2854
Trace demonstrates 4 coint. mode				
The sign * indicate rejection at the 0.05 level of significance				
Maximum Eigen Value				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigen Value	Statistic	Critical Value	Prob.**
None *	0.335422	43.31190	40.95680	0.0267
At most 1	0.255370	31.25593	34.80587	0.1250
At most 2	0.181420	21.21955	28.58808	0.3246
At most 3	0.170893	19.86508	22.29962	0.1056
At most 4	0.122201	13.81581	15.89210	0.1031
At most 5	0.045914	4.982114	9.164546	0.2854
Max-Eigen Value shows 1 coin.				
The sign * indicate rejection at the 0.05 level of significance				

Since majority of estimated parameters demonstrate limited significance so that we can consider the structural impulse response analysis as the basis for inferences. But interestingly, some notable outcomes can be observed. Some signs of the contemporaneous coefficients are in line with our expectation and theories' predictions and consistent with our restriction specifications. For instance, the coefficient of hydro energy shocks in environmental quality equation is negative as expected, based on many empirical evidence the renewable energy use is expected to contribute positively in cleaning the environmental, this result is in line with (Destekand Aslan, 2020; Karasoy and Akçay, 2019; Sarkodie et al., 2020). Unsurprisingly, the contemporaneous economic growth shocks in pollution are positive, this result supports the evidence against EKC hypothesis which postulates that in long run the economic growth is expected to improve environmental pollution. This outcome agrees with many empirical results such as Alnour et al., 2021; Al-Mulali et al., 2015; Lacheheb et al., 2015; Sirag et al.,2018).

However, the puzzling outcome from the estimated matrix is the positive coefficients of solar, wind, bio-fuels and waste energy shocks and the negative sign of globalization shocks in environmental pollution although they are in line with some empirical evidence. But the plausibility is that renewable are expected to impact negatively on environmental pollution meaning that it might be effective in mitigating the deterioration in the environment. In addition, the globalization is expected to increase the degradation in the environment, see for instance (Magazzino et al., 2021, Karasoy and Akçay, 2019).

Table 6. Structural VAR Estimates

Model: Ae = Bu where E[uu']=I					
A =					
1	C(1)	C(2)	C(4)	C(7)	C(11)
0	1	C(3)	C(5)	C(8)	C(12)
0	0	1	C(6)	C(9)	C(13)
0	0	0	1	C(10)	C(14)
0	0	0	0	1	C(15)
0	0	0	0	0	1
B =					

C(16)	0	0	0	0	0
0	C(17)	0	0	0	0
0	0	C(18)	0	0	0
0	0	0	C(19)	0	0
0	0	0	0	C(20)	0
0	0	0	0	0	C(21)
	Coefficient	Std. Error	z-Statistic	Prob.	
C(1)	0.443334	1.033704	0.428879	0.6680	
C(2)	-4.937977	3.211054	-1.537806	0.1241	
C(3)	-0.430104	0.297410	-1.446164	0.1481	
C(4)	-0.265261	3.370402	-0.078703	0.9373	
C(5)	-1.108980	0.296413	-3.741333	0.0002	
C(6)	0.115124	0.095704	1.202916	0.2290	
C(7)	19.22908	4.964883	3.873017	0.0001	
C(8)	2.505146	0.396163	6.323530	0.0000	
C(9)	0.059668	0.128644	0.463825	0.6428	
C(10)	0.359192	0.125221	2.868461	0.0041	
C(11)	-50.49438	4.734524	-10.66514	0.0000	
C(12)	-2.305265	0.382608	-6.025143	0.0000	
C(13)	0.491643	0.114927	4.277882	0.0000	
C(14)	0.179071	0.114793	1.559955	0.1188	
C(15)	0.130493	0.087720	1.487605	0.1369	
C(16)	0.030487	0.002084	14.62874	0.0000	
C(17)	0.002851	0.000195	14.62874	0.0000	
C(18)	0.000927	6.34E-05	14.62874	0.0000	
C(19)	0.000936	6.40E-05	14.62874	0.0000	
C(20)	0.000723	4.94E-05	14.62874	0.0000	
C(21)	0.000797	5.44E-05	14.62874	0.0000	
L. likelihood	3120.351				
Estimated A matrix:					
1.000000	0.443334	-4.937977	-0.265261	19.22908	-50.49438
0.000000	1.000000	-0.430104	-1.108980	2.505146	-2.305265
0.000000	0.000000	1.000000	0.115124	0.059668	0.491643
0.000000	0.000000	0.000000	1.000000	0.359192	0.179071
0.000000	0.000000	0.000000	0.000000	1.000000	0.130493
0.000000	0.000000	0.000000	0.000000	0.000000	1.000000
Estimated B matrix:					
0.030487	0.000000	0.000000	0.000000	0.000000	0.000000
0.000000	0.002851	0.000000	0.000000	0.000000	0.000000
0.000000	0.000000	0.000927	0.000000	0.000000	0.000000
0.000000	0.000000	0.000000	0.000936	0.000000	0.000000

0.000000	0.000000	0.000000	0.000000	0.000723	0.000000
0.000000	0.000000	0.000000	0.000000	0.000000	0.000797
Estimated S matrix:					
0.030487	-0.001264	0.004400	-0.000724	-0.013099	0.039540
0.000000	0.002851	0.000399	0.000992	-0.002104	0.001819
0.000000	0.000000	0.000927	-0.000108	-1.32E-05	-0.000373
0.000000	0.000000	0.000000	0.000936	-0.000260	-0.000105
0.000000	0.000000	0.000000	0.000000	0.000723	-0.000104
0.000000	0.000000	0.000000	0.000000	0.000000	0.000797
Estimated F matrix:					
0.412599	0.295493	-0.737790	0.320858	-0.204429	0.213847
0.013423	0.038921	-0.037776	0.014676	-0.033276	-0.007988
0.099310	0.053902	-0.311874	0.162660	-0.234857	-0.176986
-0.027927	-0.013021	0.102954	-0.038979	0.074190	0.056446
0.020305	0.014434	-0.037743	0.016571	0.000365	0.004709
0.018325	0.013731	-0.072811	0.031532	-0.048002	-0.025068

Figure 3 presents the structural impulse response analysis. Directly focusing on ecological footprint (environmental quality) equation, which is the constitutes the main aim of current study. It can be observed that ecological footprint responds negatively to the structural innovation in hydro energy and negatively also to the shocks in wind and solar energy but up to period four then started to respond positively, the first result should be expected.

Meanwhile the structural shocks in the bio-fuels and waste do not seem to influence environment quality. Importantly, our results reaffirm the findings of some studies in literature that ecological footprint reacts positively to the structural shocks in globalization and negatively to economic growth. These results are as expected based on the relevant theories and empirical findings as well, see (Ulucak and Ozcan, 2020, Ibrahim and Ajide,2021).

Table 7 exhibits the variance decomposition; it assesses the relative contribution of the underlying series to the fluctuation in ecological footprint. This is done by variance decomposition. The generated variance decomposition namely after its own shocks, the economic growth is the most dominant factor, followed by wind and solar energy, globalization and finally bio-fuels and waste, this may reveal that production activities is the main source of the deterioration in the environment.

Figure 3. Impulse Response Analysis

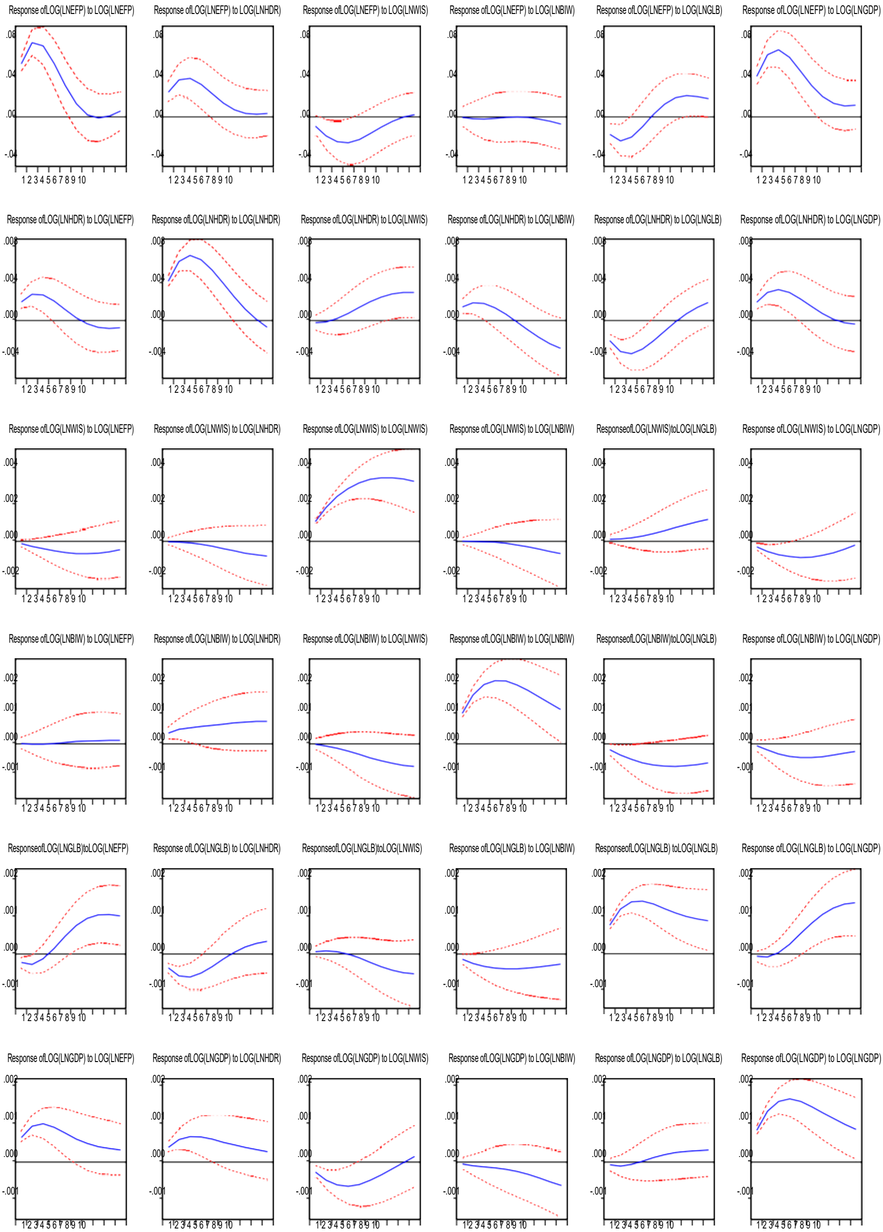


Table 7. Variance Analysis

Variance analysis of LOG(LNEFP):							
Period	S. E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.051826	100.0000	0.000000	0.000000	0.000000	0.000000	0.000000
2	0.090350	98.97671	0.109369	0.392102	0.080206	0.062852	0.378758
3	0.116355	96.09992	0.377942	1.370212	0.232541	0.414306	1.505079
4	0.131292	91.38081	0.749656	2.750305	0.400516	1.354200	3.364512
5	0.139532	85.64007	1.111219	4.111698	0.540798	3.072298	5.523919
Variance Decomposition of LOG(LNHDR):							
Period	S.E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.004124	20.56456	79.43544	0.000000	0.000000	0.000000	0.000000
2	0.007560	19.02907	80.42449	0.113554	0.094788	0.001113	0.336988
3	0.010369	16.68206	81.42235	0.438373	0.384064	0.015223	1.057932
4	0.012453	14.12369	81.83920	1.062593	0.950015	0.066782	1.957721
5	0.013910	11.90809	81.10487	2.097210	1.893397	0.184183	2.812251
Variance Decomposition of LOG(LNWIS):							
Period	S.E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.001005	4.010224	0.001106	95.98867	0.000000	0.000000	0.000000
2	0.002055	3.897769	0.025853	96.03503	0.004112	0.007910	0.029324
3	0.003159	3.967925	0.038967	95.79808	0.007412	0.042810	0.144806
4	0.004257	4.134053	0.026542	95.32606	0.007122	0.123844	0.382379
5	0.005314	4.316918	0.022888	94.62447	0.004788	0.268423	0.762512
Variance Decomposition of LOG(LNBIW):							
Period	S. E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.000977	0.080890	13.81777	0.422386	85.67896	0.000000	0.000000
2	0.001887	0.100503	11.49101	0.544802	87.47314	0.155132	0.235408
3	0.002740	0.084755	10.11714	0.790773	87.63983	0.489923	0.877579
4	0.003491	0.059492	9.413252	1.200200	86.51102	0.923143	1.892897
5	0.004125	0.042670	9.210894	1.809816	84.36797	1.380605	3.188041
Variance Decomposition of LOG(LNGLB):							
Period	S. E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.000730	12.87222	20.65862	0.117103	0.968513	65.38355	0.000000
2	0.001390	8.832161	21.14983	0.052974	0.919268	68.86531	0.180463
3	0.001991	5.034769	21.29534	0.028821	0.959581	72.18125	0.500239
4	0.002527	3.335965	20.63579	0.024301	1.064549	74.19696	0.742430
5	0.003019	4.488055	19.09546	0.054479	1.208896	74.38098	0.772122

Variance Decomposition of LOG(LNGDP):							
Period	S.E.	(LNEFP)	(LNHDR)	(LNWIS)	(LNBIW)	(LNGLB)	(LNGDP)
1	0.000797	58.20798	1.139307	4.963541	2.294621	3.787332	29.60722
2	0.001543	50.75511	1.388077	6.170266	2.423482	4.237594	35.02548
3	0.002233	43.49320	1.613278	7.131494	2.629286	4.870350	40.26239
4	0.002825	37.04960	1.799220	7.707213	2.935619	5.609805	44.89854
5	0.003311	31.84391	1.937422	7.833331	3.388274	6.382496	48.61457

Conclusion and Policy Recommendations

In the regards of vibrant development of renewable energy sources, this research tired to contribute to the global discussion of the possible dynamic effect of renewable energy and globalization on enviroenmental quality. The study considered Turkish economy as model of for emprical analysis by utilizing the structural vector auto-regression (SVAR) model and disaggregated quarterly data spanning 1990Q1-2017Q4.

The striking result from the present study is the positive impact of wind and solar energy shocks in environmental pollution which clearly contradicts the general plausibility and empirical findings. Solar and wind energy systems do not produce air pollution or greenhouse gases. Using solar and wind energies can have positive effect on environment when these energies replace or reduce the use of fossil fuels which have larger effects on the environment. However, some toxic materials and chemicals are used to make the photovoltaic cells that convert sunlight into electricity. As a result, these materials can be harmful to the environment. Similarly, wind energy can have adverse environmental impacts, including the potential to reduce or degrade habitat for wildlife, fish, and plants.

Moreover, based on the impulse response analysis, there is also some evidence that bio-fuels and waste shocks seem to have no influence on environmental pollution. Based on the obtained findings, it is extremely important to draw some policy recommendations. First, although Turkey recently developed and implement a wide range of energy policies regarding the clean and reusable energy, there still some challenges with reusable energy technological advancement, its share in the total energy structure represents small size (not more than 17%). Therefore, future energy-environment policy should enhance the development in renewable and create more competitive environment for investment in the renewable market.

Second, Turkey should also pay a huge attention to the main issues that might have thus far hampered the production of clean and reusable energy such as technological and natural issues. Third, like the most of other countries and within the scope of Paris agreement, Turkish government should continue maintaining its commitment to decreasing emissions of carbon into atmosphere. Lastly, since the economies of the world are becoming more integrated to each other, while discussing the interconnection between the renewable and deterioration of the environment and economic growth, the future research should investigate these issues among the countries by following the panel analysis such panel SVAR. This view may provide better understanding to the impact of renewable' shocks in one country to the environmental quality in other countries. This might help the policy makers to draw more effective policies to mitigating environmental problems based on the integration among the countries.

Özet: Bu çalışmanın amacı, Türkiye'de yenilenebilir enerji tüketimi ve küreselleşmenin çevre kalitesi üzerindeki dinamik etkisini 1990-2017 dönemini kapsayan üçer aylık zaman serisi verilerini kullanarak analiz etmektir. ADF birim kök testi kullanılarak serilerin durağanlık sıralaması belirlendikten sonra bu çalışmada SVAR modeli kullanılmıştır. Bunun nedeni, SVAR'ın değişkenler arasında eş zamanlı ve geçmiş şokları test etmede güçlü bir yöntem olmasıdır. Ek olarak, SVAR, varyans ayrıştırmasında güçlüdür ve uzun vadeli tahminleri gözlemleme olasılığıdır. Sonuçlar, çevresel kalitenin hidro-enerji ve ekonomik büyümedeki şoklara olumsuz tepki verdiğini, küreselleşmenin ise çevrenin bozulmasını olumlu etkilediğini ortaya koymaktadır. Bu sonuçlar, ilgili teoriler ve ampirik bulgularla tutarlıdır. Tek çarpıcı sonuç, biyo-yakıt ve atık enerjinin çevre üzerindeki olumlu etkisidir. Türkiye, yakın zamanda yenilenebilir enerjileri teşvik etmek için bir dizi enerji politikası uygulamış olsa da, bazı zorluklar hala mevcuttur, gelecekteki politika oluşturma, yenilenebilir enerjideki gelişmeyi artırmalı ve yenilenebilir enerji piyasasında yatırım için daha rekabetçi bir ortam yaratmalıdır.

Anahtar Kelimeler: Türkiye, SVAR, Küreselleşme, Yenilenebilir enerji ve Ekolojik Ayak İzi

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