Can Turkey's Environmental Pollution be Mitigated by Carbon Footprint of Bank Loans, Environmental Protection Expenditures and Taxes?

Agyemang Tieku Eric., Kwabena Ofori., Agyare Yeboah Frank

Department of Banking and Finance, Faculty of Economics and Administrative Sciences, European University of Lefke, Lefke 99770, Turkey.

DOI: https://doi.org/10.51244/IJRSI.2024.1108078

Received: 02 August 2024; Accepted: 11 August 2024; Published: 12 September 2024

ABSTRACT

Due to global sustainability uncertainty, environmental sustainability has emerged as a key concern in the process of globalization in the past few decades. Using data collected in time series from 2005 to 2018, this study employs Nonlinear Autoregressive Distributive Lag (NARDL) Model to investigate the dynamic effects of environmental taxes, carbon footprint of bank loans, and environmental protection expenditures on carbon dioxide emissions in Turkey. First, this study uses the Augmented Dickey-Fuller and Phillip-Perron to test for stationarity, then used Johansen cointeration test to analyze long run stability of the varriables. The study then proceed to estimate Nonlinear Autoregressive Distributive Lag (NARDL) to examine the effect of positive and negative changes of the predictor variables on the dependent variable. Test for the model residuals and stability followed immediately. The results showed that environmental taxes, bank loan carbon footprints, environmental protection expenditure, and carbon dioxide emissions in Turkey cointegrate. Bank loans have has both short and long-term increasing effect on carbon emissions however, carbon emissions reduces if banks lower their portfolios that promote emissions. Spending on environmental protection reduces carbon emissions. However, if environmental spending is reduced, carbon emissions is promoted. Environmental tax is has a greater impact of reducing carbon emissions in the short and long–term but if environmental levies decrease carbon emission stands significant risk of increment.

Keywords: environmental taxes, environmental protection expenditure, carbon dioxide, global warming

INTRODUCTION

One of the biggest issues facing humanity, government, industry, and finance in the twenty-first millennium is climate change (Zhang et al., 2020). Internationally, a great deal of political action has been done to slow down the impact of global warming and facilitate the shift to a more sustainable environment. The Paris Climate Convention in 2015 and the establishment of the 2030 Agenda for Sustainable Development (SDG) by the UN may have been the most significant turning points. Finding and solving the environmental issues the world is currently experiencing has become crucial and duty of all social and economic players (Baste and Watson, 2022). Environmental issues are complicated and frequently have ties to socioeconomic issues; they can have an impact on the entire world. These issues, which constitute serious challenges to human safety, health, and productivity, transcend political boundaries. Examples of these issues include air and water pollution, the production of solid and hazardous waste, soil degradation, deforestation, climate change, and biodiversity loss (Addai et al., 2022). It is imperative to address these issues since they pose such a threat to the future of humanity.

Banks and other participants in the financial sector play a distinctive part in addressing environmental challenges. Financial companies are cited by prominent figures in both academia and politics as being essential to the grand evolution (Kirikkaleli and Adebayo). Governments are also essential in establishing laws, rules,

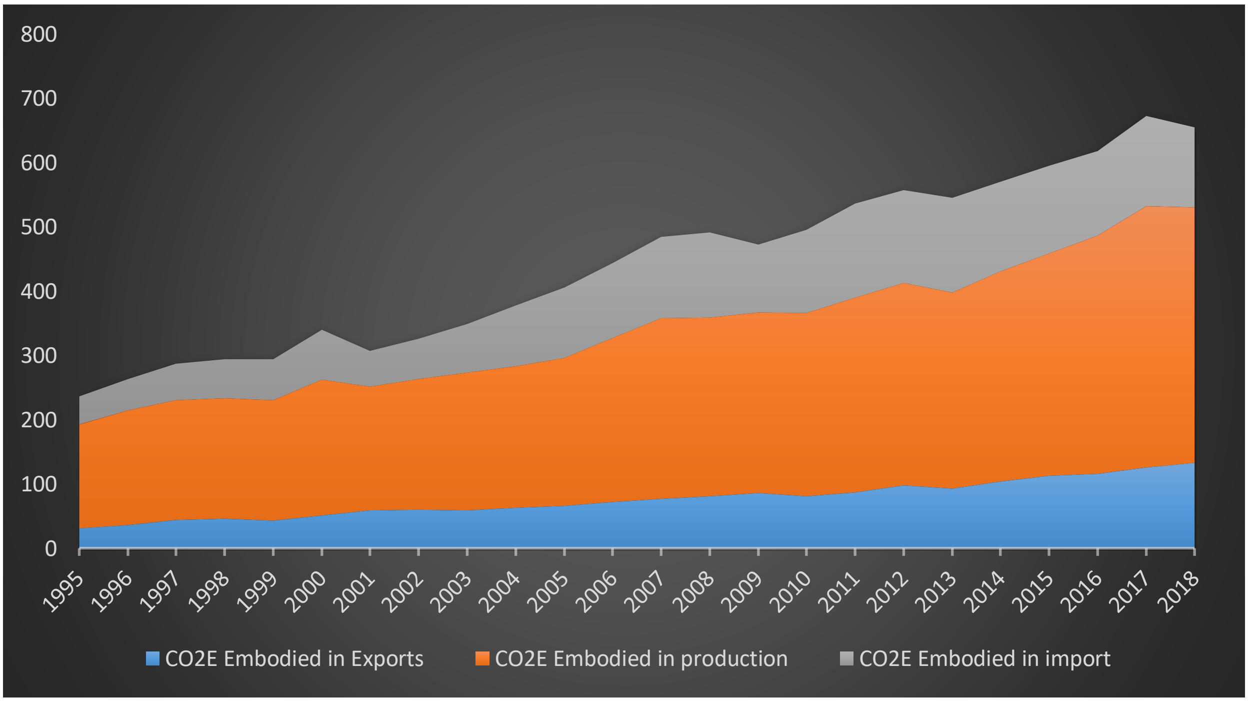
ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue VIII August 2024

and guidelines that safeguard the environment and advance sustainability (Koontz et al., 2010). Additionally, by making investments in energy efficiency, renewable energy, and other environmentally friendly innovations, governments can lower greenhouse gas emissions and lessen the effects of climate change (Kulin & Johansson Sevä, 2019).

A number of financial institutions have created methods in recent years to calculate the carbon footprint of their services and products, often working in partnership with non-profit groups. Both Nonprofits and the participating financial institutions are becoming more and more persuaded of the significance of accounting for the carbon emissions of financial portfolios, notwithstanding their disparities in starting points and goals. According to Geddes et al. (2018) financial organizations are essential for supporting the shift to a more sustainable economy as well as for funding and promoting low-carbon and green projects and initiatives.

Turkey's updated Nationally Determined Contribution (NDC) pledges to cut its emissions of greenhouse gases by 41% by 2030 (UNEP, 2023).The nation wants to reach net zero emissions by 2053, with a target emission peak by 2038 at the latest. The updated NDC covers the entire economy, contains thorough mitigation and adaptation measures, and provides information on how they will be implemented with an emphasis on public health, urban and rural development, disaster risk reduction, forestry, agriculture, and water, the adaptation components are incorporated for the first time. Figure 1 shows Turkey's historical carbon emission records.

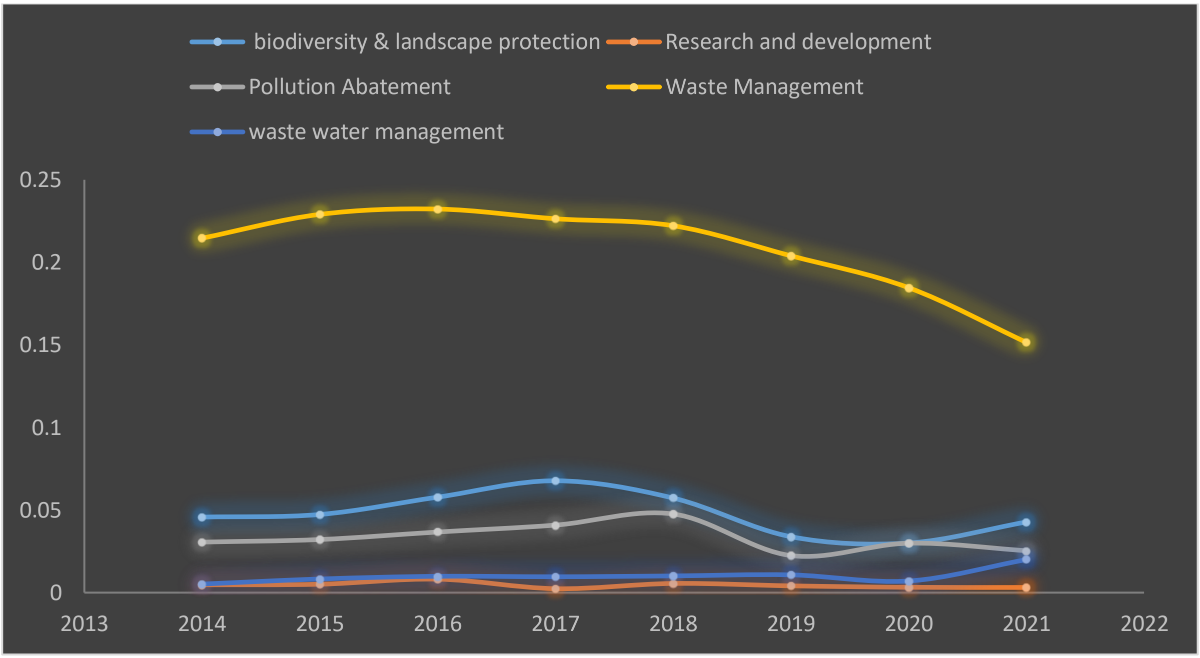
Figure 1: Turkey'scarbondioxideemissions graph. Source: OECD statistics



Currently, government regulation plays a major role in pollution control, particularly in the revenue and expenditure operations of all levels of government (Ma et al., 2019; Chai et al., 2020; Cheng et al., 2021).The Turkish Statistical Institute (TÜİK) released data indicating that environmental protection expenditures in 2022 climbed by 111.4 percent over the previous year to a total of 140.3 billion Turkish Liras. The overall investment expenditures on preservation of the environment amounted to 32.7 billion liras, up 140.9 percent from 2021. Financial and non-financial corporations accounted for 84.7 percent of this amount, while the rest went to the general government and non-profit groups serving households made up 15.3 percent. Turkish Statistical Institute (TÜİK) said that in 2022, the corresponding proportion of environmental protection expenditures to the gross domestic product was 0.93 percent, compared to 0.91 percent in 2021.Turkey has been preparing over the past few years to save its existing resources and prevent the catastrophic effects of global warming.

According to International Monetary Fund (IMF) indicators on Government Finance Statistics, the government of Turkey is spending sums of monies towards its promise on reaching net zero emissions by 2053. Compared to other categories, waste management receive largest GDP percentages of expenditure next to biodiversity and landscape preservation (see figure 2).

Figure 2:Turkey'scarbondioxideemissions graph.



Source: Authors construction on Governments Finance Statistics (GFS) from IMF.

There have been conflicting results from the latest empirical literature's discussions if environmental taxes are effective in reducing environmental harm and the carbon footprint. Studies by Chien et al. (2023) suggest that environmental levies could cause the quality of the ecosystem to decline. According to Ciaschini et al. (2012) environmental taxes could lead to a technical advancement, hence mitigating the issues related to elevated emissions. The mitigating effect of environmental taxes on emissions is supported by a number of empirical studies (Farooq et al., 2019).

This study's novelty lies in its evaluation of the structural effects of carbon footprints of bank loan, environmental protection expenditures, and environmental taxes on pollution while conducting an empirical test of the effects of these factors on pollution which has not been examined in previous studies.

Three key areas comprise this study's contribution. First, this paper examines the dynamic effects of bank loan carbon footprints, environmental protection expenditure, and environmental taxes on pollution in the environment. This research is leading-edge for the field of sustainable development studies in Turkey. In this study, the effects of environmental taxes, bank loan carbon footprints, and environmental protection expenditure all of which were only examined independently in earlier research are examined concurrently with respect to environmental pollution. Second the study's conclusions will contribute to the creation of more practical policies that support Turkey's pursuit of its sustainable development objectives. Lastly, usingNonlinear Autoregressive Distributive Lag (NARDL) to investigate the effects of shocks on environmental pollution, this study also analyzes the research findings and offers related policy recommendations that will be very important to researchers and policymakers. NARDL offer a more methodical way to assess both partial positive and negative sum decomposition of the regressors on dependent variable, which may help the researcher identify empirical patterns that are obscured by previously used methodologies.

This study is divided into five sections: Section 2 reviews relevant literature; Section 3 provides a brief overview of the empirical methodology, variables, and data used in this study; Section 4 gives the statistical evaluation; and Section 5 provides a conclusion.

LITERATURE REVIEW

Examining related studies is a crucial part of any field of study. The library of information can be expanded by identifying and assessing existing knowledge and knowledge gaps on particular situations. In contrast to conventional reviews that are narrative in nature Mengist (2020) suggests that studies adheres to the systematic literature review (SLR) paradigm, which employs a clear, scientific, and repeatable process to generate the review.

Initiatives that combat climate change and enhance sustainability through environmental financial innovations and strategies can be termed as green finance. In contrast to conventional finance, the emerging idea of green finance places a strong emphasis on environmentally friendly development and the protection of the environment. In order to minimize the damage to the environment and strike as much of a balance as possible between sustainability and growing the economy, green finance should be promoted as a new financial tool (Taghizadeh-Hesary, 2021).

Carbon Footprint of Bank Loans and Environmental Quality.

Carbon footprint exposure at the portfolio level is calculated by (Boermans and Galema, 2019). They investigate whether financiers are enthusiastically decarbonizing their portfolios by lowering the amount they invest to companies that produce significant emission by utilizing stock-level data from Dutch pension funds. By weighing the average business-level emissions intensity or carbon inefficiency defined as the total company emissions over sales and adjusting it for the portfolio holdings of individual companies, they provide a measure of the carbon footprint. According to the study, pension funds that track and disclose their carbon footprint have a greater propensity to exhibit reduced exposure to firms with large carbon emissions.

Using information from Italian banks, Faiella and Lavecchia (2020) offer another measure of the carbon footprint of bank loans. They create a metric known as the Loan Carbon Intensity (LCI), which is the amount of greenhouse gas emissions (measured in grams of CO2 equivalents) per unit of outstanding loans (measured in euros) that Italian banks make to various economic sectors. The LCI is calculated at the sectoral level, as opposed to the individual bank-level CIL indicator that Guan et al. (2017) proposed. According to the study, the carbon footprint of loans made by Italian banks has been decreasing over time, and just 10% of all loans are made to industries that account for 50% of emissions, which may indicate a potential amount of hazards.

By examining data from 34 European nations between 2000 and 2020, the study by Xu et al. (2022) examined the effect of financial development on environmental sustainability. For data analysis, the study uses the Generalized Method of Moments (GMM) technique, a random-effects model, and the Feasible Generalized Least Squares (FGLS) model. According to the findings, there is a negative correlation between loan rates and CO2 emissions by the transportation sector, overall CO2, and per capita CO2. However, overall CO2 emissions as well as CO2 emissions from the electricity and transportation sectors rise when banks and domestic lenders lend to the private sector.

Shahbaz et al. (2013) examined the relationship between financial advancement and the rate of economic growth and carbon emissions. According to their analysis, rising domestic lending to the private sector led to higher energy use and CO2 emissions. Thus, these publications have demonstrated that CO2 emissions are mostly impacted by expansion in the financial industry.

Furthermore, Ntarmah (2022) study uses panel vector autoregressive and panel quantile regression models to investigate the association between bank financing, economic growth, and carbon emissions in sub-Saharan Africa (SSA) from 1990 to 2018. The findings demonstrate that bank financing raises economic growth and carbon emissions in all SSA countries. In East and Central Africa, bank financing positively impacts both economic growth and carbon emissions. Based on the above literature the firs hypothesis can be set that:

Hypothesis H_1: Carbon footprint of bank loans promote increase in carbon dioxide emissions.

Environmental Taxes and Carbon Dioxide Emissions.

The function of carbon taxes in encouraging greener production methods and consumption habits has been discussed more and more in the literature, especially in the last 20 years. The benefits of enacting environmental taxes are discussed in the literature in comparison to other tools like tradable permits and restrictions.

One effective policy tool to reduce GHG emissions is the imposition of environmental taxes (Babatunde et al., 2017). According to Sundar et al. (2016) there is a negative correlation between the volume of CO2 and environmental tax reforms. This is because carbon emissions are the primary source of greenhouse gas emissions that require taxation, Hammar (2011) stated. This issue was expanded upon by Tamura et al. (1996) who proposed that an environmental tax reduce overall carbon emissions by raising the price of fossil fuels, which in turn reduces demand for them. According to an analysis of EU policies by Barker et al. (2001) environmental levies are a more efficient way to reduce carbon emissions when they are combined with member state policies and European Union regulations.

Energy and fuel taxes are included in the category of environmental taxes, even though they are primarily focused on carbon emissions. They can be helpful in reaching the goals for environmental preservation established by several environmental initiatives, including the Paris Climate Agreement and the Kyoto Protocol (Scrimgeour et al., 2005). Although some academics contend that environmental taxes have only minor effects on GHG emissions, investigations by Meng et al. (2013) have confirmed the effectiveness of environmental taxes. Lin and Li (2011) furthermore, analytically revealed that environmental taxes from 2014 to 2024 will only result in a 1% decrease in GHG emissions. Environmental taxes lower energy use through increasing energy efficiency, cut carbon emissions, and support renewable energy sources (Clough, 2016).

When Micekiene et al. (2018) looked into whether or not environmental taxes safeguard the environment, they found that, when advances in the energy and ecological domains are given priority, these taxes play a significant role in enhancing the sustainability of the environment. The effects of environmental taxes and technologies on greenhouse gas emissions in nine of the EU's top emitting nations were examined by (Ghazouani et al., 2021). They used the FMOLS and DOLS techniques and discovered that renewable energy sources and environmental taxes have an impact on lowering emissions. A recent study by Agyemang (2024) in examining carbon dioxide embodied in trade import in Cyprus found that environmental taxes have a reducing effect on carbon dioxide emissions embodied trade imports in the short and long run, suggesting that polices and strategies regulating them should be strengthen by the government through the finance ministry and other stakeholders to achieve even more success in handling environmental pollution Based on the above discussion hypothesis is proposed that:

Hypothesis $H_{2:}$ Environmental tax has a reducing impact on carbon emissions.

Environmental Protection Expenditure and Environmental Sustainability.

Actions aimed at preserving or improving the quality of the environment through adjustments to manufacturing methods, consumption habits, residuals handling, and other aspects are referred to as environmental protection. It also attempts to stop ecosystem harm and degraded land. Nine major areas of environmental protection are identified by Basoglu et al. (2019) in a breakdown of environmental protection activities. These include the following: (a) protecting the climate and general pollution; (b) managing waste; (c) managing waste water; (d) protecting and remediating soil; (e) protecting and remediating groundwater and surface water; (f) protecting biodiversity and landscape; (g) mitigating noise and vibration; (h) conducting research and development (R&D) on the environment; and (i) other activities not otherwise classified.

The secret to the successful implementation of sustainable development strategies is understanding how to enhance environmental quality without compromising domestic growth in the economy and create a "win-win" outcome between environmental protection and economic development (Elzen et al., 2016). In an empirical study on air and water pollutants, Lopez ´ et al. (2011) discovered that while redistributing government spending toward public goods and societies is capable of reducing pollution, raising overall government

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue VIII August 2024

spending cannot. Government spending on environmental governance, according to Adewuyi (2016) can have a reverse effect over the long and short terms.

According to research by Galinato (2016), energy use in the provision of public goods and services is one way that fiscal expenditure might have an indirect impact on environmental damage. Although the aforementioned research have demonstrated that government spending does affect environmental pollution, opinions on the impact path and response method remain divided.

Hypothesis $H_{2:}$ Environmental protection expenditure does not have long run effect on carbon dioxide emissions.

METHODOLOGY

Data sources and description

In order to minimize the damage to the environment and strike as much of a balance as possible between sustainability and growing the economy, green finance needs to be promoted as a new financial tool. In response to the above, this study seeks to empirically analyze the dynamic impact of carbon footprint of bank loan, environmental protection expenditure, and environmental taxes on carbon dioxide emissions from 2005Q1 2018Q4 in Turkey. To achieve this objective, data were sourced from Organization for Economic Cooperation and Development (OECD) database on:

- **i.** Carbon footprint of bank loan: this serves as independent variable for the study and it refers to the contribution of banks to climate change risk captured in a cross-nationally comparable manner. The carbon intensity of banks' domestic lending portfolio increases with a higher ratio.
- **ii.** Environmental protection expenditure: it indicates the amount of money, as a proportion of the nation's GDP that each government spends on environmental protection initiatives. This also serves as independent variable for the study.
- **iii.** Carbon dioxide emissions intensity, the amount of CO_2 emitted into the atmosphere as a result of burning fuel directly per million US dollars of output is represented by CO_2 emissions intensity. This was used as dependent variable and a proxy for environmental pollution.
- **iv.** Data were also obtained from Governments Finance Statistics (GFS) from IMF database on environmental taxes, this is a fee imposed on a tangible object that has been shown to have an adverse effect on the environment. Examples of such physical units are a passenger trip, a gallon of gasoline, or a ton of rubbish that has to be dumped in a landfill.

In order to facilitate simple estimation, all data were eventually converted into quarterly data employing the quarterly match sum procedure by the statistical software EViews12, as the statistical software applications limit small series of data in ARDL estimation.

Model construction

This study builds a Nonlinear Autoregressive Distributive Lag (NARDL) for empirical tests in order to examine the relationship among environmental protection expenditure, carbon footprint of bank loans, and environmental taxes and environmental pollution.

NARDL models offer an advantage over conventional large-scale macro econometric modeling due to the fact the data are readily available for easily analyzed rather than obscured behind a bulky and complex structure. According to Shin et al. (2014),NARDL model offer a more methodical way to assess both partial positive and negative sum decomposition of the regressors on dependent variable, which may help the researcher identify empirical patterns that are obscured by previously used methodologies. Conversely, the outcomes of policy exercises utilizing large-scale macro econometric models are difficult to replicate and compare, and their users can readily alter the results with subjective ex post judgments. Generalized linear form of the study model is specified as follows:

$$\mathrm{CO2E_t} = \Gamma_0 + \Gamma_1\mathrm{CFPBL_t} + \Gamma_2\mathrm{ENPEX_t} + \Gamma_3\mathrm{ENTAX_t} + \varepsilon_t \quad (1)$$

where $\mathrm{CO2E_t}$, CFPBL, ENPEX, and ENTAX represent carbon emission (metric tons), carbon footprint of bank loans (millon US dollars), environmental protection expenditure(percentage of gdp), environmental taxes, and ε is the error correction term. According to Shin et al. (2014), the partial positive and negative sums decomposition of the exogenous variable is added to the linear ARDL to create the NARDL model. In this case the ARDL model is generally specified as:

$$\Delta\mathrm{CO2E}_t = \Gamma_0 + \sum_{i=1}^{p}\Gamma_{1i}\,\Delta\mathrm{CO2E}_{t-i} + \sum_{i=0}^{p}\Gamma_{2_i}\,\Delta\mathrm{CFPBL}_{t-i} + \sum_{i=0}^{p}\Gamma_3\,\Delta\mathrm{ENPEX}_{t-i} + \sum_{i=0}^{p}\Gamma_4\,\Delta\mathrm{ENTAX}_{t-i} + \Gamma_5\mathrm{CO2E}_{t-1} + \Gamma_6\mathrm{CFPBL}_{t-1} + \Gamma_7\mathrm{ENPEX}_{t-1} + \Gamma_8\mathrm{ENTAX}_{t-1} + \varepsilon_t \quad (2)$$

To illustrate the asymmetric dynamics of the variables, segregate the coefficients into positive and negative then:

$$CFPBL_t{}^{+} = \sum_{j=1}^{t}\quad \Delta\mathrm{CFPBL}_j^{+} = \sum_{j=1}^{t} = \mathrm{Max}\,(\Delta\mathrm{CFPBL_j}, 0) \quad (3)$$

$$CFPBL_t^{-} = \sum_{j=1}^{t}\quad \Delta\mathrm{CFPBL}_j^{-} = \sum_{j=1}^{t} = \mathrm{Min}\,(\Delta\mathrm{CFPBL_j}, 0) \quad (4)$$

$$ENPEX_t{}^{+} = \sum_{j=1}^{t}\quad \Delta\mathrm{ENPEX}_j^{+} = \sum_{j=1}^{t} = \mathrm{Max}\,(\Delta\mathrm{ENPEX_j}, 0) \quad (5)$$

$$ENPEX_t{}^{-} = \sum_{j=1}^{t}\quad \Delta\mathrm{ENPEX}_j^{-} = \sum_{j=1}^{t} = \mathrm{Min}\,(\Delta\mathrm{ENPEX_j}, 0) \quad (6)$$

$$ENTAX_t{}^{+} = \sum_{j=1}^{t}\quad \Delta\mathrm{ENTAX}_j^{+} = \sum_{j=1}^{t} = \mathrm{Max}\,(\Delta\mathrm{ENTAX_j}, 0) \quad (7)$$

$$ENTAX_t^{-} = \sum_{j=1}^{t}\quad \Delta\mathrm{ENTAX}_j^{-} = \sum_{j=1}^{t} = \mathrm{MIN}\,(\Delta\mathrm{ENTAX_j}, 0) \quad (8)$$

The following are the NARDL models that were taken into consideration for estimation in this investigation after accounting for both short- and long-term asymmetric effects in the ARDL formulation in equation (2).

$$\Delta\mathrm{CO2E}_t = \Gamma_0 + \sum_{i=1}^{p}\Gamma_{1i}\,\Delta\mathrm{CO2E}_{t-i} + \sum_{i=0}^{p}\Gamma_{2_i}\,\Delta^{+}\mathrm{CFPBL}_{t-i}^{+} + \sum_{i=0}^{p}\Gamma_{2_i}\,\Delta^{-}\mathrm{CFPBL}_{t-i}^{-} + \sum_{i=0}^{p}\Gamma_{3_i}\,\Delta^{+}\mathrm{ENPEX}_{t-i}^{+} + \sum_{i=0}^{p}\Gamma_{3_i}\,\Delta^{-}\mathrm{ENPEX}_{t-i}^{-} + \sum_{i=0}^{p}\Gamma_{4_i}\,\Delta^{+}\mathrm{ENTAX}_{t-i}^{+} + \sum_{i=0}^{p}\Gamma_{4_i}\,\Delta^{-}\mathrm{ENTAX}_{t-i}^{-} + \Gamma_5\mathrm{CO2E}_{t-1} + \Gamma_6{}^{+}\mathrm{CFPBL}_{t-i}^{+} + \Gamma_6{}^{-}\mathrm{CFPBL}_{t-i}^{-} + \Gamma_7{}^{+}\mathrm{ENPEX}_{t-i}^{+} + \Gamma_7{}^{-}\mathrm{ENPEX}_{t-i}^{-} + \Gamma_8{}^{+}\mathrm{ENTAX}_{t-i}^{+} + \Gamma_8{}^{-}\mathrm{ENTAX}_{t-i}^{-} + \varepsilon_t \quad (9)$$

The long-run impacts of positive and negative shocks in the carbon footprint of bank loans, environmental protection spending, and environmental levies on CO2 emissions are captured by $\Gamma_6{}^{+}$ and $\Gamma_6{}^{-}$, $\Gamma_7{}^{+}$ and $\Gamma_7{}^{-}$, $\Gamma_8{}^{+}$ and $\Gamma_8{}^{-}$which stands for the long-run coefficients.

.$\sum_{i=0}^{p}\Gamma_{2_i}\,\Delta^{+}and\sum_{i=0}^{p}\Gamma_{2_i}\,\Delta^{-}$, $\sum_{i=0}^{p}\Gamma_{3_i}\,\Delta^{+}$and $\sum_{i=0}^{p}\Gamma_{3_i}\,\Delta^{-}$, $\sum_{i=0}^{p}\Gamma_{4_i}\,\Delta^{+}$and $\sum_{i=0}^{p}\Gamma_{4_i}\,\Delta^{-}$represent, respectively, the short-term impacts of the positive and negative shocks.

The speed at which the model recovers to equilibrium following an exogenous short-term shock is indicated as depicted by error correction model is given by:

$$\Delta\mathrm{CO2E}_t = \Gamma_0 + \sum_{i=1}^{p}\Gamma_{1i}\,\Delta\mathrm{CO2E}_{t-i} + \sum_{i=0}^{p}\Gamma_{2_i}\,\Delta\mathrm{CFPBL}_{t-i} + \sum_{i=0}^{p}\Gamma_3\,\Delta\mathrm{ENPEX}_{t-i} + \sum_{i=0}^{p}\Gamma_4\,\Delta\mathrm{ENTAX}_{t-i} + \lambda ECT_{t-1} + \varepsilon_t \quad (10)$$

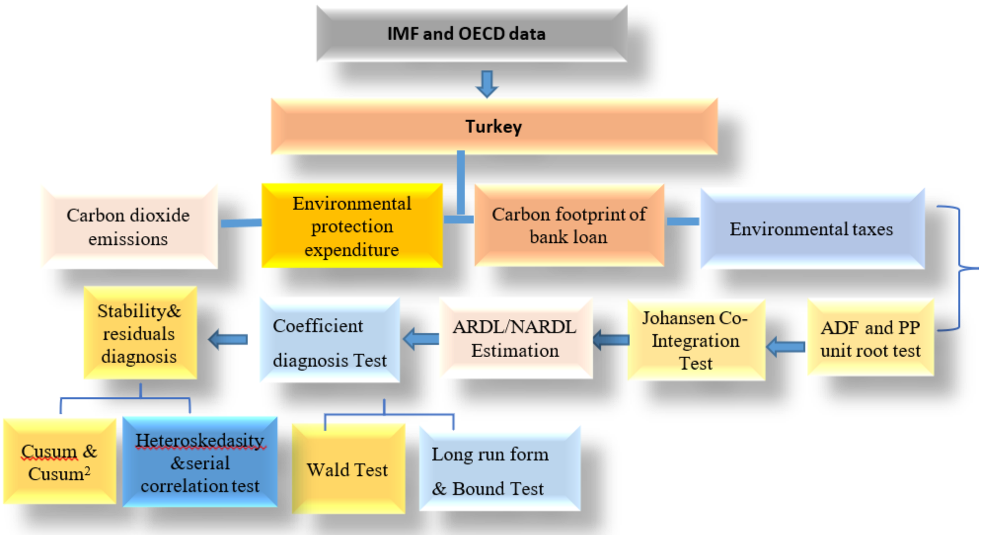
WhereECT_{t-1} is the error correction term. λ is the coefficient of ECT_{t-1}. Econometrically, λ is required to be negative and statistically significant to indicate that any short-run deviation will converge back to the long-run established equilibrium.

The relationship's long-term viability is tested. A bound test called cointegration is performed on the variables. The evaluation of H_0: $\Gamma_6^+ = \Gamma_6^- = \Gamma_7^+ = \Gamma_7^- = \Gamma_8^+ = \Gamma_8^- = 0$is done by comparing the F-statistic with the upper and lower critical constraints from Narayan (2005). In order to demonstrate a long-term relationship between the variables, H0 must be rejected.

Empirical Estimation Approach

For NARDL to be employed, time series data must be stationary. Tests for stationarity are therefore conducted. This study uses the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) because of its capacity to adjust for autocorrelation difficulties. Next, we tested the cointegrating equation in the studied series using the Johenson cointegration test.

Figure 3: Data Analysis procedures chart



Source**:** author's construction

In order to estimate Non-linear Autoregressive distribution lag (NARDL) and analyze the effects among the regressors and the dependent variable, ARDL is then estimated for the bases. The best lag order, as calculated by the Akaike information criterion (AIC) and the Schwarz information criterion (SC), was employed since lag selection is crucial in ARDL.

After that, Non-linear Autoregressive distribution lag is computed, which places emphases on partial positive and negative sums decomposition of the exogenous variables. Bound test was then performed to examine the cointegration of the model, followed by Wald test to confirm the asymmetric effects of the variables. Residual and stability test were conducted to test the stability of the model's parameters. The study's analytical procedures is depicted in Figure 3.

EMPIRICAL RESULTS

Descriptive Statistics

Averagely, the various variables from table 2 indicate that Carbon Footprint of Bank Loan, Carbon Dioxide Emissions, Environmental Protection Expenditure and Environmental Taxes has values of 86.54, 316.76, 0.33 and 3.26 respectively. The highest and lowest values for Carbon Footprint of Bank Loan is 154.48 and 53.33, Carbon Dioxide Emissions is 383.41and 239.20, Environmental Protection Expenditure is 0.37and 0.26, Environmental Taxes is 3.93and 3.20. Carbon Footprint of Bank Loan, Carbon Dioxide Emissions, Environmental Protection Expenditure and Environmental Taxes deviate from the sample mean by 26.45, 42.07, 0.03 and 0.36 respectively.

In measures of normality, regarding asymmetric of series, it can be seen from the table that all the variables have negative skewness from the average mean apart from CFPBL

Table 1. Descriptive Statistics Result.

	CFPBL	CO_2E	ENPEX	EVTAX
Mean	86.54792	316.7606	0.331715	3.262143
Median	76.38092	318.6956	0.325386	3.255000
Maximum	154.4844	383.4188	0.376582	3.930000
Minimum	53.33743	239.2044	0.265435	2.300000
Std. Dev.	26.75225	42.07111	0.033724	0.363242
Skewness	1.245671	-0.056636	-0.309813	-0.791970
Kurtosis	3.706852	2.187373	2.247411	4.718154
Jarque-Bera	15.64833	1.570785	2.217428	12.74215
Probability	0.000400	0.455941	0.329983	0.001710
Sum	4846.684	17738.59	18.57606	182.6800
Sum Sq. Dev.	39362.55	97348.80	0.062552	7.256943

Note: Carbon Footprint of Bank Loan (CFPBL), Carbon Dioxide Emissions (CO_2E), Environmental Protection Expenditure (ENPEX) Environmental Taxes (EVTAX)

Source**:** Authors compilations from Eviews

The Kurtosis indicating the peakness or the flatness of the distribution show from the table thatCO_2E and ENPEX are platykurtic in nature, that is their values 2.18 and 2.24 are less than three (< 3), which means that in the series or distribution, these two variables have more values that are less than their mean value of 316.76 and 0.33 respectively. This means that the amount of money government allocate to environmental protection is below average. On the other hand Environmental Taxes and carbon footprint bank loans indicate leptokurtic curve, meaning its values are greater than three (>3) and that the series or distribution has more values greater than its mean value of 3.26 and 86.54. The indication is that government imposition of environmental taxes is effective as its above average. Again, Bank loans for carbon footprint are happening more frequently than usual. From the table the Jarque-Bera probability for the variables indicates a partial normal distribution of the series.

Unit Root Test

According to Moon and Perron (2004), the presence of a unit root in the model is the null hypothesis. Table 2 presents the series unit root's outcomes. The findings of the unity root at the level and the first difference are displayed in table 2. This may be shown by comparing the critical thresholds of the test statistics at the 1, 5, and 10% significance levels with the values that were observed of both the Augmented Dickey-Fuller (ADF) and Phillip-Perron (PP) test statistics.

There is convincing proof of non-stationarity at level for both ADF and PP. Given that the test results' values in absolute terms are below the threshold of significance as defined by (Mackinnon, 1991). For all variables, stationary values could not be found, with the exception of the carbon dioxide emissions, whose stationarity is supported by their probability. Consequently, the null hypothesis is accepted at level, and the conclusion that the variables have a unit root is sufficient.

Table 2: Unit Root Test Results

PP and ADF at level								
variable	PP,(Intercept)		PP, (Intercept & Trend)		ADF,(Intercept)		ADF,(Intercept and Trend)	
	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.	t-Statistic	Prob.
CO2E	-0.9669	0.7589	-3.2327	0.0888*	-1.0418	0.7321	-3.2058	0.094*
CFPBL	2.1502	0.9999	-0.5412	0.9785	1.0237	0.9963	-1.0815	0.9228
ENPEX	-0.9011	0.7807	-1.1887	0.9029	-0.8697	0.7905	-1.1887	0.9029
ENTAX	-1.4446	0.5539	-1.8126	0.6851	-1.4072	0.5723	-1.7563	0.7122
PP and ADF at first difference								
variable	PP,(Intercept)		PP, (Intercept & Trend)		ADF,(Intercept)		ADF,(Intercept and Trend)	
CO2E	8.4652	0.000***	-8.4946	0.000***	-8.0494	0.000***	-7.9958	0.000***
CFPBL	7.7402	0.000***	-12.6474	0.000***	-7.7043	0.000***	-8.2885	0.000***
ENPEX	7.2553	0.000***	-7.4301	0.000***	-7.2553	0.000***	-7.4276	0.000**
ENTAX	7.4169	0.000***	-7.364	0.000***	-7.4169	0.000***	-7.3633	0.000**
Notes: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. Augmented Dickey-Fuller (ADF), Phillip-Perron (PP), Carbon Footprint of Bank Loan (CFPBL), Carbon Dioxide Emissions (CO_2E), Environmental Protection Expenditure (ENPEX) Environmental Taxes (EVTAX)								

Source**:** Authors compilations from E-views

Table 2 showed that all variables were first order differential series compared to critical values at first difference, at the 1, 5, and 10% significance levels. It is therefore certain that the variables are steady as a result of this rejection of the non-stationarity null hypothesis. This suggests integrating all variables I (1), with the exception of carbon dioxide emissions, which are integrated to I (0).

Cointegration Test

The optimal lag order determined by the Schwarz information criterion (SC) and the Akaike information

criterion (AIC) is 3 lags. The results of the Johansen cointegration test are shown in table 3. The four variables are linked by cointegration, investigation has indicated that the relationship among carbon footprint of bank loans, carbon dioxide emissions, environmental protection expenditure, and environmental taxes is longer and more stable.

Table 3:Johansen Cointegration Test Results

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.351785	55.19762	47.85613	0.0088
At most 1 *	0.251496	33.52100	29.79707	0.0178
At most 2 *	0.198517	19.03708	15.49471	0.0140
At most 3 *	0.147388	7.972538	3.841466	0.0047
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None	0.351785	21.67661	27.58434	0.2374
At most 1	0.251496	14.48392	21.13162	0.3267
At most 2	0.198517	11.06455	14.26460	0.1510
At most 3 *	0.147388	7.972538	3.841466	0.0047

Source: Authors compilations from Eviews

Trace statistics values are all higher than its critical values at none, at most 1, at most 2, at most 3, and statistically significant at 0.05 significant level. Max-Eigen Statistic also has its value at most 3 is greater than the critical value and also significant at 0.05 significant level

Nonlinear Auto-regressive distribution lag Estimates

It is important to estimate the coefficients of estimators that provide the optimal response to the non-linear character when assessing the NARDL model. Coefficients and their significance were found using the model at an ideal lag of 3 selected by Akaike information criterion (AIC). Nonlinear Auto-regressive distribution lag (NARDL) was used for testing and interpreting the significance of the coefficients, along with estimations of coefficients of Long Run Form and Bounds Test, short run Error Correction form, and residual heteroskedasticity.

The short-run and long-run estimates from the nonlinear ARDL analysis are shown in table 4

It is observed in the short run that, a unit positive change in carbon footprint of bank loans cause0.408 metric tons increase in carbon dioxide emissions. On the other hand, and a unit negative change will also lead to a 0.178metric tons decline in carbon dioxide emissions. Likewise, carbon footprint of bank loans promote an increase of 0.242 metric tons in carbon dioxide emissions in the long run as a result of a unit positive change. When a negative unit change occurs, emissions will be reduced by 0.208metric tons. Radulescu et al. (2022) also found that the ecological footprint of OECD economies is favorably and considerably impacted by banking development, suggesting that a rise in banking development also results in an increase in environmental degradation in these economies. Ntarmah (2022) also found that bank financing raises economic growth and carbon emissions in all Sub Saharan African countries. Shahbaz et al. (2013) examined the relationship between financial advancement and the rate of economic growth and carbon emissions

A positive unit change in environmental protection expenditure promote a 75.214 metric tons reduction in carbon dioxide emissions in the short-run. On the other hand, 81.956 metric tons of increase in carbon dioxide emissions is as a result of a unit negative change in in environmental protection expenditure. In the same

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue VIII August 2024

manner, in the long-run, additional 28.266 metric tons of carbon dioxide are emitted following a negative unit change in environmental protection expenditure. 59.55 metric tons of carbon dioxide are reduced when there is a positive unit change in environmental protection expenditure. Caglar and Yavuz (2023) also evaluated the effect of environmental expenditures on carbon emissions in their empirical studies in the European economies and found that higher expenditure on environmentally friendly technology, subsidies, and research aid in reducing carbon emissions

Table 4: Long run and short run NARDL coefficients relationship test result.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short run estimates				
CO_2E (-1)	-0.322233	0.102390	-3.147106	0.0033
D(CFPBL_POS)	0.407578	0.089986	4.529349	0.0010
D(CFPBL_NEG)	0.178781	0.097384	1.835835	0.0000
D(ENPEX_POS)	-75.21480	13.62241	-5.521401	0.0021
D(ENPEX _NEG)	-81.95641	15.90021	-5.154465	0.0000
D(ENTAX_POS)	-15.62060	2.648483	-5.897941	0.0000
D(ENTAX _POS(-1))	-5.780595	2.496907	-2.315103	0.2263
D(ENTAX _POS(-2))	-5.780595	2.496907	-2.315103	0.0263
D(ENTAX _NEG)	-8.149776	1.403729	-5.805803	0.0000
ECM(-1)	-0.322233	0.067609	-4.766125	0.0000
Long run estimates				
CFPBL_POS	0.241940	0.141403	1.710998	0.0355
CFPBL_NEG	-0.208325	0.170778	-1.219861	0.0202
ENPEX_POS	-59.55399	65.77853	-0.905371	0.0022
ENPEX_NEG	-28.26604	10.00636	-2.824806	0.0076
ENTAX_POS	-10.20529	5.333182	-1.913547	0.0034
ENTAX_NEG	-0.241165	6.354156	0.037954	0.0129
C	59.00897	4.306955	13.70086	0.0000
Note: Positive(POS), Negative(NEG), Error correction form (ECM),Carbon Footprint of Bank Loan (CFPBL), Carbon Dioxide Emissions (CO_2E), Environmental Protection Expenditure (ENPEX) Environmental Taxes (ENTAX)				

Source: Authors' estimation from E-views

Again in the short run, if environmental taxes experience a positive unit change it will lead to 15.620 metric

tons reduction in carbon dioxide emissions. On the other hand, a negative unit change in environmental taxes will call for 8.149 metric tons increase in carbon dioxide emissions. If a positive unit change is applied to environmental taxes, carbon dioxide emissions is reduced by 0.241 metric tons in the long run. However, a negative unit change in environmental taxes leads to 10.205 metric tons rise in CO_2E. Ghazouani et. al (2021) also found that environmental taxes have an impact on lowering emissions after their empirical studies on the effects of environmental taxes and technologies on greenhouse gas emissions in nine of the EU's top emitting nations.

The ECM term is negative and statistically significant at a 1 % significance level for NARDL model, implying a stable long-run relationship between variables. It demonstrates that short-run disequilibrium converges to long-run equilibrium at a speed of 32.2 % suggests that the NARDL model provide a moderate speed of adjustment to long-run relationship equilibrium.

Table 5 shows the results of the cointegration bounds test. Based on the bounds test approach, the long-run cointegration is confirmed, as F-statistic is greater than the critical value of the upper bound. These results established a long-run relationship among the variables. The wald test table 6 confirm that the impact of carbon footprint of bank loans, environmental taxes and environmental protection expenditure on carbon dioxide in the long-run is asymmetric and statistically significant.

Table 5: Non-linear ARDL Bounds Cointegration Test Results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.387756	10%	1.99	2.94
		5%	2.27	3.28
		2.5%	2.55	3.61
		1%	2.88	3.99
Note: Lower Bound I(0), Upper Bound I(1)				

Source: Authors' estimation from Eviews

Table 6: Wald test for long-run asymmetry

Variables	T-Statistic	F-statistic	Chi square	Probability
CFPBL	-13.99518	195.8650	195.8650	0.0000
ENPEX	4.468559	19.96802	19.96802	0.0001
ENTAX	1.782214	3.203990	3.203990	0.0001
Note: Carbon Footprint of Bank Loan (CFPBL), Carbon Dioxide Emissions (CO_2E), Environmental Protection Expenditure (ENPEX) Environmental Taxes (ENTAX)				

Source: Authors' estimation from Eviews

Table 7: Stability and residual diagnosis test results

Test	F statistics		Prob.
Heteroskedasticity: ARCH	1.533029	Prob. F(2,47)	0.2265
Breusch-Godfrey Serial Correlation LM	2.022452	Prob. F(2,35)	0.1475
Ramsey RESET Test	2.191029	Prob. F(2, 35)	0.1269

Source: Authors' estimation from Eviews

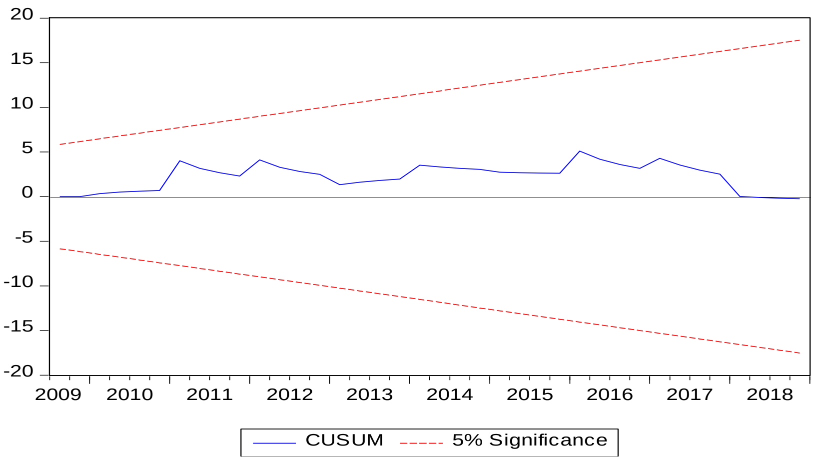
Table 7 reports the model residual diagnostic tests, including autocorrelation, heteroscedasticity and Ramsey RESET. The results of these residual diagnostic tests indicate that the null hypothesis of autocorrelation,

ISSN No. 2321-2705 | DOI: 10.51244/IJRSI |Volume XI Issue VIII August 2024

heteroscedasticity, model stability cannot be rejected. The results show that serial correlation and heteroscedasticity does not exist in the model, indicating stability. The p-values of both serial correlation and Heteroskedasticity Test are 0.1475 and 0.2265 respectively. The Ramsey's RESET prove that the estimated model is free from specification errors and that the model does not suffer from omitted variables, the probability is 0.1269 which exceed 0.05 significant level.

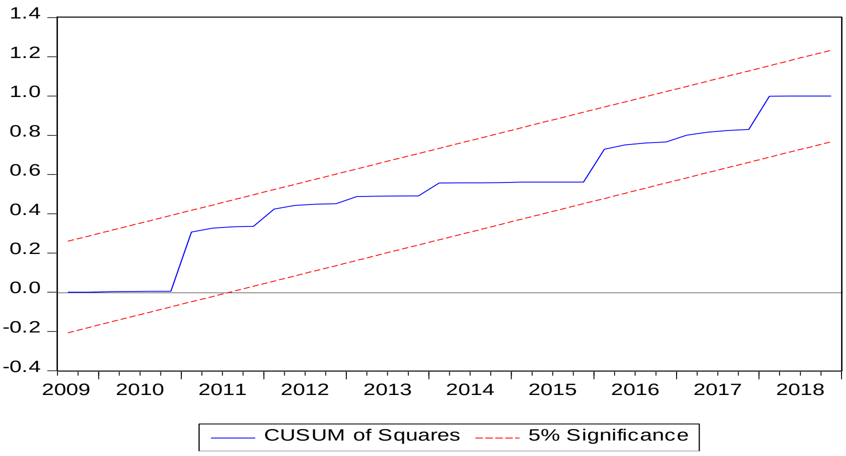
The bases of CUSUM and CUSUM of squares test are the accumulative sum of the recursive residuals and cumulative aggregate residuals squares respectively (Brown et al., 1975). In this option, the accumulative total as well as the cumulative aggregate residuals squares and the five percent crucial lines are presented together. If the accumulative sum as well as cumulative aggregate residuals squares crosses outer the region between the two crucial lines, parameter instability is identified by the test

Figure 4A: Cusum Test Graph Result.



Source: Authors' construction from E-views

Figure 4B: Cusum Test Graph Result.



Source: Authors' construction from E-views

At 0.05 significant, both the test of cumulative sum of the recursive residuals and aggregate residuals squares as seen from figure 4A and B clearly indicate stability in the parameters of the model. From the figures both the cumulative sum and cumulative aggregate residuals squares are in the interior area of the critical lines.

CONCLUSION AND POLICY IMPLICATION

Using the NARDL model and time-series data from 2005 to 2018, this study investigated the dynamic influence of bank loan carbon footprints, environmental protection expenditure, and environmental taxes on

Turkey's carbon emissions in an effort to address the country's climate concerns. The study's findings are shown below.

First, the four variables are linked by cointegration and investigation has indicated that the relationship between the carbon footprint of bank loans, carbon dioxide emissions, environmental protection expenditure, and environmental taxes is longer and more stable. The analysis demonstrates that there is an asymmetric relationship between carbon emissions, environmental protection spending, environmental taxes, and the carbon footprint of bank loans both over the long and short terms.

Second, the study has shown that carbon footprint of bank loans has both short and long-term increasing effect on carbon emissions however, carbon emissions reduces if banks lower their portfolios that promote emissions. Environmental protection expenditure reduces carbon emissions. However, if environmental spending is reduced, carbon emissions is promoted.

Lastly, environmental tax is has a greater impact of reducing carbon emissions in the short and long–term but if environmental levies decrease carbon emission stands significant risk of increment. It has seen also that environmental expenditure reduces carbon emissions than environmental tax in both long and short run.

Based on the empirical analysis the recommendations are made that: in dealing with environmental pollutions in Turkey, carbon footprint of bank loans has demonstrated to promote carbon emissions and major contributor in variation in long run. Therefore the government through the central bank of Turkey should implement laws and regulations to limit banks portfolios that promote carbon emissions and rather fund and promote low-carbon and green projects and initiatives. This will enable them cut its emissions of greenhouse gases by 41% by 2030 as pledged under National Determined Contribution (NDC).

Again, environmental taxes have proven to be an effective mitigating factor as the study has shown, polices and strategies regulating it should be strengthen to achieve even more success in handling environmental pollution. Environmental protection expenditure shown to have significant reduction in carbon emissions, it is recommended that the government, with the support of financial institutions and other nonprofit organization should make effort in spending on environmental protection initiatives to safeguard the environment.

Limitations of Study.

We cannot generalize from this study's analysis of the dynamic effects of environmental taxes, carbon footprint of bank loans, and environmental protection spending on carbon emissions in Turkey to determine whether or not these factors have an impact on carbon dioxide emissions in other nations. We cannot also conclude that environmental taxes, carbon footprint of bank loans, and environmental protection spending are the only factors that influence carbon dioxide emissions as other factors may also have influence on carbon dioxide emissions.

FUNDING

This research received no external funding.

Data Availability Statement

The variables used in this paper are collected from the database of International Monetary Fund (IMF)

Conflicts Of Interest

The authors declare no conflict of interest.

REFERENCES

1. Addai, K., Serener, B., Kirikkaleli, D. Empirical analysis of the relationship among urbanization, economic growth and ecological footprint: Evidence from Eastern Europe. Environ. Sci. Pollut. Res. **2022**, 29, 27749–27760.
2. Adewuyi, A.O. Effects of public and private expenditures on environmental pollution: a dynamic heterogeneous panel data analysis. Renew. Sustain. Energy Rev. **2016**, 65, 489–506. https://doi.org/10.1016/j.rser.2016.06.090.
3. Agyemang, E.T. Are environmental spending and environmental levies beneficial to curbing trade imports' carbon dioxide emissions? cyprus experience. J. Environ. Manage.**2024,** 07, 74-84.
4. Akgiray, V. Conditional Heteroscedasticity in Time Series of Stock Returns: Evidence and Forecasts. The Journal of Business. **1989**, 62(1), 55–80. http://www.jstor.org/stable/2353123.
5. Anderson, T. An introduction to multivariate statistical analysis. 3rd ed. New York: John Wiley.
6. Babatunde K.A., Begum R.A., Said F.F. Application of computable general equilibrium (CGE) to climate change mitigation policy: A systematic review. Renewable and Sustainable Energy Review. **2017**; 78:61–71.
7. Barker T., Kram T., Oberthur S., Voogt M. The role of EU internal policies in implementing greenhouse gas mitigation options to achieve Kyoto targets. International Environmental Agreements. **2001**, 1 (2):243–65. 35.
8. Basoglu, Aykut, and Umut Uzar. An Empirical Evaluation about the Effects of Environmental Expenditures on Environmental Quality in Coordinated Market Economies. Environmental Science and Pollution Research. **2019**, 23108–18. https://doi.org/10.1007/s11356-019- 05567-3
9. Baste, I.A., Watson, R.T. Tackling the climate, biodiversity and pollution emergencies by making peace with nature 50 years after the stockholm conference. Global Environ. Chang **2022**, 73, 102466.
10. Boschi, Melisso. International Financial Contagion: Evidence from the Argentine Crisis of 2001–2002. Applied Financial Economics. **2005**, 15. 153-163. 10.1080/0960310042000306943.
11. Caglar, E. Yavuz, The role of environmental protection expenditures and renewable energy consumption in the context of ecological challenges: insights from the European Union with the novel panel econometric approach, J. Environ. Manage. 331 **2023**, 117317, https://doi.org/10.1016/j.jenvman.2023.117317.
12. Chien, F., Zhang, Y., Li, L. Impact of government governance and environmental taxes on sustainable energy transition in China: fresh evidence using a novel QARDL approach. Environ Sci Pollut Res. **2023**, 30, 48436–48448. https://doi.org/10.1007/s11356-023-25407-9
13. Clough S. Achieving CO2 reductions in Colombia: Effects of carbon taxes and abatement targets. Energy Economics. **2016**, 56:575–86. 42.
14. Elzen, M., Fekete, H., Hohne, N., Admiraal, A., Forsell, N., Hof, A.F., Olivier, J.G.J., Roelfsema, M., Soest, H. Greenhouse gas emissions from current and enhanced policies of China until 2030: canemission speak before 2030? Energy Pol. **2016** 89, 224–236. https://doi.org/10.1016/j.enpol.2015.11.030.
15. Faiella, Ivan, and Luciano Lavecchia. The Carbon Footprint of Italian Loans. Occasional Paper Series **2020**, No. 557, Banca D'Italia.
16. Galinato, G.I., Galinato, S.P. The effects of government spending on deforestation due to agricultural land expansion and CO2 related emissions. Ecol. Econ. **2016**, 122, 43–53. https://doi.org/10.1016/j.ecolecon.2015.10.025.
17. Geddes A, Schmidt TS, Steffen B. The multiple roles of state investment banks in low-carbon energy finance: An analysis of Australia, the UK and Germany. Energy policy. **2018**, 115:158–170
18. Ghazouani, M.B. Jebli, U. Shahzad Environ. Sci. Pollut. Control Ser., 28 (18) (2021), pp. 22758-22767.
19. Guan, Rong, Haitao Zheng, Jie Hu, Qi Fang, and Ren Ruoen. The Higher Carbon Intensity of Loans, the Higher Non-Performing Loan Ratio: The Case of China Sustainability. **2017**, 9(667): 10.3390/su9040667
20. Hammar H., Sjostrom M. Accounting for behavioral effects of increases in the carbon dioxide (CO2) tax in revenue estimation in Sweden. Energy Policy. **2011**, 39(10):6672–6. 33.
21. Hunter, Alex Non-linear Autoregressive Distributed Lag Model Approach and the J-Curve Phenomenon: China and Her Major Trading Partners. Major Themes in Economics, **2019**, 21, 1-13. Available at: https://scholarworks.uni.edu/mtie/vol21/iss1/3

22. International Monetary Fund (IMF), Statistics Department. Government Finance Statistics (GFS) Database **2021**. Available online. https://data.imf.org/?sk=a0867067-d23c-4ebc-ad23-d3b015045405. Accessed on 2023-01-12.
23. Joakim Kulin & Ingemar Johansson Sevä. The Role of Government in Protecting the Environment: Quality of Government and the Translation of Normative Views about Government Responsibility into Spending Preferences. International Journal of Sociology. **2019**, 49:2, 110-129, DOI: 10.1080/00207659.2019.1582964.
24. Kirikkaleli, D., and Adebayo, T. S. Do renewable energy consumption and financial development matter for environmental sustainability? New global evidence. Sustain. Dev. **2021**, 29 (4), 583–594. doi:10.1002/sd.2159
25. Koontz, T.M., Steelman, T.A., Carmin, J., Korfmacher, K.S., Moseley, C., & Thomas, C.W. Collaborative Environmental Management: What Roles for Government. Routledge. **2004** 1 (1st ed.) https://doi.org/10.4324/9781936331185
26. Lin B., Li X. The effect of carbon tax on per capita CO2 emissions. Energy Policy. **2011**, 39(9):5137–46. 40.
27. Lopez, ´ R., Galinato, G.I., Islam, F. Fiscal spending and the environment: theory and empirics. J. Environ. Econ. Manag. **2011**, 62, 180–198. https://doi.org/10.1016/j. jeem.2011.03.001.
28. Lütkepohl, Helmut. Vector autoregressions. Companion to Theoretical Econometrics', Blackwell Companions to Contemporary Economics, Basil Blackwell, Oxford, UK. **2001**, 678-699.
29. Ma, X., Wang, C., Dong, B., Gu, G., Chen, R., Li, Y., Zou, H., Zhang, W., Li, Q. Carbon emissions from energy consumption in China: Its measurement and driving factors. Sci. Total Environ. **2019**, 648, 1411–1420.
30. MacKinnon, J. Critical Values for Cointegration Tests. In: Engle, R. and Granger, C., Eds., Long Run Economic Relationships, Oxford University Press, Oxford. **1991**, 267-276.
31. Martijn A. Boermans, RientsGalema. Are pension funds actively decarbonizing their portfolios? Ecological Economics, **2019**, 161, 50-60, 0921-8009, https://doi.org/10.1016/j.ecolecon.2019.03.008.
32. Meng S., Siriwardana M., McNeill J. The environmental and economic impact of the carbon tax in Australia. Environmental and Resource Economics. **2013**; 54(3):313–32.
33. Mengist, W.; Soromessa, T.; Legese, G. Method for conducting systematic literature review and meta-analysis for environmental science research. MethodsX**2020**, 7, 100777.
34. Micekiene A., Ciuleviciene V., Rauluskeviene J., Streimikiene D. Assessment of the effect of environmental taxes on environmental protection. Ekonomicky´ časopis. **2018**; 66:286–308.
35. Moon, H., & Perron, B. Testing for a Unit Root in Panels with Dynamic Factors. Journal of Econometrics, **2004**, 122,81-126.https://doi.org/10.1016/j.jeconom.2003.10.020.
36. Ntarmah AH, Kong Y, Obeng AF, Gyedu S. The role of bank financing in economic growth and environmental outcomes of sub-Saharan Africa: evidence from novel quantile regression and panel vector autoregressive models. Environ SciPollutRes Int. **2022**, 29, (21):31807-31845. doi: 10.1007/s11356-021-17947-9.
37. Scrimgeour F., Oxley L, Fatai K. Reducing carbon emissions? The relative effectiveness of different types of environmental tax: The case of New Zealand. Environmental Modelling & Software. **2005**, 20 (11):1439–48. 36.
38. Shahbaz, M.; Solarin, S.A.; Mahmood, H.; Arouri, M. Does financial development reduce CO_2 emissions in Malaysian economy? A time series analysis. Econ. Model. **2013**, 35, 145–152.
39. Sims, C.A. Macroeconomics and Reality. Econometrica. **1980**, 48 (1): 1–48
40. Song Chai, Zhicong Zhang, Jianping Ge. Evolution of environmental policy for China's rare earths: Comparing central and local government policies, Resources Policy, **2020**, 68, 101786, 03014207, https://doi.org/10.1016/j.resourpol.2020.101786.
41. Sundar S., Mishra A.K., Naresh R. Effect of environmental tax on carbon dioxide emission: A mathematical model. American Journal of Applied Mathematics and Statistics. **2016**, 4(1):16–23.
42. Tamura H., Nakanishi R., Hatono I., Umano M. Is environmental tax effective for total emission control of carbon dioxide? Systems analysis of an environmental economic model. IFAC Proceedings. **1996**, 29(1):5435–40
43. Turkish Statistical Institute 2023. Available online https://www.aa.com.tr/en/environment/turkiyes-environmental-efforts-in-2023-towards-a-greener-nation/3090804. Accessed on 2023-01-24.

44. Umar Farooq, Bilal Haider Subhani, Muhammad Nouman Shafiq, Seemab Gillani, Assessing the environmental impacts of environmental tax rate and corporate statutory tax rate: Empirical evidence from industry-intensive economies, Energy Reports, **2023**, 6241-6250, ISSN 2352-4847, https://doi.org/10.1016/j.egyr.2023.05.254.
45. UNEP. Climate Action Note report. **2021** https://www.unep.org/explore-topics/ climate-action/what-we-do/climate-action-note/state-of-climate.html
46. Usman, M. and Radulescu, M. Examining the role of nuclear and renewable energy in reducing carbon footprint: does the role of technological innovation really create some difference? Science of The Total Environment, **2022**, 841, p.156662.
47. Xu B, Li S, Afzal A, Mirza N, Zhang M. The impact of financial development on environmental sustainability: A European perspective. Resour Policy, **2022**, 78, 102814.
48. Yang, Qi-Cheng & Feng, Gen-Fu & Chang, Chun-Ping & Wang, Quan-Jing. Environmental protection and performance: A bi-directional assessment. Science of the Total Environment. **2021**,774. 145747. 10.1016/j.scitotenv.2021.145747.
49. Zhang ZK, Guan DB, Wang R, Meng J, Zheng HR, Zhu KF, Embodied carbon emissions in the supply chains of multinational enterprises. Nat Clim Chang **2020**, 10(12): 1096-101.
50. Zhang, J., Patwary, A.K., Sun, H., Raza, M., Taghizadeh-Hesary, F., Iram, R. Measuring energy and environmental efficiency interactions towards CO2 emissions reduction without slowing economic growth in central and western Europe. J. Environ. Manag. **2021**, 279, 111704.